Energy Audit
Magnus Theatre
10 South Algoma Street
Thunder Bay, ON

Prepared for:
Artsbuild Ontario
100 Regina Street S, Suite 325
Waterloo, ON N2J 4P9

Attention: Lindsay MacDonald, Director of Programs

November 14, 2014

Pinchin File: 88911

Pinchin Ltd.
2470 Milltower Court, Mississauga, ON L5N 7W5
www.pinchin.com

Report:	Energy Audit Magnus Theatre, 10 South Algoma Street Thunder Bay, ON
Issued to:	Artsbuild Ontario
Contact:	Lindsay MacDonald, Director of Programs
Issued on:	November 14, 2014
Pinchin File:	88911

Author:
Primary Contact

Kevin Potts, B.Eng.Mgt, LEED GA
Project Manager
1-289-971-0932
kpotts@pinchin.com

Reviewer:
Primary Contact

Bryn Jones, M.A.Sc., P. Eng.
Director & National Practice Lead
1-416-804-5153
bjones@pinchin.com

EXECUTIVE SUMMARY

Pinchin Ltd. (Pinchin) was retained by Artsbuild Ontario to conduct an energy audit at the Magnus Theatre located at 10 South Algoma Street Thunder Bay, ON.

The purpose of the energy audits is to maximize available funds across the best energy reduction measures. To achieve the greatest emissions reduction, the Client would like to implement a series of energy reduction measures (ERMs) while improving the occupant comfort of staff and guests.

This report provides an analysis of historical energy data at the Magnus Theatre located at 10 South Algoma Street, ON to determine the effects of weather and any billing abnormalities. Energy consumption data is summarized by end use and includes lighting, heating, cooling, ventilation and plug load. Energy reduction measures for the subject building are summarized based on the information gathered during the audit.

TABLE OF CONTENTS

APPENDICES

TABLES

FIGURES

1.0 BUILDING DESCRIPTION

The site building is a leased space located at **50 Fultz Blvd. Winnipeg, MB.** Table 1 provides a summary of the building use and construction.

Table 1: Building Characteristics

Building Age	130 years (original building) 13 years (north addition)
Ownership Status	Owned
Utility Data	Thunder Bay Hydro & Union Gas (provided in Appendix I)
Gross Floor Area	29,000 ft^2 (2,694 m^2)
Building Type	Multi-use (office space, classrooms, performing arts theatre & workshop)
Occupied Hours	8:30 am to 5:00 pm Monday to Friday
Regular Occupancy	Approximately 8 people
Roof System	Sloped shingle roof (original building) Flat membrane roof (north addition)
Wall System	Brick masonry (original building) Durisol Block (north addition)
Windows	Double hung single pane (original building) Insulated glass (north addition)

1.1 Space Use Analysis

The original building consists of administrative offices on the ground floor, rehearsal rooms on the second floor and a basement storage area. The new addition is a purpose built performance arts theatre including a large production shop. The Table 2 below summarizes the areas and hours of operation for each space. In addition to weekly hours of operation, the Site Building has seasonal hours in which the purpose built theatre is occupied and unoccupied.

Table 2: Site Building operating schedule

Site Building Area	Weekly Operating Hours	Seasonal Schedule	Total Hours per Week	Total Hours per Year
Administrative Offices	Mon - Fri 9 am - 6 pm	52 weeks per year	45	2,340
Box Office	Sat - Sun 9:30 am - 4 pm	Sept-May	13	507
Rehearsal Studios	Mon - Fri 10 am - 6 pm	Aug-April	40	1,560
Production Shop	Mon - Fri 9 am -5 pm	Aug-April	40	1,560
Theatre	Mon - Sat 8 pm - 11 pm Wed, Sat 2 pm - 5 pm	Aug-April	22	858

1.2 Building Operator Interview Results

During the audit, Pinchin sat down with the Technical Manager Daniel Diamond to discuss the current operation strategy of the Site Building and to note any known deficiencies in the building's performance.

Location	System	Deficiency
Original Building (1st & 2nd Floors)	HVAC	Inability to control room temperature (zone control is limited)
Original Building (Basement)	Building Envelope	The basement is noted as being cold and damp and prone to leaks on the west elevation
Original Building (South Elevation)	Building Envelope	Ice buildup leads to water infiltration
Original Building	Entrance Doors	Air infiltration around doors
North Addition	Building Envelope	Systematic failure of Durisol block exterior material
North Addition (Production Shop)	Overhead Door	Air infiltration around doors (additional door cover installed)
Original Building	Roof	Ice buildup on the northwest corner leads to water infiltration

2.0 HISTORICAL DATA ANALYSIS

2.1 Utility Data Summary

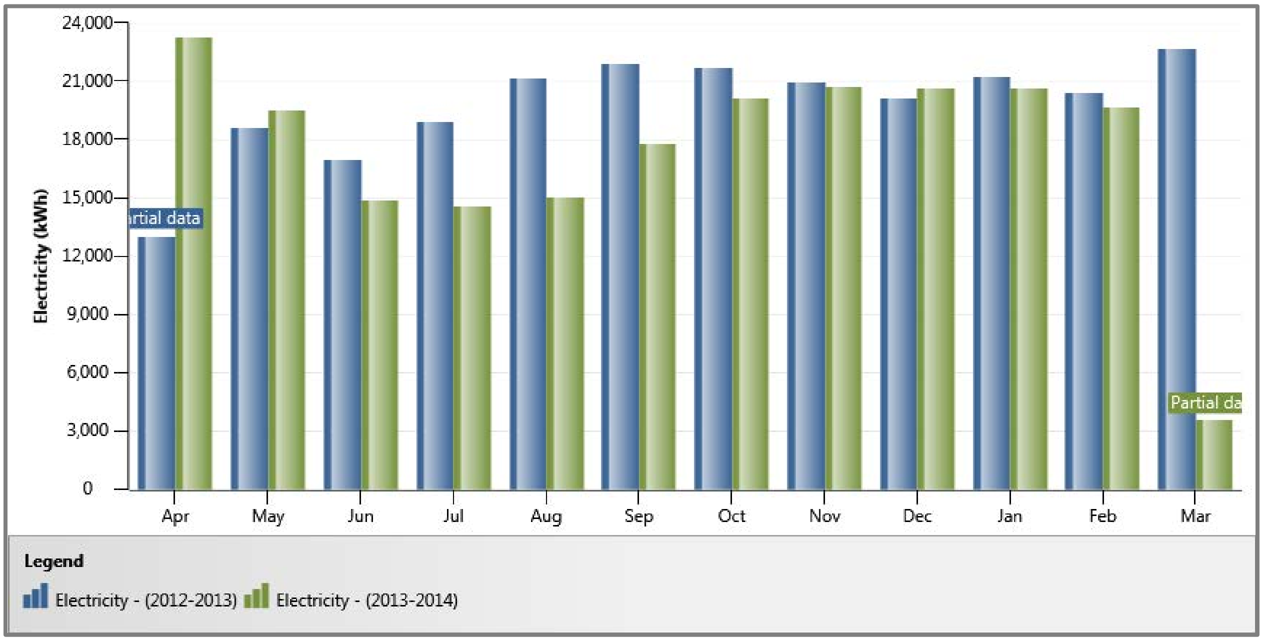
Monthly electricity invoices from Thunder Bay Hydro were provided from April 11, 2012 to March 5, 2014 excluding the period between May 10, 2012 and June 11, 2012. Monthly natural gas invoices from Union Gas were provided from May 10, 2012 to April 7, 2014. A full summary of the utility data provided is available in Appendix I.

