September 25, 2013

Energy Audit Report

Canada's National Ballet School

400 Jarvis St, Toronto

Customer:

Canada's National Ballet School

Reference:

2013-21

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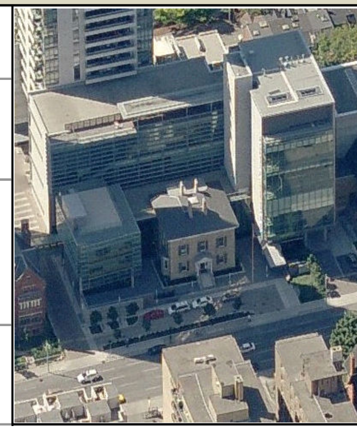


ENERGY AUDIT OF:	Canada's National Ballet School 400 Jarvis St, Toronto
YEAR OF CONSTRUCTION / MAJOR RENOVATIONS	The Betty Oliphant Theatre originally opened in the late 1980s. A capital expansion and renovation project for the Northfield House, Academic Building, and the Studio Building was completed in 2005.
GENERAL DESCRIPTION	Canada's National Ballet School includes 4 buildings located on Jarvis street: Betty Oliphant Theatre (BOT), Northfield House, Academic Building, and the Studio Building. Total combined square footage for the four buildings is approximately 218,000 ft².
HVAC SYSTEM	Multiple air handling units distributed in mechanical rooms at various levels in the Betty Oliphant Theatre (BOT), Academic Building, and the Studio Building. All units are equipped with hydronic (or glycol) heating and cooling. Distributed HVAC equipment includes hot water radiators, re-heat coils, air distribution terminals boxes, radiant heating panels, fancoils, forced flow heaters.
HEATING SYSTEM	A separate 8,000 MBH total input boiler plant provides hot water heating to the Northfield House, Academic Building, and the Studio Building . A pair of atmospheric boilers with a combined input of 2,200 MBH provide heating to the Betty Oliphant Theatre.
HUMIDIFICATION	Single gas-fired steam boiler provides humidification to air handlers serving the Studio building; boiler has been out of commission for approximately 1 year. A 280 MBH humidifier generates steam for the air handler serving the Academic building.
CENTRAL COOLING	Central cooling plant equipped with two centrifugal chillers; cooling capacity is 350 ton per chiller. Heat rejection is through two cooling towers. Cooling is available throughout the year for the 4-pipe system; during the winter, a wet economizer is used (plate heat exchanger).
DOMESTIC HOT WATER	The domestic hot water for the Northfield House, Academic Building, and the Studio Building is prepared by a pair of instantaneous water heaters with a combined input of 2,000 MBH. A 40 gallon, 40 MBH water heater supplies the Betty Oliphant Theatre.
DOMESTIC COLD WATER	The domestic cold water to the four Jarvis Street buildings is supplied through a booster system equipped with three unequal pumps.
KITCHEN	The Studio building is equipped with a full-size kitchen complete with refrigerated walk-in coolers and freezers. The kitchen prepares approximately 300 meals per day for the duration of the school year.
INDOOR POOL	A small training pool is located inside the Betty Oliphant Theatre. Pool water is heated through a heat exchanger using hot water supplied by the boiler plant. Ventilation for the pool area is by a dedicated Dry-o-Tron dehumidification unit paired with an HRV.
PARKING GARAGE	The garage is ventilated by two propeller-type exhaust fans, paired together with two gas-fired make-up air units. Garage ventilation is controlled by a CO monitoring system.

ENERGY CONSERVATION MEASURES BREAKDOWN		ENERGY SAVINGS (GJ)	COST SAVINGS ($)	EST. NET CAPITAL COST	SIMPLE PAYBACK (YEARS)
Domestic Hot Water	Recover the Heat Rejected by the Chillers & Use It to Preheat Domestic Hot Water	550	$5,300	$74,950	14.1
Domestic Hot Water	Replace the Existing DHW Heater Serving the BOT with an Instantaneous Indirect Water Heater Fed from the Main BOT Boilers	32	$300	$13,800	46.0
Heating	Replace the Existing Heating Boilers Serving the BOT with High Efficiency Models	818	$7,850	$307,650	39.2
Pool	Install a Pool Cover to Reduce Heat Loss During Unoccupied Periods	164	$2,200	$5,050	2.3
Lighting	Lighting Retrofit	495	$18,300	$119,900	6.6
Water Conservation	Install Ultra High Efficiency Toilets, Urinals & Low-Flow Aerators	133	$6,150	$37,800	6.1
Monitoring & Tracking	Monitoring & Tracking, Training & Education	407	$10,200	$14,350	1.4
TOTAL		**2,599**	**$50,300**	**$573,500**	**11.4**

BASELINE ENERGY DATA	ELECTRICITY	NATURAL GAS	WATER	GHG
CONSUMPTION / YEAR	2,833,779 kWh	263,753 m³	14,282 m³	924 tonnes
COST / YEAR	$377,263	$97,680	$35,470	
POTENTIAL SAVINGS / YEAR	7%	19%	16%	13%

NOTE: The above energy costs and capital costs do NOT include HST.

2. Introduction

2.1 Objectives

This study was defined to meet the following objectives:

- Audit the available data related to electricity, natural gas and water usage in the building.
- Review and analyze energy usage history to create a baseline from which savings can be measured.
- Provide an analysis of the condition of existing lighting, heating and air-conditioning systems.
- Determine what can be done to reduce energy use in the facility and what options are available for system retrofits.
- Provide a summary of cost effective retrofits and a financial analysis.
- Identify and evaluate measures that improve the environmental performance and provide recommendations.

3. Building Description

Canada's National Ballet School provides ballet training combined with academic education, as well as a full-time teacher training program. The campus consists of four buildings located at 400 Jarvis Street, and the Maitland Residences (not part of this report). The buildings located on Jarvis street are as follows:

- Betty Oliphant Theatre (BOT): 30,000 ft²
- Lozinski House: 5,000 ft²
- Academic Building: 30,000 ft²
- Studio Building: 153,000 ft²

Studio Building: This building has been occupied since 2005. It consists of twelve dance studios, staff and administration offices, library, a full kitchen with servery, an underground parking garage, as well as utility rooms housing various mechanical and electrical equipment located at the basement and seventh floor penthouse levels.

Academic Building: This building was renovated in 2005. There are a total of five floors, consisting of administration offices and classrooms (including science rooms).

Lozinski House: This building was renovated in 2005 and includes three above-ground stories plus basement. The majority of the building is allocated to administration offices.

Betty Oliphant Theatre: This building opened in the late 1980s and includes a large 265-seat theatre used for stage training, a small pool, and administration offices.

4. Energy & Utility Analysis

4.1 Rates Used for Calculations

Electrical

The analysis is based on the available monthly bills provided. The blended hydro rate used for the savings calculations has been set by Metrix™ software at $0.133 per kWh (see Appendix A). The blended rate accounts for consumption, demand and NCEC (non-competitive energy charges), but does not include HST.

Natural Gas

The analysis is based on the available monthly bills provided. The gas rate used for the savings calculations has been set by Metrix™ software at $0.370 per m³. This rate accounts for natural gas consumption charges including delivery, supply and NCEC, but does not include HST.

Water

The analysis is based on the available monthly bills provided. The water rate used for the savings calculations has been set by Metrix™ software at $2.483 per m³.

Note: As the energy rates increase beyond the values shown above, the energy savings will increase and the payback will decrease.

4.2 Conversions Used for Calculations

The following is a list of the conversion factors used in calculating the amount of gigajoules (GJ) saved and in the calculation of Greenhouse Gases (GHG), from Canada's National Inventory Report 1990-2011 (issued April 2013):

- 0.03846 GJ/m³ for natural gas
- 0.150 kg CO_2e/kWh of electricity
- 1.879 kg CO_2/m³ of natural gas
- 0.000037 kg CH_4/m³ of natural gas, with a global warming potential of 21
- 0.000035 kg N_2O/m³ of natural gas, with a global warming potential of 310

4.3 Energy Summary

The proposed energy savings measures and estimated capital costs are summarized as follows:

Ref #	Description of Energy Saving Measures	Estimated Annual Utility Savings			Estimated Annual Cost Savings	Available Incentives	Net Cost of Retrofit	Simple Payback	Ranking
		Elec.	Gas	Water					
		kWh	m³	m³	$	$	$	Years	
8.1	Recover the Heat Rejected by the Chillers & Use It to Preheat Domestic Hot Water		14,310		$5,300	-$1,450	$74,950	14.1	Long Term
8.2	Replace the Existing DHW Heater Serving the BOT with an Instantaneous Indirect Water Heater Fed from the Main BOT Boilers		820		$300	-$100	$13,800	46.0	Long Term
8.3	Replace the Existing Heating Boilers Serving the BOT with High Efficiency Models		21,260		$7,850	-$2,150	$307,650	39.2	Long Term
8.4	Install a Pool Cover to Reduce Heat Loss During Unoccupied Periods	6,350	3,670		$2,200	-$350	$5,050	2.3	Immediate
8.5	Lighting Retrofit	137,550			$18,300	-$10,300	$119,900	6.6	Short Term
8.6	Install Ultra High Efficiency Toilets, Urinals & Low-Flow Aerators		3,470	1,960	$6,150		$37,800	6.1	Short Term
11	Monitoring & Tracking, Training & Education	56,650	5,270	280	$10,200	-$5,650	$14,350	1.4	Immediate
	Total Estimated Savings	**200,550**	**48,800**	**2,240**	**$50,300**	-$20,000	$573,500	**11.4**	
	Annual Baseline Utilities (at same rates as savings)	2,833,779	263,753	14,282	$510,414	**Energy Cost Reduction: 9.4%**			
	Percent Reduction	7.1%	18.5%	15.7%	9.9%				

NOTES:

- The above energy costs and capital costs do NOT include HST.
- Canada's National Ballet School should resist implementing recommended measures on measure by measure basis in descending order of payback; however, we recognize that implementation of the above measures may be dependent on matching available funds and as such have ranked the measures as either Immediate, Short Term or Long Term projects. Typically the Immediate measures are low-cost or no cost measures.

In addition to implementing the above energy efficiency measures, there are maintenance and labour savings as a result of newer equipment.

The associated GHG emission reductions would be:

Greenhouse Gas Emissions Summary	Elec.	Gas		TOTAL	% Reduction
CO_2 Baseline (tonnes)	425	499		924	
CO_2 Reduction (tonnes)	30	92		122	13.2%

A reduction of 122 tonnes of GHG is equivalent to growing 3,137 tree seedlings for 10 years, or taking 26 passenger cars off the road.

The actual energy savings may vary from the proposed savings in the tables above due to a number of factors including changes to equipment, changes to equipment operating schedules, variances in building occupancy and changes to building operation.

The savings have been estimated based on a walkthrough visual audit of the facility, equipment and operations. Detailed engineering calculations, metering, specifications, engineered drawings and the development of scopes of work for each of the energy efficiency measures will be required prior to the implementation of the above measures.

4.4 Financial Incentives

The incentives have been estimated based on the following available programs:

OPA's 2011 CDM Program - Equipment Replacement

The Ontario Power Authority (OPA) is providing incentive payments to the commercial, industrial, institutional and agricultural and social housing sector where peak demand reductions and/or energy consumption reductions have been achieved through retrofitting existing lighting and other building systems. The program provides incentives for Prescriptive, Custom or Engineered energy efficiency measures. The Prescriptive incentives are offered to pre-defined energy efficient appliances and lighting systems that include fridges, washers, dishwashers, compact fluorescent lamps and energy efficiency fluorescent fixtures, etc. The Custom or Engineered measure incentives are:

- $400/kW or $0.05/kWh for lighting measures (whichever is higher) to a maximum of 50% of the project costs.
- $800/kW or $0.10/kWh for non-lighting measures (whichever is higher), including lighting controls, to a maximum of 50% of the project costs.

Pre-approval is required for all OPA incentives.

Enbridge Gas Distribution's Incentives for Energy Retrofits

Enbridge Gas Distribution offers financial incentives for energy retrofits, calculated on projected first year's natural gas savings using the following rates:

- $0.10/m³ saved up to a $100,000 limit (regardless of the number of measures) OR
- $0.12/m³ saved up to a $30,000 limit (for use of condensing boiler technology)

Incentives are remitted upon project completion. Enbridge pre-approval is required.

Enbridge Gas Distribution's Run it Right Program

Enbridge offers the Run it Right operational improvement service to commercial buildings consuming over 100,000 m³ natural gas annually, to assist in reducing energy use and for monitoring energy consumption.

The building must have an Enbridge MetreTek meter, or similar to Enbridge direct access to the interval data during the monitoring term. No major capital upgrades that impact natural gas consumption can be implemented for the monitoring term.

Enbridge will fund an on-site building investigation to identify operational improvement opportunities unique to your building, to help you complete an Operational Building Tune-up to optimize building efficiency by funding. Enbridge will cover between $2,000 and $10,000 of the operational implementation costs.

4.5 Energy Audit and Analysis Methodology

Lighting Audit and Analysis

The lighting study includes an audit of the lighting systems and controls, an analysis of retrofit alternatives and a summary of recommendations. The audit includes a detailed review of various sources of lighting. This information was obtained through a physical, on-site review of the lighting system and an examination of the available drawings.

Mechanical Audit and Analysis

The mechanical study includes an audit of the facilities heating and ventilation systems and controls, an analysis of retrofit alternatives and a summary of recommendations. The audit includes a detailed review of the mechanical systems in the buildings. This information was obtained through a physical, on-site review of the equipment throughout the complex and examination of the drawings and documentation provided.

End-Use Breakdown

The equipment loads and hours of operation determined from the audit were compared to consumption figures obtained from monthly meter readings to ensure an accurate analysis.

Energy Analysis Methodology

The energy analysis was carried out based on the following methodology:

- An audit of the equipment was carried out including physical equipment counts, nameplate readings to determine the equipment load in kilowatts (kW).
- The hours of operation were determined for all equipment from the system schedules, hardware settings, building operators experience, and site observations. The hours and load information was combined to determine the consumption in kilowatt-hours (kWh).
- The energy use calculated above was reconciled to the actual metered consumption.
- The impacts of weather variables on the energy consumptions were reviewed.

Measure Selection Criteria

Measures proposed for implementation on this project have been selected based on the viability of the measure against the following criteria:

- Appropriateness for tasks performed in the space;
- Condition of existing systems;
- Cost to retrofit existing system compared to cost to replace systems;
- Maintenance requirements;
- Consistency of application (all areas of similar function are consistent);
- Overall impact on staff and general acceptance of changes;

- Costs and savings within overall payback guidelines, where appropriate.

Cost Estimation Methodology

Costs based on our estimates, pricing from suppliers and data from previous projects. It is our intent to provide accurate pricing; however, the pricing provided should be used as budgets only and not fixed prices.

Savings Methodology

The savings for the lighting are calculated by a customized database approach whereby existing and proposed energy use for any type of lighting and quantity can be determined. Calculations in spreadsheet format are used to calculate the mechanical savings. Savings are based on our engineering estimates.

4.6 Baseline Determination Methodology

The energy analysis provides a thorough review and analysis of the energy use profiles of the facility. This analysis (a) establishes a baseline of energy use from which savings may be measured and (b) act as a guide to investigating certain building systems and operations exhibiting energy saving potential.

Metrix™ Utility accounting software was used for the energy analysis including multi-variable linear regression.

Utility bills only record total consumption for a particular billing period. The consumption can be considered to consist of a Base Load plus a Weather Dependent Load. The latter is dependent on the building Weather Factor (WF) and the external environmental conditions.

The first step in the analysis was to develop a statistical model, using regression analysis, of the base year representing the billing period use for each meter.

The daily weather information for the Toronto Pearson Airport, as recorded by Environment Canada, is used to analyze the impact of weather conditions on energy use. Consumption and demand information is taken from actual utility bills.

The number of degree-days in a billing period is the sum of the difference between the meter's balance point temperature and the mean daily outdoor temperature noted each day. (Balance point temperature is the mean daily outdoor temperature at which, on a long-term average, the solar and internal gains of a building will offset heat loss.) The balance point temperature for each meter was determined by testing for a reasonable temperature that provided a straight-line model that closely fit the actual energy use/degree day relationship in the base year.

For each meter, regression analysis was used to test for the best straight-line relationship between the number of degree-days and the actual use per billing period in the base year. Each model must have a correlation (R^2) greater than 75%. The number of degree-days used in determining each model is the billing period sum of the difference between the balance point temperature being tested and the mean daily temperature. A reasonable balance point temperature, whose model closely matched the actual base year energy relationship, was chosen for each meter.

For each meter the base year mathematical model is of the form:

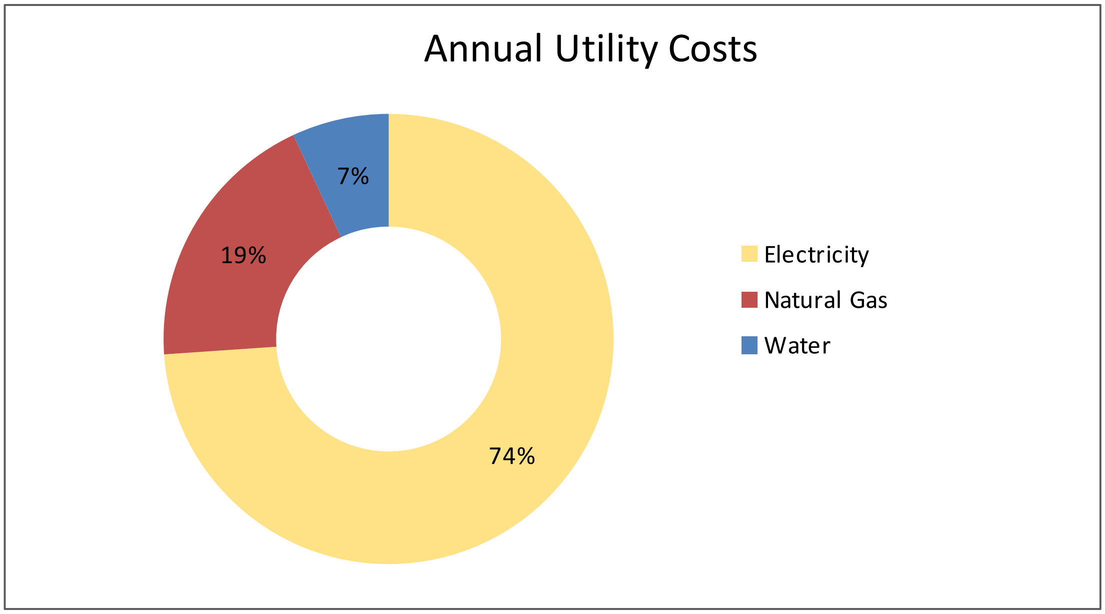
Use/Month = 30 Day base load + (Weather factor x Degree days)

Analysis of each model reveals the base load and weather factor. The base load is the portion of the load that is always present regardless of the number of degree-days in the billing period. The weather factor is the rate at which the usage increased with an increase in the number of degree-days in the billing period. This model will be used to predict the energy usage in the building after the energy retrofit.