The monthly electricity use is displayed in Figure 1 below for the 2012-2013 and 2013-2014 years. It is interesting to note that electricity use was lowest in the period from June 2013 to August 2013. Typically electricity consumption is at its peak in the summer when air conditioning equipment is enabled. Given the schedule of the theatre, it is Pinchin's belief that during the period from June-August 2013 the theatre was operating at a reduced occupancy compared to the same period June-August 2012.

Natural gas is used on site for space heating via the steam boiler and radiant heat system, air handling units with indirect fired gas furnace modules and the domestic hot water heaters.

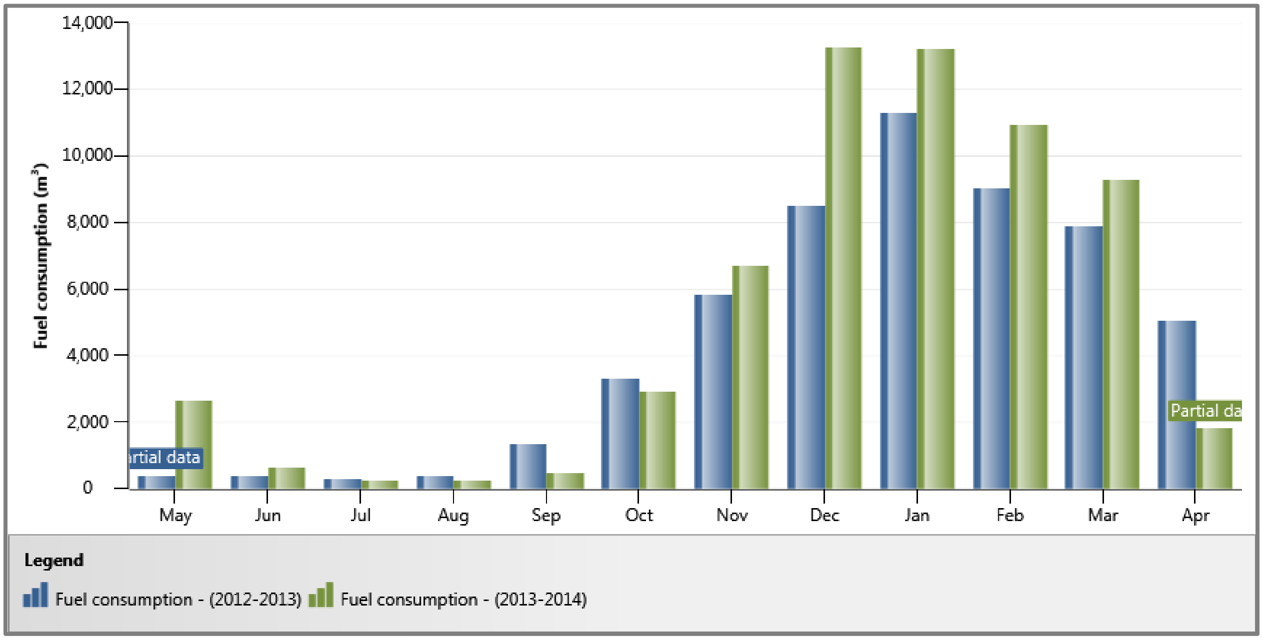
Figure 2 highlights the seasonality of natural gas use on the site. The peak in usage from October to April is assumed to be for space heating purposes while the summer baseline of 300 m^3 is assumed to be used by the domestic hot water system.

Figure 1: Monthly Electricity Consumption (kWh)[1]



[1] Partial data exists on the first and last data entry since the billing cycle ends on the 9th of each month (first entry April 2013 data consists of April 11th to April 30th and last entry March 2014 data consists of May 1st to March 5th).

Figure 2: Natural gas consumption (m3)



2.2 Utility Bill Analysis

To determine the effects of weather, two regression analyses were performed using:

i) Natural gas consumption and heating degree days (HDD); and

ii) Electricity consumption and cooling degree days (CDD).

The first analysis looked at the relationship between electricity consumption and cooling degree days.[2] The results in Figure 3

show a very strong linear relationsphip between outdoor temperature and electricity consumption which indicates the site relies on electric baseboard heating significantly in the winter months.

[2] A heating degree day is calculated by taking the daily average temperature and subtracting 16°. If the average outdoor temperature is 5°C, the corresponding HDD would be 16°C - 5°C = 11°C.