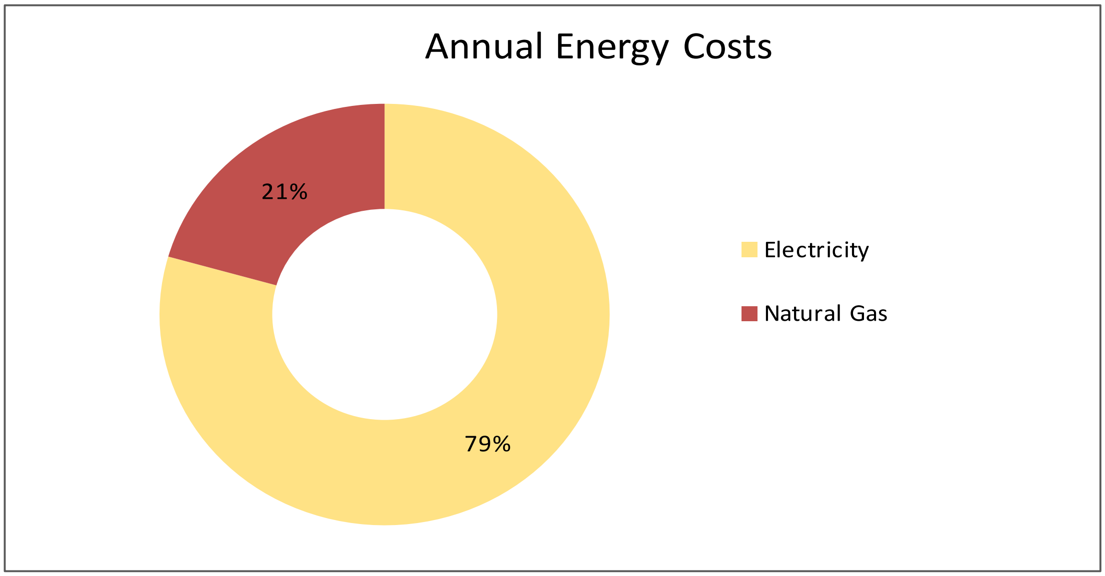
5. Utility Analysis

5.1 Annual Energy Cost & Consumption

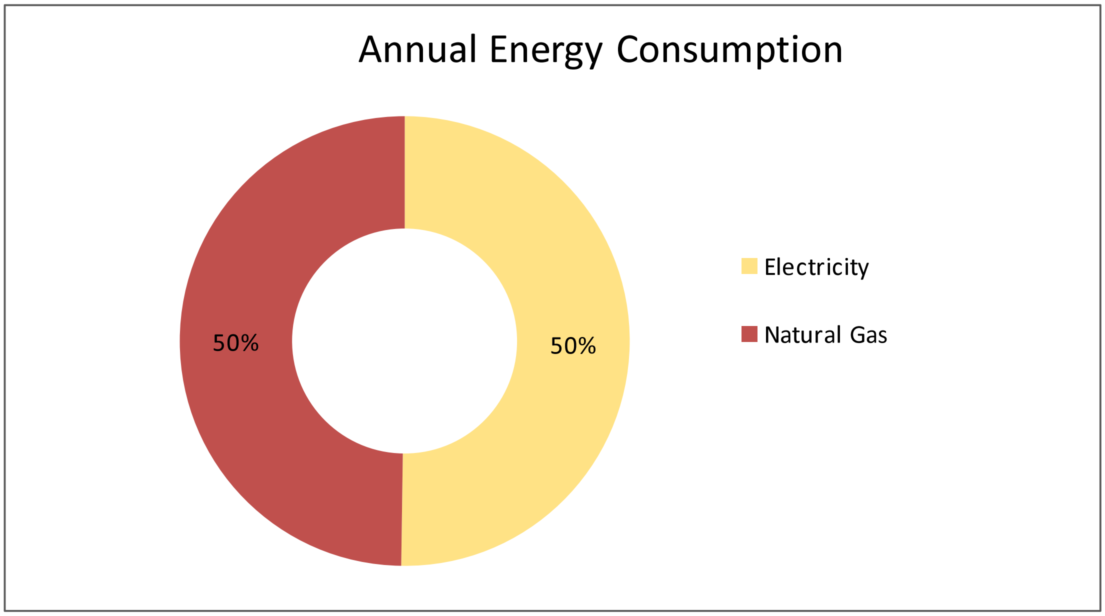
Based on the available billing data, , the graph below details the split in annual utility costs of $510,414 for electricity, gas and water based on energy data from utility costs for the period January 2012 - December 2012.



Electricity represents 79% of annual energy costs while natural gas represents 21% as detailed in the graph below.



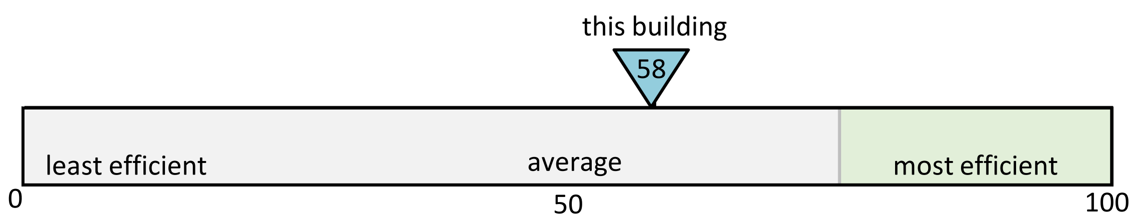
Electricity represents 50% of annual energy consumption while natural gas represents 50% as detailed in the graph below.



5.2 Energy Intensity Comparison

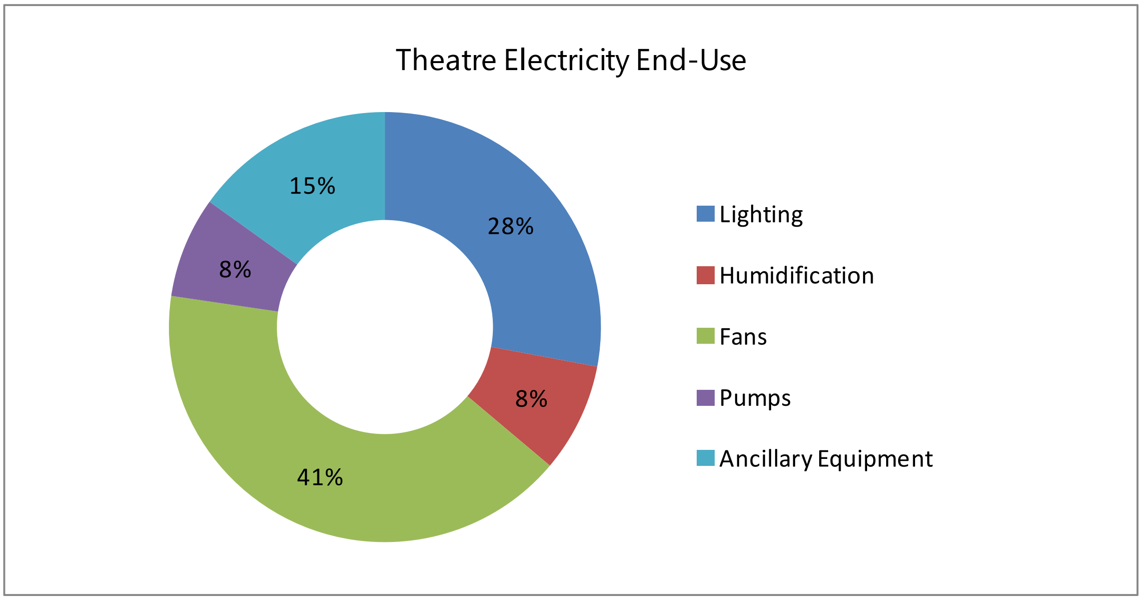
Energy benchmarking analyzes and reports on a facilities energy performance per unit area or unit of physical production (energy intensity) and focuses on a comparative analysis of energy use. The facility was benchmarked using data from the Local Authority Service's Energy Performance Benchmarking of Ontario's Municipal Sector Report. This report compares data from municipal facilities across Ontario and created energy benchmarks for various municipal facilities, split into categories.

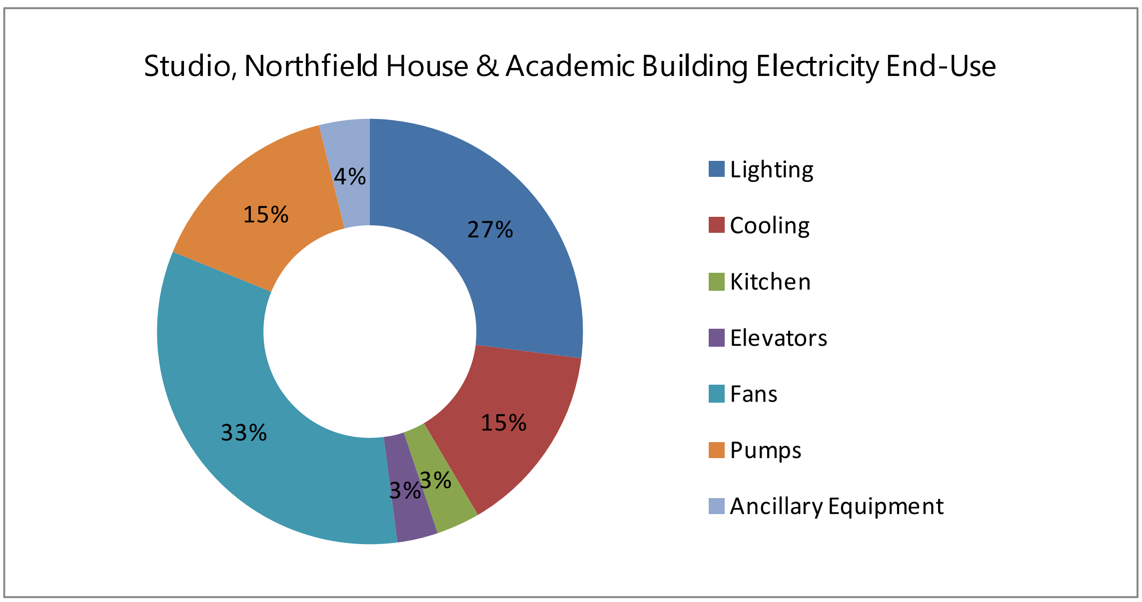
The facility was benchmarked against the average energy intensity benchmark identified by the Local Authority Service's Energy Performance Benchmarking of Ontario's Municipal Sector Report for Arts and Culture Buildings. The figure below shows how well the facility compares to similar facilities within the province; a higher score represents a building that has a lower energy intensity (i.e. is more efficient).



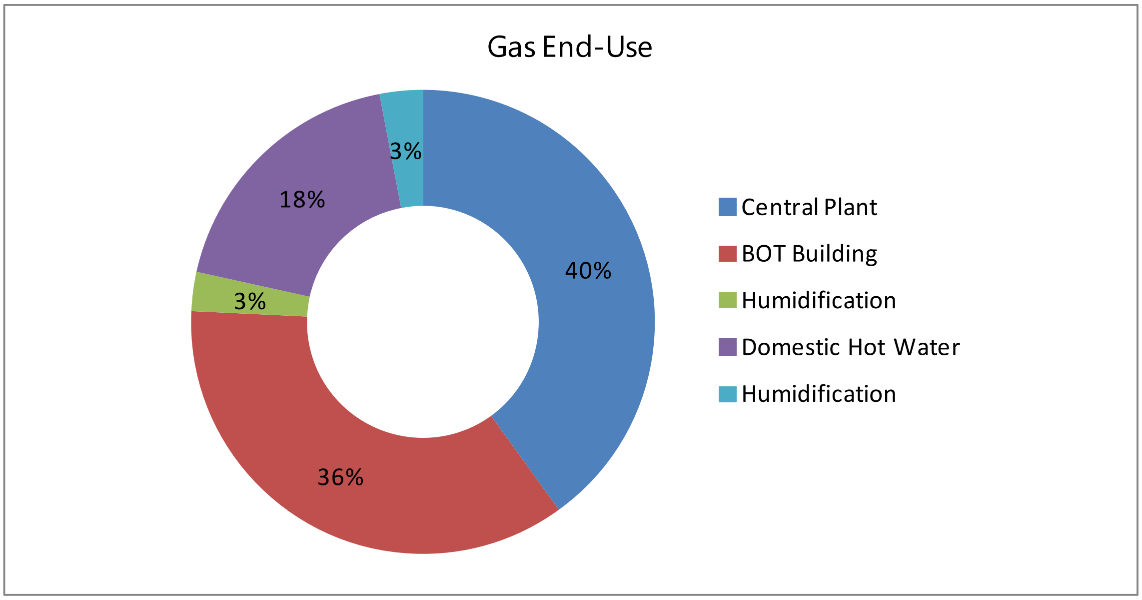
5.3 Energy Use Breakdown

The following graph gives an approximate end-use breakdown of electricity for the theatre and the rest of the building, based on the on-our site observations.





The following graph gives an approximate end-use breakdown of natural gas, based on our observations onsite:



Graphs and tables detailing the electricity, gas and water consumption and cost are included in Appendix A. The following charts and graphs for each utility are included in Appendix A:

Cost Performance

Cost performance compares the baseline (or forecasted) cost versus the billed cost. The baseline is the forecasted cost based on the historical energy cost adjusted for changes in billing period length and variations in weather where applicable. If the baseline is established using a base year prior to implementing any energy efficiency measures then the difference between the baseline cost and the billed cost is a good approximation of the utility cost avoided from the implemented measures.

Consumption Performance

Consumption performance compares the baseline (or forecasted) consumption versus the billed consumption. The difference between the baseline consumption and the billed consumption in each month is a good approximation of the utility savings achieved from the implemented measures.

Ledger

The ledger provides details of the utility bill and the weather conditions over the billing period.

6. Strategies

Adopting utility cost reduction programs is the number one key strategy to reducing energy consumption. Inherent in an effective energy efficiency program is the intertwining of five strategies.

Implementation Strategies

Canada's National Ballet School should resist implementing recommended measures on measure by measure basis in descending order of payback. Cherry-picking will result in a residual list of long-payback measures that may never be completed. Bundling the recommended measures enables that the short payback measures subsidize the long payback measures. We believe this is the key to achieving the projected annual utility cost savings of $50,300 with a blended simple payback of 11.4 years.

Canada's National Ballet School should also integrate energy efficient upgrades with the building's capital plans, ensuring that energy efficient equipment is used for capital upgrades. Also, Canada's National Ballet School should prepare a list for emergency replacements and failures. This would ensure that standard equipment is not replaced with new standard equipment, but rather with energy efficient equipment.

Technological Changes

This strategy relates to building systems such as lighting, heating and domestic hot water.

Organizational Changes

This strategy broadly refers to the institution of new practices at the corporate and operations levels that will facilitate the achievement of cost-reduction targets. Examples are the monitoring & tracking of utility consumptions & costs; utility purchasing policies; and preventative maintenance programs.

Behavioural Changes

This strategy is largely driven by awareness, education and training. The behaviour of the staff is critical to the success of the project, having a huge impact on energy consumption.

Communication

The two biggest pitfalls in implementing an energy efficiency program are lack of occupant time/commitment and failure to communicate. The staff communications program must create awareness; identify the energy efficiency goals; detail the actions to be taken by individuals and departments; and must recognize staff achievements.

7. Mechanical & Lighting Systems

7.1 General

The four Jarvis street buildings are served by a central water-cooled chiller plant located in the basement level of the Studio Building.

Heating to the group of buildings is provided by two separate boiler plants. The Lozinski House, Academic Building, and the Studio Building are served by a common boiler plant located at the penthouse level of the Studio building. The Betty Oliphant Theatre (BOT) is served by an in-house, dedicated pair of boilers located at the basement level.

Distributed heating, ventilation and air conditioning (HVAC) equipment includes hot-water radiators, re-heat coils, terminal boxes, radiant heating panels, fancoils, and forced flow heaters.

Multiple air handling units (AHUs) provide heating, cooling and ventilation to building common areas. Typically, units are equipped with chilled water cooling and glycol or hot-water heating coils. Five air handlers (VAV types) are equipped with variable frequency drives, the rest of AHUs are constant volume.

A single gas-fired steam boiler provides humidification to air handlers serving the Studio Building; however the boiler has been out of commission for approximately one year.

Domestic hot water (DHW) for the Lozinski House, Academic Building, and the Studio Building is centrally prepared by a pair of instantaneous water heaters. The Betty Oliphant Theatre is supplied by a single gas-fired water heater.

Cold water is supplied to the buildings using a booster system equipped with three unequal pumps.

The Studio Building is equipped with a full-size kitchen complete with refrigerated walk-in coolers and freezers, gas and electric cooking appliances, commercial type dishwasher and an exhaust hood.

The parking garage located in the basement of the Studio Building is ventilated by two propeller-type exhaust fans paired together with two gas-fired make-up air units, controlled by a CO monitoring system.

A small indoor pool is located inside the Betty Oliphant Theatre. Pool water is heated primarily from a dedicated Dry-O-Tron unit. Secondary heating to the pool is through a heat exchanger using hot water supplied by the boiler plant. Ventilation for the pool area is by the Dry-O-Tron unit paired with an HRV.

A common gas meter serves the four Jarvis street buildings. The hydro meter is common to the Lozinski House, Academic Building, and the Studio Building. Hydro for the Betty Oliphant Theatre is metered separately.

7.2 Cooling Equipment

The following is a summary of our observations on site:

- The central chiller plant is located at the basement level of the Studio Building inside a dedicated mechanical room. The plant provides cooling to the Betty Oliphant Theatre, Lozinski House, Academic Building, and the Studio Building.
- The cooling plant includes a pair of 350 ton York chillers equipped with variable frequency drives (VFDs) for capacity modulation. Both chillers operate on R-123.
- The cooling system contains a free-cooling feature consisting of a plate heat exchanger that can reject the buildings' load directly to the ambient through the cooling towers, rather than using the chillers, when the outdoor conditions are favourable.

- The chilled water piping is arranged in a primary/secondary configuration; each operating chiller is served by a primary chilled water pump; a third primary chilled water pump is used for circulating water through a plate heat exchanger during free-cooling periods. Each primary chilled water pump is rated at 520 gpm, 7½ HP.
- A total of three secondary chilled water pumps distribute water to the four Jarvis Street buildings. Each pump is controlled by a VFD, rated at 350 gpm, 20 HP. At the time of our investigation, only one of the three pumps was operating, at 51 Hz.

- Heat is rejected through two forced-draft, counter-flow cooling towers, manufactured by Evapco, located on the roof of the Studio Building in a dedicated enclosure. Each cooling tower is equipped with a 40 HP electric motor controlled by a VFD. At the time of our investigation, both cooling towers were operating at 78% and 63% capacity respectively.

- Since the building has a year-long cooling load, the towers are in operation during the winter as well; for this purpose, the water sumps are equipped with 8 kW electric heaters, to prevent freezing.
- Similar to the pumping arrangement on the primary chilled water side, a set of three condenser water pumps serve the two chillers and plate heat exchanger used for free-cooling. The pumps are constant volume, each rated at 813 gpm, 25 HP.

- Because the cooling towers are of the open loop design, condenser water filtration is accomplished using a system equipped with a pair of 2 HP pumps located in the penthouse mechanical room of the Studio Building.
- The entire chilled water plant is relatively new, and appears to be well maintained.

- The Studio Building mechanical room housing the new chillers is equipped with a refrigerant monitoring and evacuation system, with controllers and sensors by Vulcain. Audible alarms could not be located inside the chiller room, nor at its entrances.

7.3 Heating Equipment

The following is a summary of our observations on site:

- Heating to the group of four Jarvis street buildings is provided by two separate boiler plants. The Lozinski House, Academic Building, and the Studio Building are served by a common boiler plant, while the Betty Oliphant Theatre is served by an in-house dedicated pair of boilers.

- The boiler plant serving the Lozinski House, Academic Building, and the Studio Building includes:
    - Two water-tube boilers equipped with modulating burners. The boilers are manufactured by Cleaver Brooks; each is rated at 4,000 MBH. Burners are equipped with $1\frac{1}{2}$ HP electric motors.
    - A pair of 15 HP primary heating pumps that circulate hot water through the boilers. The pumps operate in a lead/lag arrangement and are rated at 670 gpm.

- A secondary heating loop that supplies hot glycol to selected air handling unit (AHU) heating coils (AHS-01, 02, 03, 04, 09, 10, 16, 17) and fancoils. Hot glycol is prepared inside a plate heat exchanger; output of the heat exchanger is modulated by a 3-way control valve. A pair of VFD controlled vertical pumps circulate glycol to the buildings' end-users; glycol pumps are rated at 305 gpm, 7.5 HP.

- Another secondary heating loop that provides hot water to the rest of the air handlers, fan-coils and radiators serving the three Jarvis street buildings. Water circulation in the secondary loop is accomplished by a pair of 300 gpm, 20 HP pumps controlled by VFDs. Water temperature in the hot water loop is re-set based on outdoor air temperature, using a 3-way control valve.
- Boilers, primary heating pumps and secondary loop glycol distribution pumps with heat exchanger, are located at the penthouse level of the Studio Building. The secondary loop hot water distribution pumps are located inside the 6th floor Studio Building mechanical room.
- The boiler plant operates during the heating season and is 'off' in the summer.

- Boiler plant serving the Betty Oliphant Theatre includes:
  - Two atmospheric boilers manufactured by Teledyne Laars, rated at 1,100 MBH each. The boilers are located at the sub-basement level of the BOT building, inside the pool equipment room.
  - Water is circulated between the boilers and building end-users by a 3 HP in-line pump.
  - A small fractional HP in-line fan supplies combustion air into the pool equipment room, which houses the boilers.
  - Due to the fact that the boilers also act as

a secondary source of heating for the pool, they remain operational for the majority of the year.

- Parts of the heating plant available for visual inspection, including boilers, pump, and piping appear in poor condition (rust on heating boilers, damaged piping insulation, missing second circulating pump).

7.4 Ventilation Equipment

The following is a summary of our observations on site:

- Ventilation Equipment – Studio Building
  - All air handling units serving the Studio Building were manufactured by Haakon, and were installed during 2004-2005 renovation period. Typically, units are equipped with chilled water cooling and glycol or hot water heating coils. Coil modulation is accomplished by local 2-way control valves. The majority of air handlers are equipped with steam humidification coils (refer to the Humidification section of this report for more information).

  - The indoor air handling unit AHS-1 supplies conditioned outside air to selected air handlers (AHN-5, AHS-8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19) located inside the Studio Building. The same unit collects and exhausts air from the above mentioned AHUs; the amount of air exhausted is proportional to the amount of air being supplied. Supply and exhaust fans are controlled by variable frequency drives. Chilled water cooling and glycol heating coils condition the outside air in order to maintain a constant pre-set supply air temperature. AHS-1 is also equipped with a heat recovery wheel between the supply and exhaust air streams, as well as a glycol heat recovery system consisting of:

    - A glycol coil located in the fresh air stream of the AHU.
    - A plate heat exchanger serving as an interface between the glycol coil and the building's chilled water loop.
    - A 1-½ HP glycol pump.

- A ½ HP chilled water circulator.
- A 3-way control valve on the glycol side of the heat exchanger.