Figure 3: Natural Gas and Heating Degree Day Regression Analysis

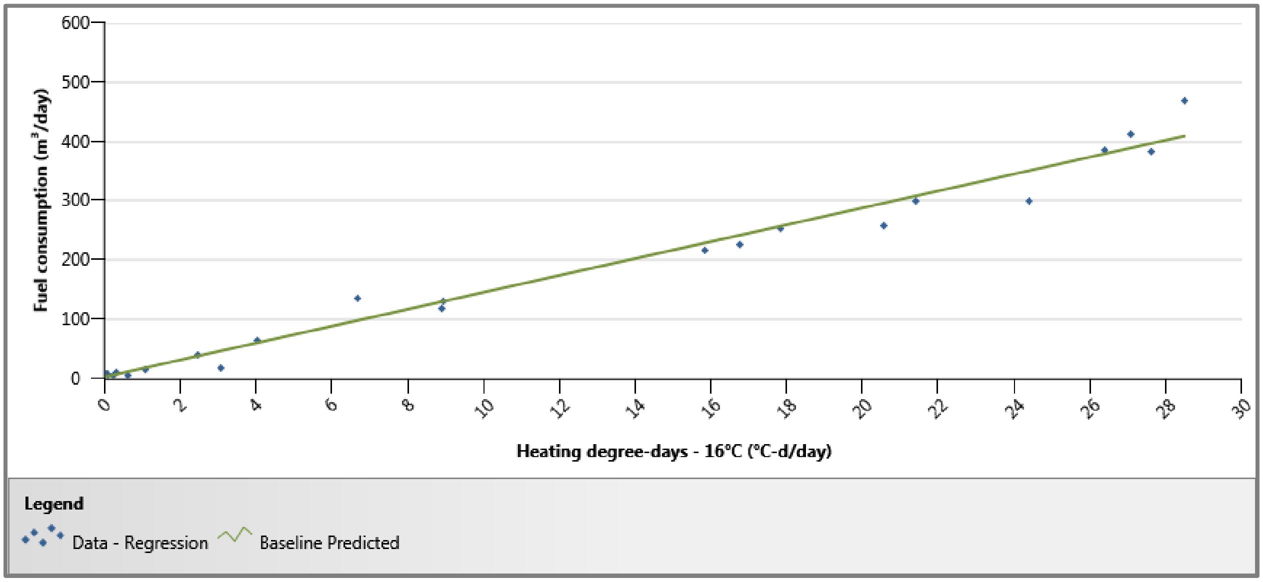


Figure 4: Natural Gas Consumption and Heating Degree Days

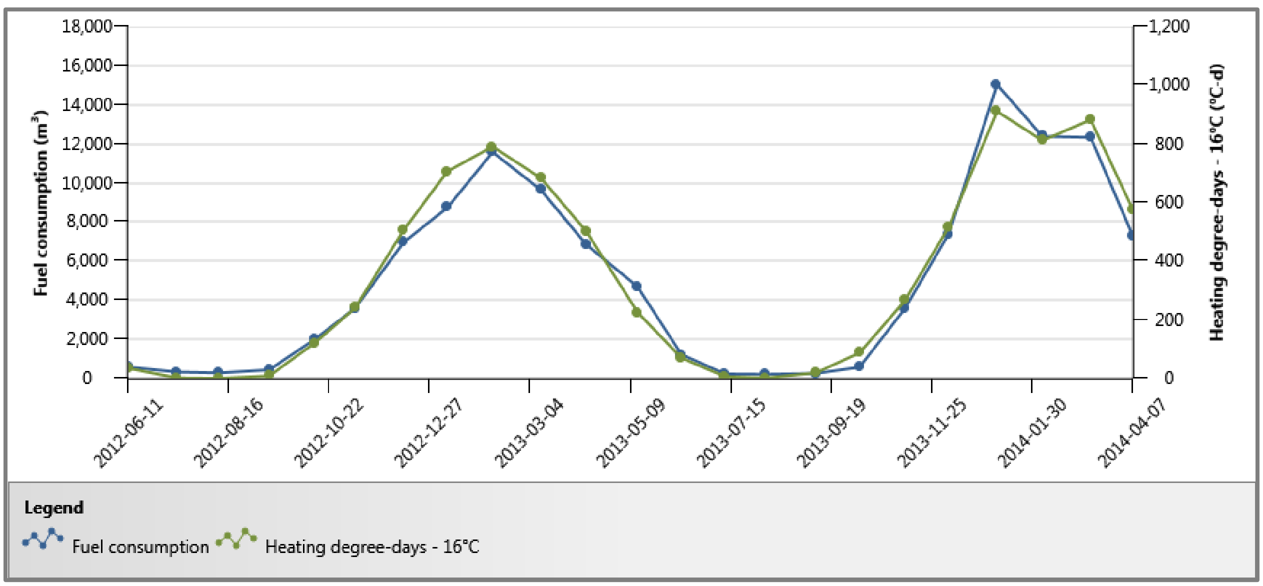


Figure 4 shows on a monthly basis the relationship between electricity consumption and HDDs.

The regression analysis for electricity and cooling degree days indicates that cooling is not a significant source of electricity use and is marginal in comparison to the heating electricity use.