- Indoor air handling units AHS-2, 3, 4, 6, AHN-7, have separate fresh air components taken directly from the outdoors.
- The following table is a schedule of air handling equipment serving the Studio Building:

#	Location	Service	Supply Air Flow (cfm)	Return Air Flow (cfm)	Supply Fan (HP)	Return Fan (HP)	Humid.	Remarks
AHS-1	7th floor penthouse mechanical room	Supplies tempered O/A to other AHUs	17,000	18,242	20	15	no	VFD; heat reclaim coil & wheel; 100% FA
AHS-2	6th floor mechanical room	Studio Building corridors	11,000	8,500	15	5	yes	CV
AHS-3	6th floor mechanical room	Studio Building town square	8,700	3,500	15	5	yes	CV
AHS-4	7th floor penthouse mechanical room	Studio Building north side	16,500	12,700	20	7.5	yes	VFD
AHS-6 /EF-S3	Concourse level mechanical room	Studio Building Pavilion	13,000	-	20	-	no	VFD
AHS-8	5th floor mechanical room	Studio Building S508	3,000	-	5	-	yes	CV
AHS-9	6th floor mechanical room	Studio Building Studio 4C	3,000	-	5	-	yes	CV
AHS-10	6th floor mechanical room	Studio Building S513	3,000	-	5	-	yes	CV
AHS-11	4th floor mechanical room	Studio Building S423	4,000	-	5	-	yes	CV
AHS-12	4th floor mechanical room	Studio Building S417	4,000	-	5	-	yes	CV
AHS-13	2nd floor mechanical room	Studio Building S215	4,000	-	5	-	yes	CV

#	Location	Service	Supply Air Flow (cfm)	Return Air Flow (cfm)	Supply Fan (HP)	Return Fan (HP)	Humid.	Remarks
AHS-14	2nd floor mechanical room	Studio Building S208	4,000	-	5	-	yes	CV
AHS-15	Main floor mechanical room	Studio Building SC126	4,000	-	5	-	yes	CV
AHS-16	6th floor mechanical room	Studio Building S517	5,750	-	7.5	-	yes	CV
AHS-17	6th floor mechanical room	Studio Building S609	5,750	-	7.5	-	yes	CV
AHS-18	4th floor mechanical room	Studio Building S430	5,750	-	7.5	-	yes	CV
AHS-19	5th floor mechanical room	Studio Building S502	6,750	-	7.5	-	yes	CV

- The Studio Building is equipped with a number of exhaust fans. With the exception of the kitchen hood exhaust, these fans range between 1 HP and fractional HP. The majority of fans are utilized for washroom and utility/service room ventilation.
- The low roof of the Studio Building houses a total of 8 such exhaust fans including kitchen hood exhaust, dishwasher exhaust, washroom exhaust, wardrobe exhaust, etc.

- <u>Ventilation Equipment – Academic Building</u>

  - The building is served by a single air handling unit AHA-7. The unit is manufactured by Engineered Air and is located inside the Academic Building's 5th floor mechanical room. It is equipped with a 20 HP, 17,000 CFM supply fan and a 5 HP, 13,000 CFM return air fan; both fans are controlled by variable frequency drives.

- Similar to the air handlers serving the Studio Building, this AHU was installed during the 2004-2005 renovation period.
- AHA-7 is equipped with chilled water cooling and hot water heating coils; coil modulation is accomplished by local 2-way control valves. A ½ HP pump helps circulate hot water through the heating coil.
- The unit is equipped with steam humidification provided by a dedicated gas-fired humidifier (refer to the Humidification section of this report for more information).
- Exhaust fans serving the Academic Building are of fractional HP. The majority of fans are located on the roof and provide general ventilation, science room exhaust, washroom exhaust, and utility/service room ventilation.

- Ventilation Equipment – Lozinski House
  - The Lozinski House is served by single air handling unit AHN-5. The unit is manufactured by Haakon, and is located inside the basement mechanical room of the Studio Building. The fresh air component for this AHU is provided from AHS-1 (see Studio Building ventilation equipment description). The air handler is equipped with a 15 HP, 8750 CFM supply fan controlled by a variable frequency drive.
  - The AHU is relatively new, installed during the 2004-2005 renovation period.
  - The unit includes a chilled water cooling coil. Heating is provided through terminal re-heat coils.
  - Four fractional HP exhaust fans provide ventilation to the Lozinski House.
- Ventilation Equipment – Betty Oliphant Theatre

  - The theatre is served by four air handling units, manufactured by Trane, located inside the BOT building mechanical rooms. The air handlers are 26 years old; each AHU consists of supply air and return air sections. The supply section is equipped with a fan, chilled water cooling and hot water heating coils; the return air sections consist of dedicated centrifugal fans ducted to each AHU.

- In addition to the hot water heating coils, the hot water re-heat coils are installed on two of the four air handlers - AHU-2 and AHU-3. The re-heat coils are used when air dehumidification is necessary during high humidity seasons.
- All coil modulation is accomplished by local 3-way control valves.
- The amounts of outside and exhaust air for each AHU is modulated by local dampers powered by electric actuators.

- The following table is a schedule of air handling equipment serving the Betty Oliphant Theatre:

#	Location	Service	Supply Air Flow (cfm)	Return Air Flow (cfm)	Supply Fan (HP)	Return Fan (HP)	Humid.	Remarks
AHU-1	Ground floor mechanical room	BOT Lower level	6,000	6,000	7.5	2	no	CV
AHU-2	3rd floor mechanical room	BOT Stage	12,000	12,000	15	5	no	CV
AHU-3	2nd floor mechanical room	BOT Auditorium	8,000	8,000	10	3	no	CV
AHU-4	Ground floor mechanical room	BOT Lobby	4,000	4,000	5	1.5	no	CV

Due to absence of any relevant information on the subject of these AHUs operational parameters, the supply and return air CFM were estimated based on the ductwork size and fan HP.

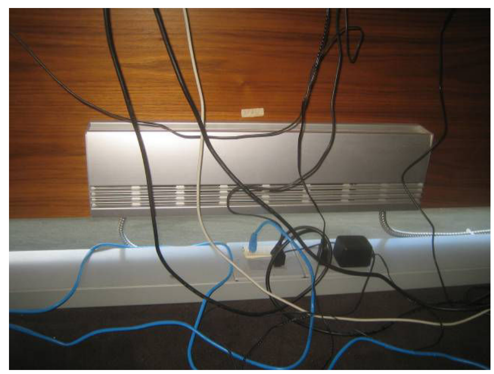
- An in-line exhaust fan located inside the ground floor mechanical room provides ventilation to the BOT washrooms. The size of the fan was estimated at 1.5 HP.

7.5 Terminal Heating and Cooling Equipment

The following is a summary of our observations on site:

- <u>Terminal Equipment – Studio Building</u>
  - Terminal equipment inside the Studio Building includes a number of fancoils serving utility rooms (elevator machine room, electrical room), the bridge joining the Academic Building to the Studio Building, vestibules, corridors, and other common areas. Fancoils are typically equipped with chilled and/or hot water (or glycol) heating coils; coil modulation is by local control valves.

  - Air from the variable air volume (VAV) indoor air handlers is supplied through terminal VAV boxes.
  - Electric heat in the form of baseboards and unit heaters is provided to the generator room and 3rd floor offices. Estimated total connected load is 6 kW.



  - Hot water radiant heating panels are located in the 4th floor administration offices.
  - Supplementary hot water heating to selected areas is provided by perimeter radiation and trench heating.
- <u>Terminal Equipment – Academic Building</u>
  - Terminal equipment inside the Academic Building includes a small number of fancoils equipped with chilled and/or hot water heating coils; fancoils serve corridors, stairs, and the elevator machine room.

  - Hot water radiators and forced flow heaters provide supplementary heating to selected common areas.
  - Air from the variable air volume unit AHA-7 is supplied through terminal VAV boxes. Selected VAV boxes are equipped with re-heat coils.

- <u>Terminal Equipment – Lozinski House</u>

  - Hot water, cast-iron radiators are located throughout the building. Radiators are equipped with 2-way control valves.
  - Air from the variable air volume unit AHN-5 is supplied through terminal VAV boxes equipped with re-heat coils. One of the re-heat coils is electric; the rest use hot water.
  - Two electric forced flow heaters are located at the building's front entrance. Heaters are estimated at 1 kW each. This entrance is not used by staff.

- <u>Terminal Equipment – Betty Oliphant Theatre</u>

  - Terminal equipment inside the BOT building includes two (cooling only) fancoils equipped with chilled water coils; fancoils serve the dimmer room and the communication equipment room.
  - Hot water radiators and re-heat coils provide heating to select building areas.
  - Approximately 3.5 kW of electric heating was noted in the rotunda and adjacent entrance.

7.6 Domestic Hot Water System

The following is a summary of our observations on site:

- Domestic hot water (DHW) to the Lozinski House, Academic Building, and the Studio Building is provided from a central system located inside the 7th floor penthouse boiler room in the Studio Building.
- The DHW system is comprised of two fully condensing, instantaneous, gas-fired water heaters. The heaters are manufactured by Aerco, rated at 1,000 MBH, each.
- A $\frac{1}{6}$ HP DHW recirculation pump operates continuously.
- The Betty Oliphant Theatre is served by a dedicated DHW heater located in the sub-basement pool room of the BOT building. The gas-fired water heater is manufactured by GE, rated at 40,000 Btu/hr with a 40 gallon storage capacity.

7.7 Domestic Cold Water (DCW) System

The following is a summary of our observations on site:

- The four Jarvis street buildings (Betty Oliphant Theatre, Lozinski House, Academic Building, and the Studio Building) are supplied from a common water meter through a DCW booster system located in the basement mechanical room of the Studio Building.
- The booster package consists of three unequal HP pumps (3 HP, 7.5 HP, 7.5 HP) operated by a control panel. The panel sequences the pumps based on demand. At the time of our investigation, water was being discharged at 105 psi.

7.8 Humidification

The following is a summary of our observations on site:

- A single gas-fired steam boiler provides humidification to air handlers serving the Studio Building. Low pressure steam is distributed to the air handlers equipped with steam humidification coils.

- The steam boiler is manufactured by Hurst, rated at 1,260 MBH input. It is located inside the 7th floor penthouse boiler room of the Studio Building.
- The humidification boiler is currently out of commission, and has not been operational for a period of almost 1 year.
- The indoor air handler serving the Academic Building is served by a dedicated gas-fired humidifier manufactured by Nortec. The 280 MBH humidifier is located inside the 5th floor mechanical room of the Academic Building, adjacent to air handler AHA-07.

7.9 Kitchen Ventilation and Refrigeration Equipment

The following is a summary of our observations on site:

- The Studio Building contains a central kitchen located at the concourse level. The kitchen prepares daily meals for lunch and afterhours programs.
- It is estimated that the kitchen prepares approximately 300 meals per day for the duration of the school year (close to 37 weeks/year).

- The kitchen contains a variety of cooking equipment that uses both gas and electricity.
- The main cooking equipment is covered by a single exhaust hood, with an approximate area of 70 ft^2. The hood is connected to a roof-top exhaust fan rated at 3000 CFM. The kitchen exhaust fan operates continuously throughout the duration of the school year. There is no dedicated make-up air unit to replenish the air extracted by the kitchen hood.

- The dishwasher, manufactured by Hobart is a commercial-type unit that contains a 54 kW electric DHW booster for sanitation. The dishwasher is connected to a dedicated roof-top exhaust fan rated at 600 CFM.
- The kitchen contains two walk-in coolers (maintained at 3°C to 4°C) and one walk-in freezer (maintained at -15°C).

- Refrigeration compressors are located in a small storage room at the concourse level; they reject heat towards the building's chilled water loop. In the event that the chilled water loop fails, the compressors may reject heat directly to DCW by opening the operating series of 2-way valves.

- The following is a listing of the refrigeration compressors:
  a. System 1 compressor: 208V/3ph/4.3 Amps.
  b. System 2 compressor: .208V/3ph/12.8 Amps.
  c. System 3 compressor: 208V/3ph/4.3 Amps.
- The main floor servery contains some standard refrigeration equipment, typical electrical appliances, and electric food-warming trays.

7.10 Swimming Pool Equipment

The following is a summary of our observations on site:

- Betty Oliphant Theatre is equipped with a small training pool located at the basement level.
- The pool covers an area of approximately 500 ft^2; the water is maintained at 80°F.
- The pool filtration and pumping equipment is located in the sub-basement pool equipment room. The equipment includes two fiberglass sand filters, and a 5 HP circulation pump.

- Heating for the pool water and ventilation to the pool area is provided by a dedicated Dry-O-Tron unit located in the basement mechanical room of the BOT building.
- Secondary heating to the pool is provided through a tube-in-shell heat exchanger using heating boiler water as the agent. Output of the heat exchanger is modulated by a 2-way control valve.
- Pool heating and filtration equipment appears in poor condition. The heat exchanger and associated steel and copper piping are un-insulated with notable signs of rust.

- The pool ventilation unit provides 8.8 ton of mechanical refrigeration and can reject the condensation heat towards the pool water (via a fractional HP pump), towards the pool ventilation air or to a dedicated condenser located on the roof. The Dry-O-Tron is equipped with a 3 HP blower, supplying 3,300 cfm. A small heat recovery unit is installed between the fresh air and exhaust air streams in order to recover some of the heat from the exhausted pool air.

7.11 Garage Ventilation Equipment

The following is a summary of our observations on site:

- The Studio Building has a single level of underground parking.
- Ventilation to the garage is provided by a pair of 1-½ HP propeller exhaust fans paired together with two make-up air units.
- The two make-up air units are located in the underground garage. Each MAU is equipped with a 585 MBH gas-fired heat exchanger, and a supply fan rated at 5 HP, 7000 CFM.
- The operation of the make-up air units is interlocked with the operation of the exhaust fans. Garage ventilation is controlled by a CO monitoring system.

7.12 Building Automation System

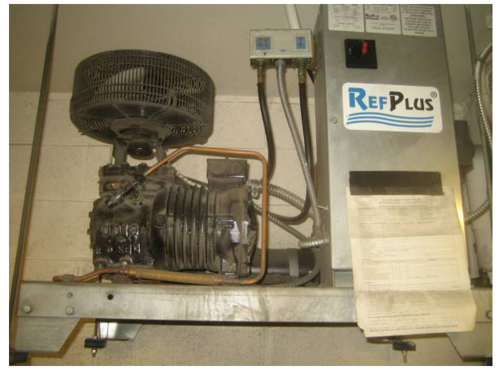
The following are our observations from on site:

- The building automation system (BAS) for the entire group of buildings is by TAC – Automated Logic.
- The system controls all major HVAC equipment serving the four Jarvis buildings including the heating and cooling plants, air handlers, exhaust fans, as well as terminal HVAC equipment such as radiators, unit heaters, re-heat coils, etc.
- The digital controls are tied into a workstation with a graphical user interface.

7.13 Miscellaneous Equipment

The following are our observations from on site:

- A natural gas fireplace is located at the main level of the Studio Building. The fireplace operates between November and March for approximately 6 hours/day. Combustion air to the fireplace is provided by a fractional HP fan located in the Studio Building basement chiller room. The fireplace also has an exhaust air fan located on the 4th floor.



- Cooling to the garbage room located at the P1 level of the Studio Building is provided by a two-fan evaporator connected to a refrigeration compressor. The air cooled compressor is installed adjacent to the garbage room, in the parking garage; it is rated at 208V/3ph/3.5RLA.
- Utility rooms with large heat gains are equipped with split type DX AC units, with the condensers located in the P1 level parking garage space of the Studio Building. The total cooling capacity of the DX condensers located in the garage is 51,100 Btu/hr.

- Electric heating cables are installed inside gutter drains serving the Academic Building, Studio Building and the Lozinski House. Underslab heating cables have been installed for the Pavilion slab overhang. Total connected load for the electric heating cables is 22,545 Watts.

- A total of 8 submersible pumps are located at the underground level of the Studio Building and the Academic tunnel. Sanitary sump pumps located in the P1 level mechanical room are rated at 1.5 HP each; sanitary sump pumps located in the chiller room are rated at 10 HP each; storm sump pumps located in the chiller room are rated at 15 HP each; sanitary sump pumps located in the Academic tunnel are rated at $\frac{1}{3}$ HP each.

7.14 Elevators

The following are our observations from on site:

- The Studio Building is served by a pair of main public use elevators equipped with 50 HP electric motors; elevator equipment is located in the penthouse elevator machine room. A large freight elevator serves the sub-basement to 2^{nd} floor of the building; the elevator is powered by a 40 HP hydraulic motor located inside the dedicated elevator machine room at the sub-basement level. A small servery elevator is used for moving food between the concourse level and main floor; the elevator is powered by a 5 HP motor located at the P1 parking level inside a dedicated elevator machine room.

- The Academic Building: basement to 4th floors are served by a single public use elevator powered by a 50 HP hydraulic motor located in the basement mechanical room.
- Lozinski House includes a small 5 HP elevator serving basement to 3rd floor.
- Betty Oliphant Theatre is equipped with a small freight elevator. A stage lift located in the main theatre is powered by 4 electric motors.

7.15 Lighting

The following are our observations from on site:

- In general the lighting fixtures are in good condition. Control of the lighting is done by timers or the staff in the various areas of the building. Many valence fixtures in the corridors have lamps removed to help reduce consumption.
- Most fluorescent linear lighting is a mixture of T8 and T5 high output lamps with electronic ballasts. Older areas such as the BOT have T12 lamps with magnetic ballasts.
- Pot lights are a mixture of CFL with external ballasts, LED, CFL, or halogen.
- There is a mixture of CFL and incandescent lamps in various areas in the buildings.
- Occupancy sensors are utilized in washrooms and storage rooms throughout the facility.
- Exit signs are LED.
- Outdoor lighting consists of fixtures utilizing HID lamps of various wattages as well as T5 high out linear fluorescent lamps.

7.16 Water Fixtures

The following are our observations from on site:

- Faucets in change rooms and washrooms are rated at 7.6 litres per minute (lpm). Showers in the facility are rated for 9.5 lpm.
- Toilets in the renovated spaces including the Studio, Lozinski House and Academic buildings are rated for 6 liters per flush (lpf) and urinals are rated for 3.8 litres per flush (lpf). Toilets in the theatre are rated at 13 lpf. The urinals utilize infrared controls.

8. Recommended Measures

The following sections detail the savings measures that are recommended for implementation.

8.1 Recover the Heat Rejected by the Chillers & Use It to Preheat Domestic Hot Water

Existing Conditions

Our visual inspection revealed the following:

- The heat rejected by the chiller plant during the cooling season is dissipated to the ambient.

Recommendations

In order to decrease the energy consumption of the DHW system located in the penthouse mechanical room of the Studio Building, we recommend the following measure:

- Recover the heat rejected by the chillers to prepare the DHW.

Outline of Scope of Work

- Supply and install a heat exchanger, using the condenser water as the primary agent.
- Divert the domestic cold water through the heat exchanger.
- Modify the domestic cold water and condenser water as required to suit the new equipment layout.
- Install a 3-way mixing valve to have the condenser water by-pass the heat exchanger if sufficient heat was exchanged to preheat the cold water.
- Provide the necessary control sensors and devices.

Benefits

The main benefit of this measure would be the energy savings resulting from recovering the heat rejected by the chiller plant to preheat the DHW. The potential savings are shown below:

Recover the Heat Rejected by the Chillers & Use It to Preheat Domestic Hot Water

Consumption Savings / Year	GHG Savings / Year	Cost Savings / Year	Net Cost of Retrofit	Payback
14,310 m^3 gas	27 tonnes	$5,300		
Total	27 tonnes	$5,300	$ 74,950	14.1 years

8.2 Replace the Existing DHW Heater Serving the BOT with an Instantaneous Indirect Water Heater Fed from the Main BOT Boilers

<u>Existing Conditions</u>

Our visual inspection revealed the following:

- The DHW for the Betty Oliphant Theatre is prepared using an atmospheric water heater which, most of the time, works in condensation mode.

<u>Recommendations</u>

In order to improve the efficiency of the DHW system serving the BOT building, we recommend the following measure:

- Replace the existing DHW tank heater with an instantaneous indirect water heater fed from the main heating boilers.

<u>Outline of Scope of Work</u>

- Remove the existing atmospheric water heater.
- Supply and install the instantaneous indirect water heater.
- Connect new heater to heating loop, power and controls.
- Make good the existing vent opening.

<u>Benefits</u>

The main benefit of this measure would be the energy savings resulting from the increased efficiency of the DHW preparation for the BOT building. The potential savings are shown below:

Replace the Existing DHW Heater Serving the BOT with an Instantaneous Indirect Water Heater Fed from the Main BOT Boilers

Consumption Savings / Year	GHG Savings / Year	Cost Savings / Year	Net Cost of Retrofit	Payback
820 m³ gas	2 tonnes	$300		
Total	2 tonnes	$300	$ 13,800	46.0 years

8.3 Replace the Existing Heating Boilers Serving the BOT with High Efficiency Models

Existing Conditions

Our visual inspection revealed the following:

- The existing atmospheric boilers serving the BOT building have an efficiency of approximately 70% and little modulation capacity. They are also in below-average condition.

Recommendations

In order to improve the efficiency of the heating system, we recommend the following measure:

- Replace the existing hot water boilers with new ones, of high efficiency, equipped with modulating burners and with an efficiency range of 82 to 85%.

Outline of Scope of Work

- Remove the existing atmospheric boilers.
- Supply and install the new high-efficiency boilers.
- Modify the piping, add balancing and other fittings as required.
- Make good the existing vent opening, provide new venting for the new heater.
- Modify the controller programming to reflect the new equipment being controlled, including the burners.

Benefits

The main benefit of this measure is the energy savings resulting from the boilers increased efficiency. The potential savings are shown below:

Replace the Existing Heating Boilers Serving the BOT with High Efficiency Models

Consumption Savings / Year	GHG Savings / Year	Cost Savings / Year	Net Cost of Retrofit	Payback
21,260 m³ gas	40 tonnes	$7,850		
Total	40 tonnes	$7,850	$ 307,650	39.2 years

8.4 Install a Pool Cover to Reduce Heat Loss During Unoccupied Periods

<u>Existing Conditions</u>

Our visual inspection revealed the following:

- Betty Oliphant Theatre is equipped with a small training pool located at the basement level. The pool covers an area of approximately 500 ft^2; the water is maintained at 80°F.
- Currently, the pool does not have a pool cover.