Figure 5: Electricity and Cooling Degree Day Regression Analysis

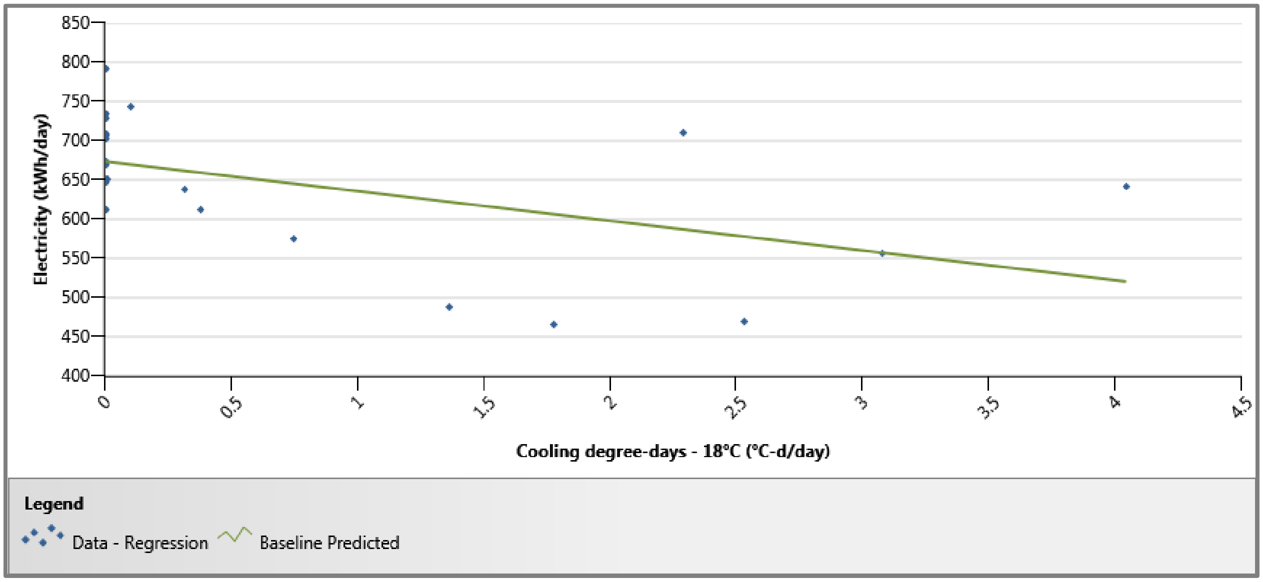


Figure 6: Natural Gas Consumption and Heating Degree Days

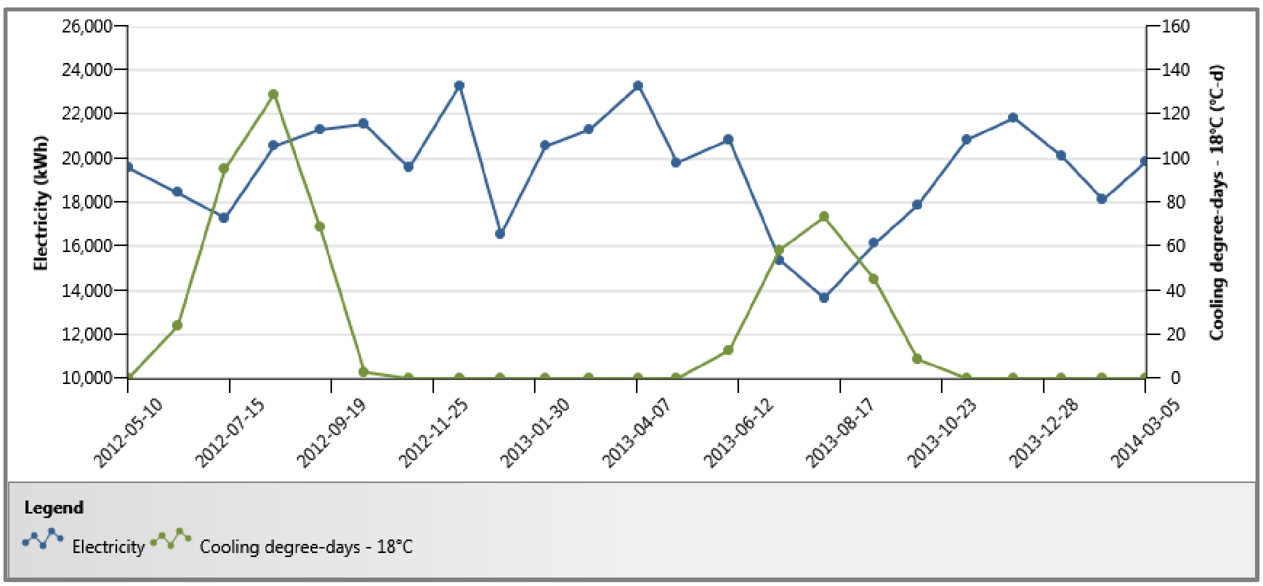
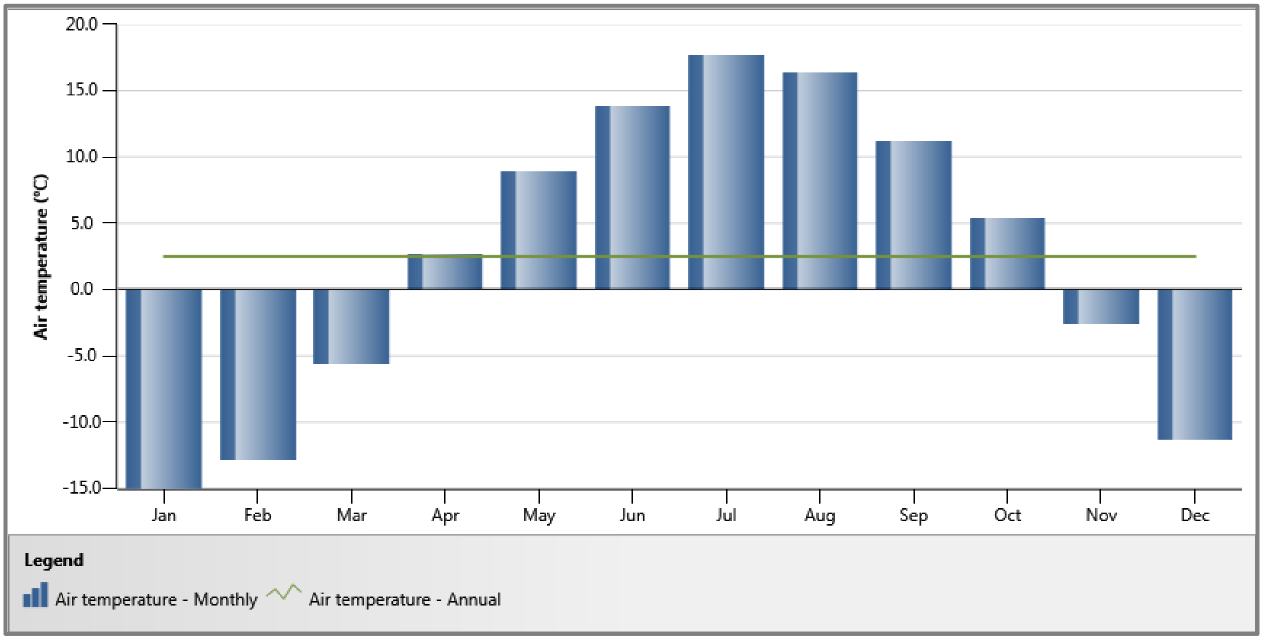


Figure 6 shows the relationship between natural gas consumption and heating degree days. The strong linear relationship indicates that outdoor air temperature is the strongest influence on gas consumption for the site. In the Thunder Bay ON climate, average daily temperatures are never above 18 degrees Celsius, peaking at 17.7°C in July as shown in Figure 7.

Figure 7: Climate Data for the Thunder Bay ON



2.3 Energy Star Score

Energy Star Portfolio Manager[3] is an online tool that allows property owners and facility managers to determine their building's performance in comparison to a larger population[4] of buildings. Data which includes space use, energy consumption and building characteristics is input into Portfolio Manager and the energy intensity per square meter is computed with comparable benchmarks. Table 2 below lists the portfolio manager results for this building.

[3] http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

[4] The analysis for offices in Canada is based on data from the Survey on Commercial and Institutional Energy Use (SCIEU), which was commissioned by Natural Resources Canada (NRCan) and carried out by Statistics Canada.
Source: http://www.energystar.gov/buildings/tools-and-resources/energy-star-score-offices-canada

Table 3: Energy Star Portfolio Manager Results

Energy Star Results	Baseline (Apr 2013)	Current (Feb 2014)	Median Property*
ENERGY STAR score (1-100)	Not Available	Not Available	50
Source EUI (GJ/m^2)	1.46	1.46	1.3
Site EUI (GJ/m^2)	1.10	1.22	1.02
Source Energy Use (GJ)	3,935	4,205	3,504
Site Energy Use (GJ)	2,956	3,289	2,740
Energy Cost ($)	Not Available	Not Available	Not Available
Total GHG Emissions (MtCO2e)	131	149	124

3.0 ENERGY USE BREAKDOWN

Electricity and natural gas are the primary sources of energy on site. Table 3 summarizes the total energy consumption by source.

Table 4: Summary of annual energy use by source and by category

Category	Electricity (kWh)	Natural Gas (kWh)
Domestic Hot Water	0	25,300
HVAC	87,900	622,200
Lighting	60,700	0
Plug Load	86,200	0
Grand Total	**234,800**	**647,500**

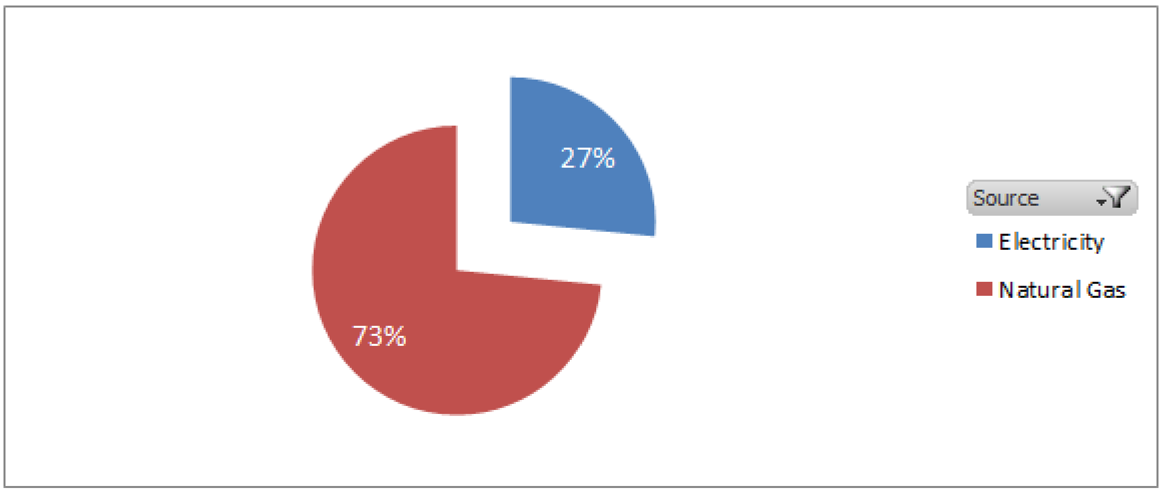


Figure 8: Breakdown of energy use on site by source

3.1 Electricity Breakdown

Electricity use on site is broken down into three main categories; HVAC, Lighting & Plug Load.

In this analysis, lighting only contains lights used to illuminate the building areas and does not include lights specific to the performing art shows.

The primary consumer of HVAC electricity are electric motors used to move air in the air handling units (AHU) and exhaust fans as well as the electric motors that power the air conditioning system via the compressors in the rooftop condensing units.

Plug load includes all electricity using devises that enable the building occupants to perform their primary business function.

Table 5: Summary of HVAC electricity consumption by end use item

HVAC Item	Electricity (kWh)
AHU-1 Compressor & Condensing Unit	23,200
AHU-1 (Theatre)	20,500
AHU-3 Compressor & Condensing Unit	16,400
AHU-3 (Administration & Rehearsal)	9,800
AHU-2 (Stage)	5,900
Mini-Split System	5,900
Electric Baseboard Heaters	4,000
EF-3 (washroom exhaust)	800
EF-5 (Janitor room exhaust)	800
EF-6 (Electrical room exhaust)	400
EF-9 (Control room exhaust)	200
Grand Total	**87,900**

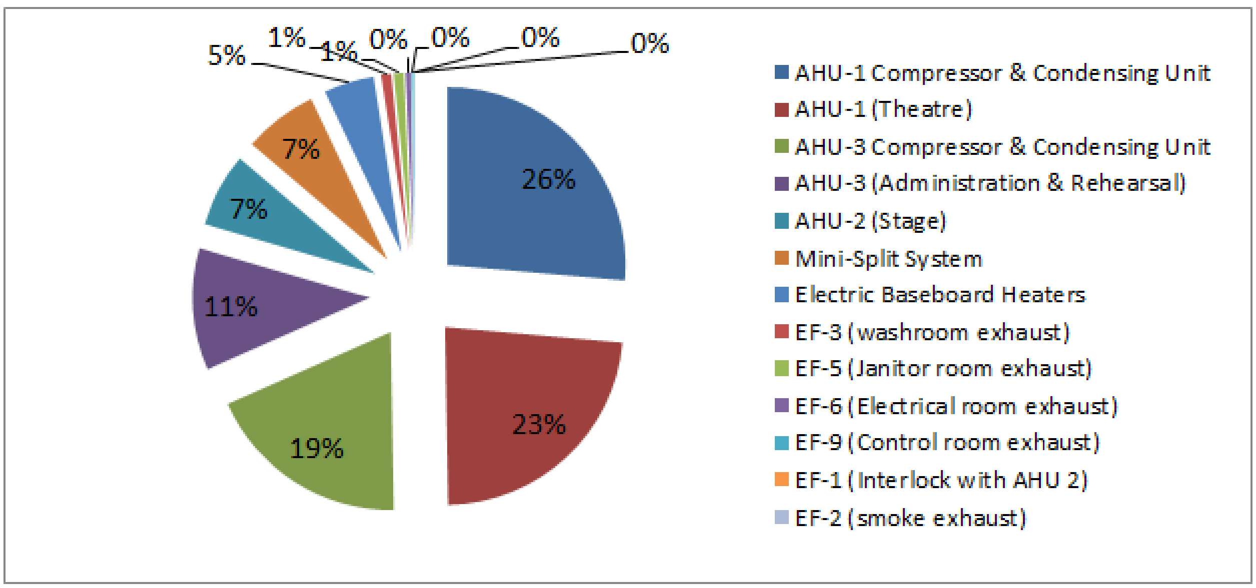


Figure 9: Breakdown of HVAC electricity use on site

Table 6: Summary of lighting electricity consumption by end use item

Lighting Item	Electricity (kWh)
Exterior Flood Lights	29,800
T8 Flourescent Tube (2 lamp fixture)	13,200
T12 Flourescent Tube (2 lamp fixture)	11,200
Emergency Lighting & Exit Signs	2,600
T12 Flourescent Tube (4 lamp fixture)	1,900
Incandescant Mirror Lights	1,200
CFL Pot Lights	800
Grand Total	**60,700**

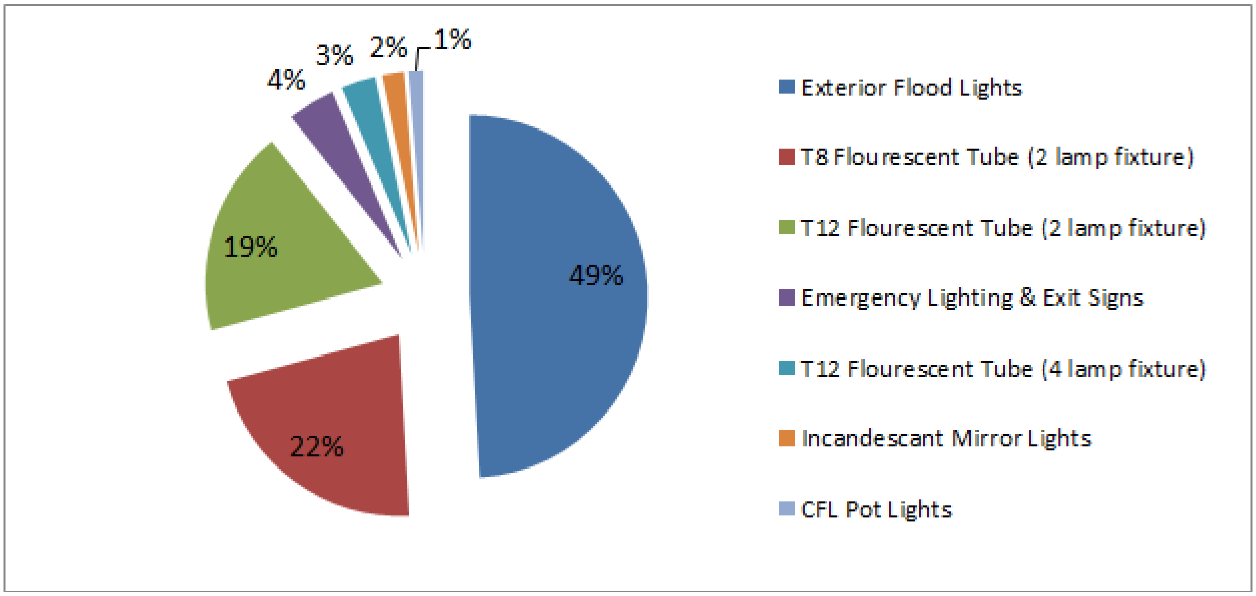


Figure 10: Breakdown of lighting electricity use on site

Table 7: Summary of plug load electricity consumption by end use item

Plug Load Item	Electricity (kWh)
Lighting Equipment	65,900
Desktop Computers	7,800
Motorized Rigging Equipment	3,400
Computer Monitors	3,100
Refrigerator	2,600
Audio Equipment	2,100
Production Shop Tools	700
Microwave	400
Clothes Washing Machine	100
Clothes Drying Machine	100
Grand Total	**86,200**