<u>Recommendations</u>

In order to lower the water evaporation from the pool and from the hot tub we recommend, we recommend the following measure:

- Install a pool cover for the swimming pool. Use of the cover will cut down on water evaporation from the surface and would cut down on humidity in the space. This would also lower the operation of the Dry-O-Tron unit.

<u>Benefits</u>

The make-up water for the pool would be lowered and cost of heating of the pool water would be reduced. The potential savings are shown below:

Install a Pool Cover to Reduce Heat Loss During Unoccupied Periods

Consumption Savings / Year	GHG Savings / Year	Cost Savings / Year	Net Cost of Retrofit	Payback
6,350 kWh elec. 3,670 m^3 gas	2 tonnes 7 tonnes	$850 $1,350		
Total	9 tonnes	$2,200	$ 5,050	2.3 years

8.5 Lighting Retrofit

Existing Conditions

Our visual inspection revealed the following:

- Fluorescent lighting consists of 32W T8 lamps on electronic ballasts. These fluorescent lamps are found in areas such as offices, washrooms, and corridors. There are 54W T5HO lamps located in the studios and exterior.
- There are CFL lamps ranging from 18W to 32W located throughout the facility in pot lights.
- Occupancy sensors are located in the washrooms and most storage rooms.
- Some areas utilize halogen, CFL or incandescent lamps of various wattages.
- Exit signs are all LED.
- Exterior lighting utilizes HID lamps of various wattages.

Recommendations

In order to improve the efficiency of the lighting and decrease the electricity usage of the building, we recommend the following measures:

- Replace all 32W T8 lamps with 25W lamps. Replace all 54W T5HO lamps with 44W or 49W (where applicable) lamps. Replace any T12 lamps and magnetic ballasts with T8 lamps and electronic ballasts. Replace all magnetic ballasts with electronic ballasts.
- Replace any halogen, incandescent or CFL lamps with LED equivalents where applicable.
- Replace all exterior lighting with LED equivalents where applicable.
- The major areas that are included in the retrofit include the pool, studios, academic building and Lozinski House. Please refer to Appendix B for further details.

Benefits

The main benefit of these measures is the reduction of energy used for lighting while maintaining the lighting level. The potential savings are shown below:

Lighting Retrofit

Consumption Savings / Year	GHG Savings / Year	Cost Savings / Year	Net Cost of Retrofit	Payback
137,550 kWh elec.	28 tonnes	$18,300		
Total	28 tonnes	$18,300	$ 119,900	6.6 years

8.6 Install Ultra High Efficiency Toilets, Urinals & Low-Flow Aerators

Existing Conditions

Our visual inspection revealed the following:

- Faucets in change rooms and washrooms are rated at 7.6 litres per minute (lpm). Showers in the facility are rated for 9.5 lpm.
- Toilets in the renovated spaces including the Studio, Lozinski House and Academic Buildings are rated for 6 liters per flush (lpf) and urinals are rated for 3.8 litres per flush (lpf). Toilets in the theatre are rated at 13 lpf.

Recommendations

In order to reduce the water consumption and the energy used to heat it, we recommend the following measures:

- Replace all flush-valve toilets with high efficiency toilets (HET) using 4.8 lpf. Replace existing tank-type toilets with 3.0 lpf ultra high efficiency toilets.
- Replace the urinals with high efficiency urinals (HEU) using 0.5 lpf.
- Replace all aerators with new 1.9 gpm aerators.
- Replace all showerheads with new 5.7 gpm showerheads.

Benefits

The benefits of the measure would be water cost savings, and water heating energy savings. The potential savings are shown below:

Install Ultra High Efficiency Toilets, Urinals & Low-Flow Aerators

Consumption Savings / Year	GHG Savings / Year	Cost Savings / Year	Net Cost of Retrofit	Payback
3,470 m³ gas 1,960 m³ water	7 tonnes	$1,300 $4,850		
Total	7 tonnes	$6,150	$ 37,800	6.1 years

9. Additional Considerations

9.1 Install Renewable Energy Equipment

The existing roofs contain areas which could be used for solar photovoltaic panels; unfortunately, the higher surrounding buildings shadow these roof sections for considerable periods of the day, thereby reducing the efficiency of the panels which would make their cost prohibitive.

9.2 Replace the Domestic Cold Water Booster System with One Equipped with Variable Frequency Drive

The cold water booster system already includes three pumps (5 stage capability), which is controlled based on the downstream pressure. We see no economic feasibility in replacing the system with a new variable frequency drive controlled package.

10. Monitoring & Tracking, Training & Education

Energy monitoring and target setting is the collection, interpretation and reporting of information on energy use. Its role within energy management is to measure and maintain performance and to locate opportunities for reducing energy consumption and cost. Energy M&T has much in common with the information side of performance management in that it uses similar techniques of data gathering, analysis and reporting.

A simple way to use energy information as an aid to management is to compare the overall energy consumption of an enterprise, site or process with others of a similar kind. This general assessment approach is known as benchmarking. By consistently collecting energy data, analyzing and creating meaningful indices then reporting to all levels of management with easily understood parameters, the process has been shown to reduce energy use by up to 15% when compared to “normal” operations.

The main concept is to compare operations of a building under similar conditions and see if the energy index can be improved. For example, if a building can provide comfort for X kJ/heating degree days, but uses X+Y kJ/HDD on another day, why is there the “Y” kJ/HDD and what was happening differently on that day compared to the X kJ/HDD situation.

An M&T program is best implemented with an automated data collection and analysis system such as Emmit, which measures by circuit level for highly granular data. The ideal system provides customizable reports to pinpoint opportunities for efficiency—such as distribution between HVAC loads or after-hours costs, and makes this information available to the right parties at the right times in an easily-digestible and actionable format.

Training is an integral part of the project plan and is critical to the success of the project in terms of achieving and sustaining the proposed savings. The overall intent of the training program is to complement the technological and organization changes proposed in the plan and maximize the energy savings resulting from the project. Training on building systems and energy efficiency will allow the building staff to modify operations to increase efficiencies, identify opportunities for energy savings measures and raise awareness of energy efficiency among the non-technical staff. Case studies have shown that energy training and education for operators and staff can lead to greater energy savings than many building retrofits.

While only the maintenance/engineering staff require technical training, Canada's National Ballet School should conduct information seminars for the staff to instruct them of steps they can take to reduce energy consumption.

It has been assumed that (a conservative) 2.0% of the building’s annual energy costs (excluding the process usage) will be saved by the implementation of a these programs.

Monitoring & Tracking, Training & Education

Consumption Savings / Year	GHG Savings / Year	Cost Savings / Year	Net Cost of Retrofit	Payback
56,650 kWh elec. 5,270 m³ gas 280 m³ water	11 tonnes 10 tonnes	\$7,550 \$1,950 \$700		
Total	21 tonnes	\$10,200	\$ 14,350	1.4 years

11. Communication

Canada's National Ballet School should implement a communication program to communicate any activities and achievements related to energy efficiency. The communications program should employ a variety of tools including demonstrations, bulletin boards, posters and newsletters to create awareness of energy efficiency, the environment and climate change. The communication program should also provide a channel for input from the occupants for future energy efficiency projects, activities and programs. By keeping everyone informed of what is expected of them in terms of reducing energy consumption; what changes are being made to the facility; and how the building is progressing towards its energy reduction target, will help occupants to buy into the idea of becoming energy efficient.

The communication program could also perform the additional function of keeping new occupants informed of reasons behind energy efficiency measures implemented at the building.

Appendix A – Utility Data Consumption & Cost

The baseline is the forecasted utility usage for the given billing period and weather conditions based upon historical energy performance and weather conditions. The baseline is adjusted to account for changes in the weather and changes in the length of the billing period, e.g. if the current billing period is longer and colder than the historical billing period, the forecasted energy consumption would be increased to predict the consumption more accurately.

The baseline can be used to predict what utility consumption and cost would have been if no energy efficiency measures had been implemented at the property. Comparing the actual utility billings to the baselines can provide an accurate measure of the savings achieved from energy efficiency projects.

The following baselines were selected for the building utility meters:

Electricity Consumption

Base year from January 2012 - December 2012 with corrections to cooling degree days and billing period length.

Natural Gas Consumption

Base year from January 2012 - December 2012 with corrections to heating degree days and billing period length.

Water Consumption

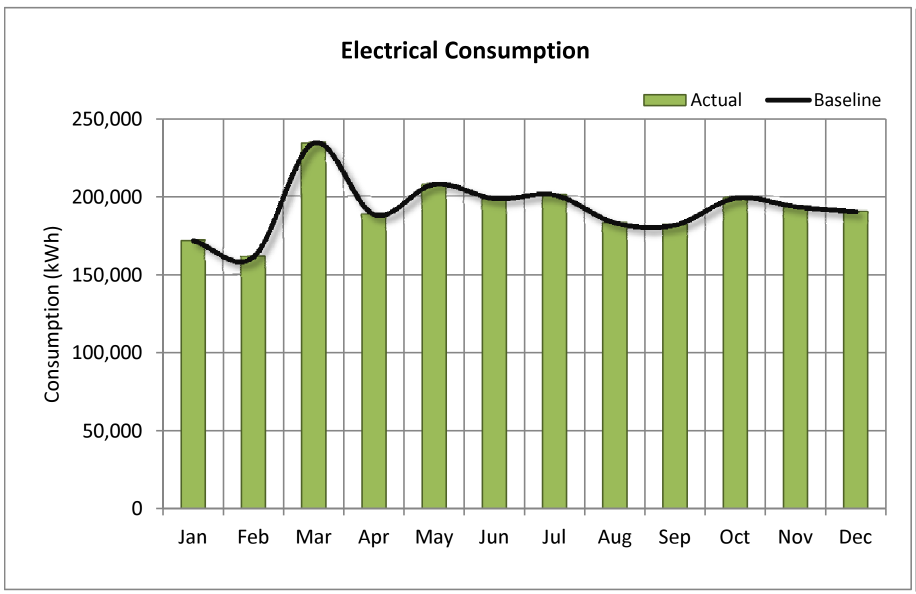
Base year from January 2012 - December 2012 with corrections billing period length only.