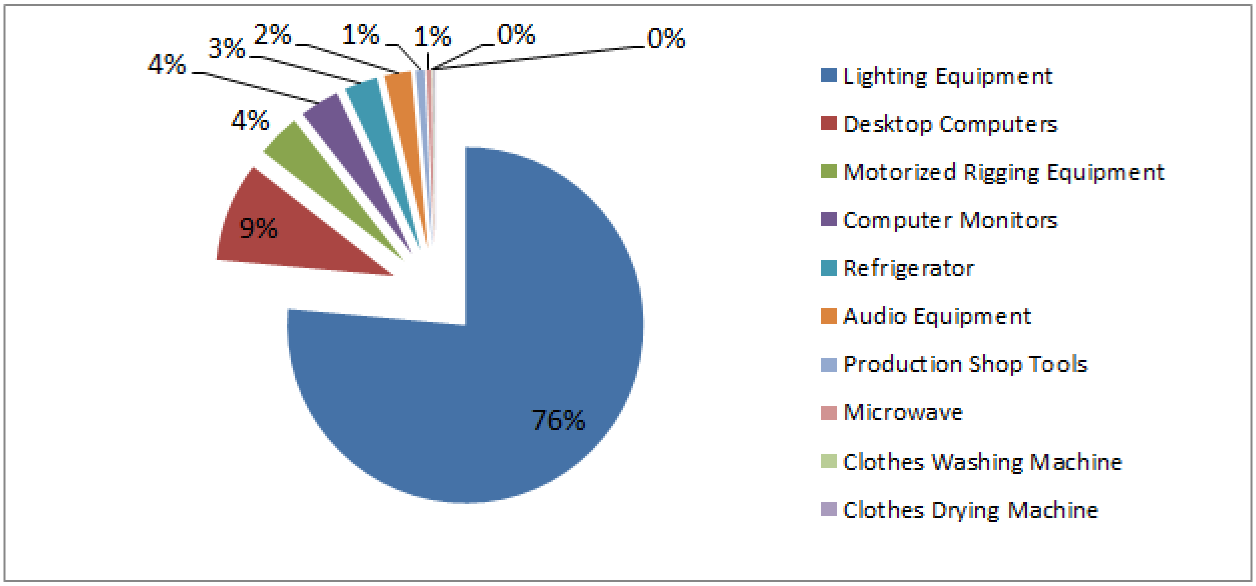


Figure 11: Breakdown of plug load electricity use on site.

3.2 Natural Gas Consumption Analysis

Natural gas is used on site to provide space heating and to heat domestic hot water. Table 8 below summarizes the end use of natural gas on site.

Table 8: Summary of natural gas use by category and item

Category & Items	Natural Gas (kWh)
HVAC Total	**622,200**
Sunnyday 402 Steam Boiler	267,800
AHU-1 (Theatre)	177,200
AHU-3 (Administration & Rehearsal)	103,400
AHU-2 (Stage)	44,300
Unit Heaters	29,500
Domestic Hot Water Total	**25,300**
RUUD CL-60-60T	25,300
Grand Total	**647,500**

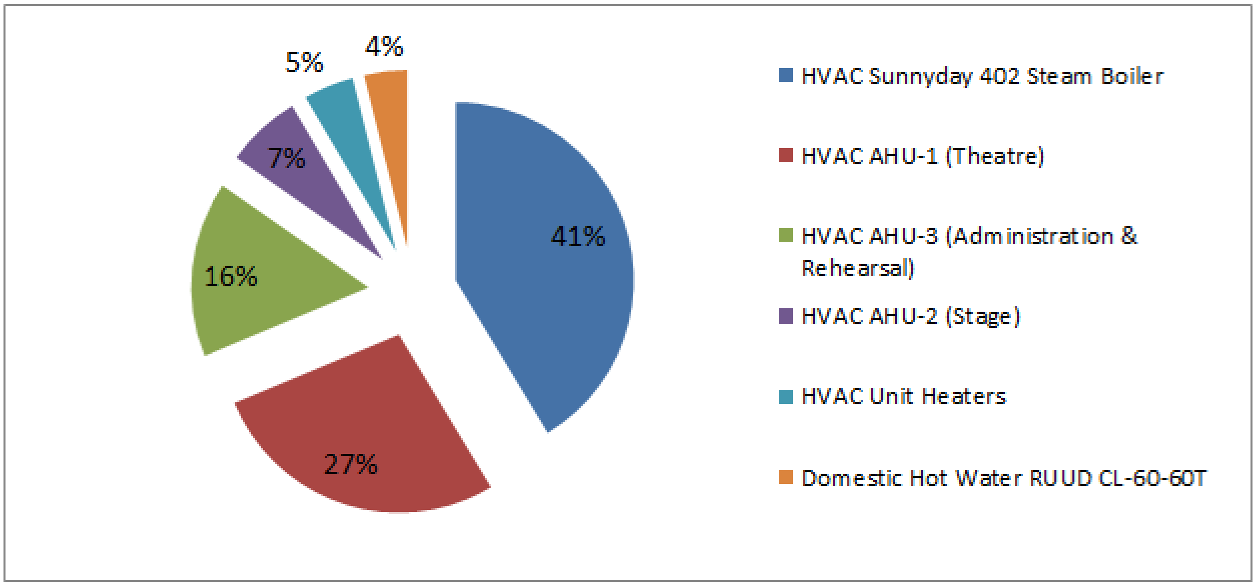


Figure 12: Breakdown of natural gas use on site

4.0 ENERGY USING SYSTEMS

4.1 Heating Ventilation & Air Conditioning (HVAC)

HVAC systems ensure occupants are comfortable in the building. Space heating is available for the entire building however space cooling is limited to the theatre seating area and lounge.

4.1.1 AHU -1 & Condensing Unit 1

AHU-1 is located in the second floor mechanical room and provides heating, cooling and ventilation air to the theatre seating area. The following points describe AHU-1:

- Supplies 6,000 CFM (constant volume) to the theatre seating area.
- Powered by a 7.5 HP supply fan motor and 3 HP return fan motor.
- Heating provided by 600,000 BTU/hr indirect fired natural gas furnace.
- Cooling provided by Condensing Unit 1 located on the roof which is equipped with three (3) Trane 7.25 ton compressors for a total cooling capacity of approximately 22 tons (260,000 BTU/hr).

4.1.2 AHU-2

AHU-2 is located is suspended from the ceiling in the production shop and provides heating and ventilation air to the theatre stage area. The following points describe AHU-2:

- Supplies 2,600 CFM (constant volume) to the theatre stage area.
- Powered by a 3 HP supply fan motor (no return fan).
- Heating provided by 150,000 BTU/hr indirect fired natural gas furnace.

4.1.3 AHU-3 & Condensing Unit 3

AHU-3 is located in the second floor mechanical room and provides heating, cooling and ventilation air to the theatre lobby area. The following points describe AHU-3:

- Supplies 4,600 (constant volume) CFM to the theatre lobby area.
- Powered by a 5 HP supply fan motor (no return fan).
- Heating provided by 350,000 BTU/hr indirect fired natural gas furnace.
- Cooling provided by Condensing Unit 3 located on the roof which is equipped with two (2) Trane 7.25 ton compressors for a total cooling capacity of approximately 15 tons (180,000 BTU/hr).

4.1.4 Hydronic Radiant Heating System

The hydronic radiant heating system provides space heating to the administrative offices, basement storage rooms and second floor rehearsal rooms in the original building. The following points describe the hydronic system and its components:

- Sunnyday 402 Steam Boiler with a gas input capacity of 2,040,000 BTU/hr provides the heat for the system.
- Baseboard radiant heaters with control valves connected to a combination of digital and analog thermostats provide space heating.

4.1.5 Exhaust Fans

Exhaust fans provide a number of functions for the Site Building including removing contaminated air from bathrooms, providing heat relief in electrical rooms and providing pressure relief in the theatre spaces. The following list summarizes the exhaust fans on site and the area they serve:

- EF-1, located on the roof of the fly tower and is interlocked with AHU-2 to provide pressure relief.
- EF-2, located on the roof of the fly tower and is connected to the fire panel to provide smoke removal in a fire situation.
- EF-3, located on the roof of the original building and serves the washrooms to ensure air doesn’t migrate from the washrooms to the common corridors.
- EF-5, located in the production shop and serves the janitor closet to ensure air doesn’t migrate from the closet to the shop.
- EF-6, located in the electrical room and is enabled by a thermostat to remove air when a temperature setpoint is reached.
- EF-9, located in the theatre control room and is enabled by a thermostat to remove air when a temperature setpoint is reached.

4.1.6 Unit Heaters

There are two indirect fired natural gas unit heaters suspended from the ceiling in the production shop. These units provide space heating for the production shop and are controlled by analog thermostats located in the production shop.

4.1.7 Electric Baseboard Heaters

There are a handful, less than 5, electric baseboard heaters located in the basement lounge. This area is used by performers while not on stage.

4.1.8 Mini-Split AC Unit

There is one mini-split AC unit located in the theatre electrical room. This unit consists of an evaporator with fan located in the electrical room and an outdoor unit with a compressor and condenser. The unit is controlled by a digital thermostat located in the electrical room.

4.2 Lighting (Building)

4.2.1 T12 Fluorescent Lights

The primary source of lighting observed during the walkthrough was 34W T12 fluorescent tube fixtures with magnetic ballasts. Areas served by this lighting include all second floor rehearsal and storage rooms as well as all ground floor administrative areas.

It was observed that some fixtures, approximately 1 out of 10, had 32W T8 lamps rather than 34W T12 lamps. Pinchin has accountant for this measure in its assessment.

4.2.2 CFL Recessed Pot Lights

CFL recessed pot lights are the primary lighting fixtures used to illuminate the hallways and theatre lounge in the North Addition.

4.2.3 T8 Fluorescent Lights

T8 fluorescent lights are the primary lighting fixture used to illuminate all production areas of the North Addition including the production shop, fly tower and stage area.

4.3 Plug Loads

4.3.1 Production Lighting & Sound Equipment

Production lighting and sound equipment are primary elements of the performing art shows. The amount of lighting used in any given production is variable making the energy consumption from plug loads difficult to quantify. Pinchin has taken the maximum amperage from the lighting panels and sound panels and described this as the upper limit of electricity consumption for production equipment. Pinchin then assumed that 80% of the lighting is used for any given show. Sound equipment is assumed to operate at 60% load for any given show.

The efficiency of each piece of lighting and sound equipment was not analyzed in this assessment because the operating characteristics are prioritized over the power consumption. A specific light will be chosen because it offers the correct output and hue rather than its power consumption relative to another lamp with different output characteristics.

4.3.2 Office Equipment

Office equipment includes desktop computers, monitors and printers. During the assessment Pinchin observed each desk space for the type of computer (desktop or laptop) and the number of monitors.

4.3.3 Miscellaneous Production Equipment

Miscellaneous production equipment includes the power tools used in the production shop and the motorized rigging used to raise and lower production backdrops. These items are used sporadically which makes the allocation of energy use difficult for these systems. Pinchin has assumed that motorized rigging operates for 20 minutes per show and that one production shop power tool is operating for 4 hours per day during the theatre season.

4.3.4 Miscellaneous Appliances

There are several appliances located in the Site Building including refrigerators, microwaves and coffee machines. Pinchin counted the quantity and type of each appliance for the assessment.

4.4 Domestic Hot Water

Domestic hot water is provided by one Ruud CL-60-60T natural gas fired water heater with an input capacity of 95,000 BTU/hr. Domestic hot water is used on site for hand washing, production shop equipment cleaning and performing artist showers. The amount of energy used by the domestic hot water system is proportional to the number of shows and customers the theatre has.

5.0 ENERGY CONSERVATION MEASURES

After visiting the site and reviewing the information there are several initiatives that Magnus Theatre can take to save energy. These measures are presented in the following sections.

5.1 T12 Lighting Upgrade

Existing System: The primary method of lighting in the original building is fluorescent tube lighting with 34W T12 lamps with magnetic ballasts.

Recommendation: Pinchin recommends converting the existing lighting to 25W T8 fluorescent tube lighting with electronic ballasts.

Implement	Demand Reduction (kW)	Annual Energy Savings (kWh)	Annual Savings ($)	System Cost	Incentives Available ($)	Payback With Incentives
Immediately	3.4	6,095	914	6300	1462	5
Incentive Details	New or Retrofit Fixtures: Re-lamp and re-ballast or new fixtures with Consortium for Energy Efficiency listed High Performance T8 lamps and electronic ballasts. Lamps and electronic ballast must comply with Consortium for Energy Efficiency qualifying list 1. For the replacement of T12 lamps and ballast with T8 lamps using electronic ballasts.					

5.2 Original Building Attic Insulation

Existing System: The existing insulation system in the original building attic space is loose batt insulation approximately 4” thick. During the site visit Pinchin observed areas in the attic floor (where the insulation is located) that were uncovered with clear views of the second floor.

Recommendation: Pinchin recommends removing and disposing of the existing insulation. While the insulation is removed, holes and gaps between the second floor and attic should be sealed. New insulation should strive to achieve an R-value of 49 or higher. This corresponds to approximately 14” of loose cellulose insulation, 15” of fibreglass batt insulation or 20” of loose fibreglass insulation.

Implement	Demand Reduction (kW)	Annual Energy Savings (kWh)	Annual Savings ($)	System Cost ($)	Incentives Available ($)	Payback With Incentives
After all immediate ECM have been implemented	4.5	16,000	300	7,500	0	25

5.3 Domestic Hot Water Conversion

Existing System: The existing domestic hot water heater is a 95,000 BTU/hr natural gas fired heater with a capacity of 80 US Gallons with a thermal efficiency of approximately 80% and a system efficiency of approximately 60%.

Recommendation: Pinchin recommends upgrading the DHW heater and storage tank to a condensing model with thermal efficiencies approaching 97% and a system efficiency of 86%

Implement	Demand Reduction (kW)	Annual Energy Savings (kWh)	Annual Savings ($)	System Cost ($)	Incentives Available ($)	Payback With Incentives (years)
After all immediate ECM have been implemented	0.0	7,600	140	2500	800	12
Incentive Details	Union Gas - $600 per unit up to 299 MBtu/hr, plus $200 bonus incentive					

5.4 Original Building Window Replacement

Existing System: The original building windows are double hung single pane windows that have reached the end of their expected useful life. Double hung single pane windows have a R-Value of approximately 2.

Recommendation: Replace all existing windows with triple pane low e coating windows with a R-Value of approximately 7.5

Implement	Demand Reduction (kW)	Annual Energy Savings (kWh)	Annual Savings ($)	System Cost ($)	Incentives Available ($)	Payback With Incentives (years)
After all immediate ECM have been implemented	1.4	5,000	100	20000	0	200

5.5 Weather Seal All Exterior Doors

Existing System: The existing exterior doors have significant air infiltration problems according to the site representatives. When cold outdoor air infiltrates an indoor space, that air must be heated from the outdoor temperature to the indoor temperature. This adds to the head demand of the building and uses additional natural gas to heat the theatre.

Recommendation: Pinchin recommends weather proofing all doors as part of a fall maintenance procedure.

Implement	Demand Reduction (kW)	Annual Energy Savings (kWh)	Annual Savings ($)	System Cost ($)	Incentives Available ($)	Payback With Incentives (years)
After all immediate ECM have been implemented	3.8	14,000	300	300	0	1
Incentive Details	Currently no incentives available for weather proofing doors					

5.6 Replace Air Filters on AHU's

Existing System: During the site visit Pinchin observed air filters that were dirty and need replacing. Dirty filters add to the static pressure loss in air systems which have a negative impact on fan performance.

Recommendation: Pinchin recommends inspecting the filters on a quarterly basis and changing the filters when they become dirty.

Implement	Demand Reduction (kW)	Annual Energy Savings (kWh)	Annual Savings ($)	System Cost	Incentives Available ($)	Payback With Incentives (years)
Immediately	3.0	8,600	1,300	100	0	0.08

6.0 AREAS REQUIRING FURTHER STUDY

6.1 AHU-1 Supply Air System Modifications

The current supply air system does not provide adequate heating for the theatre guests. The supply air diffusers are located in the ceiling space above the audience likely leading to stratification of the supply air. Unfortunately this limits the supply air's ability to reach the ground level where it is required to provide heating. Alternatives may include ducting the supply air to the ground level, adding hydronic radiant heating along the perimeter of the theatre or installing in-floor radiant heating below the theatre seating area.

A full investigation by a HVAC consulting firm is required to determine the available options to adequately distribute the heat in the theatre seating area.

6.2 Original Building Attic Ventilation

It was noted during the site visit that the building suffers from ice buildup on the sloped shingle roof in the winter. The most likely cause of this is warm humid air migrating from the second floor to the attic space and subsequently escaping the attic space and freezing on the roof. Adding a power exhaust fan that is controlled by a thermostat and humidistat will increase the airflow through the attic space, reducing the likelihood of humid air condensing and freezing on the shingles.

6.3 Exterior Repairs to Durisol Block Wall

During the site visit the exterior coating on the Durisol Block Wall on the new addition was observed to be systematically failing. Larger portions of the coating were losing adhesiveness and falling off the block wall.

A full investigation by an architect or building scientist is required to determine the exact cause of the premature failure.

6.4 Theatre Stage Area Cooling

AHU-2 which serves the stage area only provides ventilation air and heating. It was noted during the site visit that the stage areas can become uncomfortably warm during a performing art show. Adding a direct exchange cooling system, similar to the systems on AHU-1 and AHU-3 may help but likely won't provide sufficient cooling for the stage area since the maximum amount of cooing the 2,600 CFM AHU can provide is 6.5 tons of cooling.

A full investigation by a HVAC consulting firm is required to determine the actual cooling demand of the stage area to properly size a new cooling system.

6.5 Electrical Power Factor

The Site's power factor is provided monthly in the Thunder Bay Hydro invoice and is observed to be consistently around 75% and is recorded to be as low as 67% in July 2012. Ideally the power factor should not be lower than 95% to ensure the electrical power delivered is doing useful work. Correcting the power factor will also reduce the "non-completive charges" including Network Transmission, Conn Transmission and Distribution Charge on the Thunder Bay Hydro invoice. These charges are calculated at 90% of the measured kVa (improving power factor will reduce the measured kVa).

A full investigation by an electrical engineer is required to determine the size and feasibility of installing power factor correction controllers to the Site's existing electrical infrastructure.

APPENDIX I
Utility Bill Data

Table 9: Summary of Thunder Bay Hydro invoices.

Start Date	Invoice Data	Consumption (kWh)
4/11/2012	5/10/2012	19,559
5/10/2012	6/11/2012	18,430
6/11/2012	7/12/2012	17,302
7/12/2012	8/13/2012	20,562
8/13/2012	9/12/2012	21,314
9/12/2012	10/11/2012	21,565
10/11/2012	11/9/2012	19,559
11/9/2012	12/12/2012	23,319
12/12/2012	1/8/2013	16,549
1/8/2013	2/6/2013	20,562
2/6/2013	3/7/2013	21,314
3/7/2013	4/8/2013	23,319
4/8/2013	5/3/2013	19,809
5/3/2013	6/6/2013	20,849
6/6/2013	7/9/2013	15,388
7/9/2013	8/7/2013	13,651
8/7/2013	9/9/2013	16,133
9/9/2013	10/7/2013	17,871
10/7/2013	11/8/2013	20,849
11/8/2013	12/9/2013	21,842
12/9/2013	1/9/2014	20,105
1/9/2014	2/5/2014	18,119
2/5/2014	3/5/2014	19,857

Table 10: Summary of Union Gas invoices.

Start Date	Invoice Data	Consumption (m^3)
5/10/2012	6/11/2012	581
6/11/2012	7/13/2012	330
7/13/2012	8/10/2012	283
8/10/2012	9/12/2012	440
9/12/2012	10/12/2012	1,989
10/12/2012	11/8/2012	3,595
11/8/2012	12/10/2012	6,957
12/10/2012	1/8/2013	8,741
1/8/2013	2/7/2013	11,573
2/7/2013	3/11/2013	9,640
3/11/2013	4/10/2013	6,847
4/10/2013	5/14/2013	4,688
5/14/2013	6/12/2013	1,225
6/12/2013	7/11/2013	226
7/11/2013	8/7/2013	210
8/7/2013	9/9/2013	258
9/9/2013	10/8/2013	578
10/8/2013	11/7/2013	3,582
11/7/2013	12/6/2013	7,397
12/6/2013	1/7/2014	15,032
1/7/2014	2/6/2014	12,388
2/6/2014	3/10/2014	12,331
3/10/2014	4/7/2014	7,271

APPENDIX II
Photographs

Example of the exterior coating on the Durisol Block wall failing.

Example of attic insulation not providing full coverage of the second floor ceiling.

Example of dirty air filters in the AHUs.

Example of the original double hung windows and evidence of condensation deteriorating the wood window sill.

Example of the existing DHW with a thermal efficiency of approximately 80%. New condensing DHWs have thermal efficiencies approaching 97%.