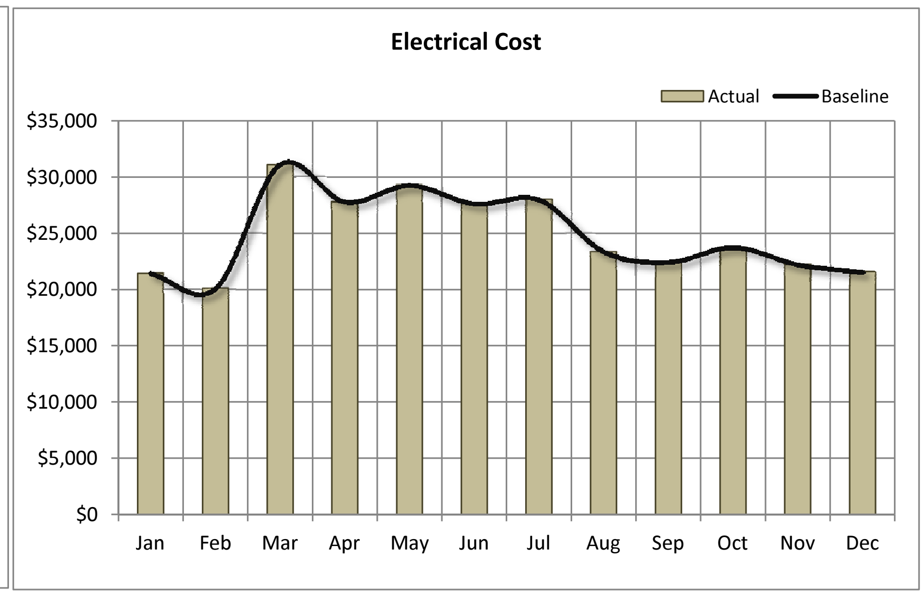
The National Ballet School

2012 Electrical Consumption and Cost Savings - Studio, Northfield House and Academic Buildings

	Adjusted Baseline for 2012		Actual 2012		Variance	
	Consump (kWh)	Cost ($)	Consump (kWh)	Cost ($)	Consump (kWh)	Cost ($)
Jan	171,885	$21,424	171,885	$21,424	-	$0
Feb	161,636	$20,100	161,636	$20,100	-	$0
Mar	234,584	$31,100	234,584	$31,100	-	$0
Apr	188,600	$27,779	188,600	$27,779	-	$0
May	208,126	$29,242	208,126	$29,242	-	$0
Jun	198,795	$27,609	198,795	$27,609	-	$0
Jul	201,049	$27,962	201,049	$27,962	-	$0
Aug	183,276	$23,353	183,276	$23,353	-	$0
Sep	182,008	$22,425	182,008	$22,425	-	$0
Oct	199,156	$23,752	199,156	$23,752	-	$0
Nov	193,665	$22,206	193,665	$22,206	-	$0
Dec	190,327	$21,540	190,327	$21,540	-	$0
Total	2,313,106	$298,492	2,313,106	$298,492	-	$0

Note: +=Savings () = Overrun





Finn Projects
(Synchronicity Projects Inc.)

The National Ballet School
Electricity Ledger - Studio, Northfield House and Academic Buildings

Year 2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$21,480	$21,082	$22,685	$22,051	$24,920	$27,689	$27,338	$23,529	$23,485	$23,758	$21,679	$22,939	$282,637
Consumption (kWh)	181,553	171,179	185,938	177,628	192,542	203,673	204,642	190,243	180,671	191,924	183,046	184,535	2,247,575
Demand (kW)	426	414	398	446	554	648	648	523	530	530	422	422	5,959
% PF	93.8%	92.8%	92.9%	92.9%	91.5%	91.5%	91.5%	91.9%	92.0%	93.3%	93.3%	93.3%	92.6%
Cooling Degree-Days	0	0	0	3	59	182	353	275	145	31	1	0	1,050
Heating Degree-Days	619	514	416	221	67	0	0	0	5	111	193	380	2,527
Unit Cost ($/kWh)	$0.118	$0.123	$0.122	$0.124	$0.129	$0.136	$0.134	$0.124	$0.130	$0.124	$0.118	$0.124	$0.126

Year 2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$21,424	$20,100	$31,100	$27,779	$29,242	$27,609	$27,962	$23,353	$22,425	$23,752	$22,206	$21,540	$298,492
Consumption (kWh)	171,885	161,636	234,584	188,600	208,126	198,795	201,049	183,276	182,008	199,156	193,665	190,327	2,313,106
Demand (kW)	411	494	494	493	539	609	609	511	495	475	424	416	5,970
% PF	92.8%	92.8%	93.7%	93.7%	91.8%	91.8%	91.2%	91.2%	91.1%	93.5%	93.5%	93.5%	92.6%
Cooling Degree-Days	0	0	17	8	124	228	349	264	113	20	0	0	1,122
Heating Degree-Days	457	386	211	180	14	0	0	0	13	107	284	379	2,032
Unit Cost ($/kWh)	$0.125	$0.124	$0.133	$0.147	$0.141	$0.139	$0.139	$0.127	$0.123	$0.119	$0.115	$0.113	$0.129

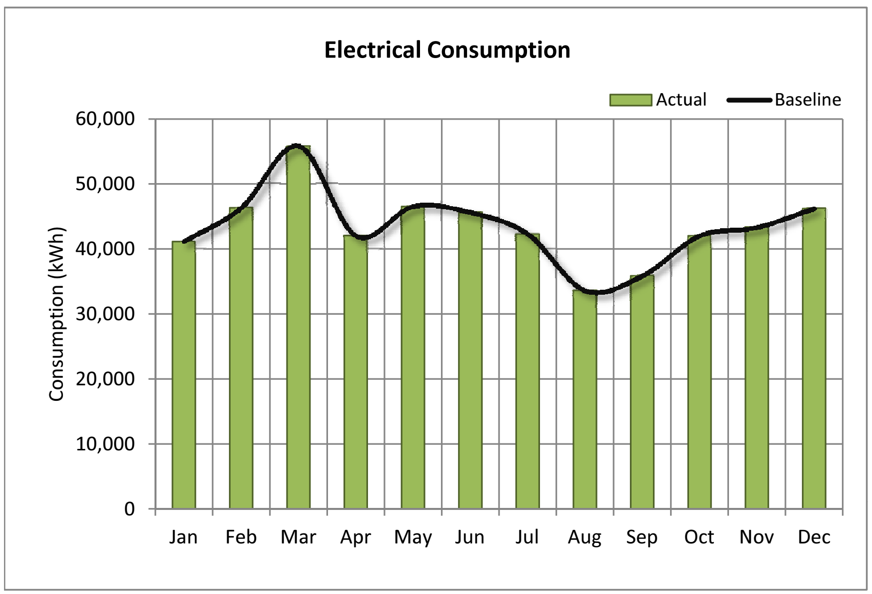
Year 2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$19,958	$20,289	$22,240	$22,662	$25,123								$110,272
Consumption (kWh)	180,983	171,952	194,459	184,482	201,305								933,181
Demand (kW)	432	432	469	515	515								2,364
% PF	94.1%	94.1%	93.3%	92.3%	92.3%								93.2%
Cooling Degree-Days	0	0	0	3	103								106
Heating Degree-Days	469	492	399	212	34								1,606
Unit Cost ($/kWh)	$0.110	$0.118	$0.114	$0.123	$0.125								$0.118

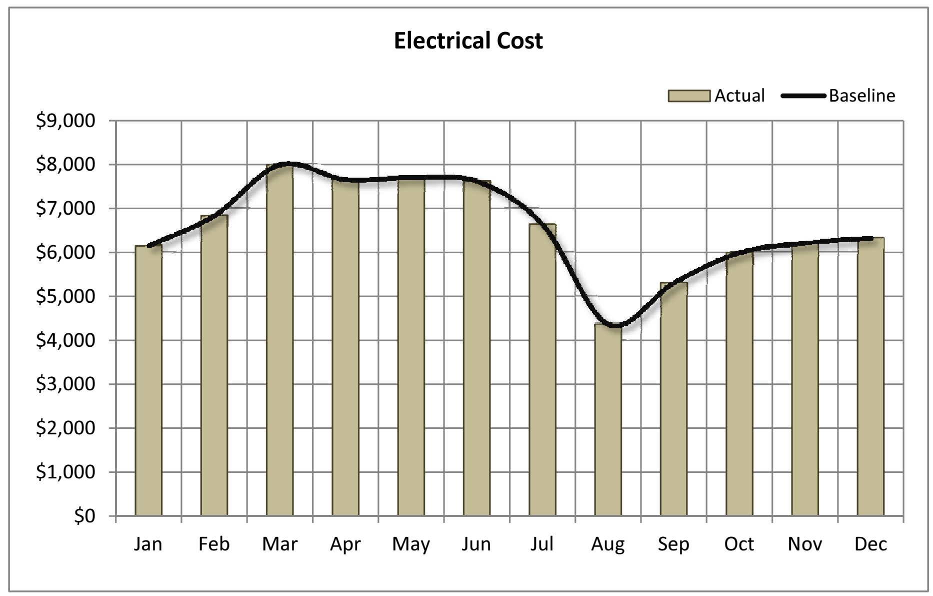
The National Ballet School

2012 Electrical Consumption and Cost Savings - Theatre

Note: +=Savings () = Overrun

	Adjusted Baseline for 2012		Actual 2012		Variance	
	Consump (kWh)	Cost ($)	Consump (kWh)	Cost ($)	Consump (kWh)	Cost ($)
Jan	41,145	$6,148	41,145	$6,148	-	$0
Feb	46,327	$6,832	46,327	$6,832	-	$0
Mar	55,800	$7,993	55,800	$7,993	-	$0
Apr	42,000	$7,651	42,000	$7,651	-	$0
May	46,531	$7,705	46,531	$7,705	-	$0
Jun	45,596	$7,612	45,596	$7,612	-	$0
Jul	42,273	$6,626	42,273	$6,626	-	$0
Aug	33,579	$4,360	33,579	$4,360	-	$0
Sep	35,871	$5,310	35,871	$5,310	-	$0
Oct	42,030	$5,994	42,030	$5,994	-	$0
Nov	43,302	$6,213	43,302	$6,213	-	$0
Dec	46,218	$6,326	46,218	$6,326	-	$0
Total	520,673	$78,771	520,673	$78,771	-	$0





Finn Projects
(Synchronicity Projects Inc.)

The National Ballet School
Electricity Ledger - Theatre

Year 2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$6,842	$7,010	$7,950	$7,200	$7,406	$7,730	$6,071	$4,496	$6,870	$5,979	$6,309	$6,428	$80,292
Consumption (kWh)	52,934	49,891	62,022	48,501	48,688	48,371	41,576	35,824	45,000	38,944	41,456	40,927	554,134
Demand (kW)	178	178	218	241	241	241	157	157	197	198	226	185	2,417
% PF	82.5%	82.5%	87.3%	87.4%	87.4%	87.4%	83.7%	85.5%	83.9%	85.7%	91.1%	91.4%	86.3%
Cooling Degree-Days	0	0	0	3	59	182	353	275	145	31	1	0	1,050
Heating Degree-Days	619	514	416	221	67	0	0	0	5	111	193	380	2,527
Unit Cost ($/kWh)	$0.129	$0.141	$0.128	$0.148	$0.152	$0.160	$0.146	$0.126	$0.153	$0.154	$0.152	$0.157	$0.145

Year 2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$6,148	$6,832	$7,993	$7,651	$7,705	$7,612	$6,626	$4,360	$5,310	$5,994	$6,213	$6,326	$78,771
Consumption (kWh)	41,145	46,327	55,800	42,000	46,531	45,596	42,273	33,579	35,871	42,030	43,302	46,218	520,673
Demand (kW)	185	185	212	212	227	227	174	136	152	203	203	173	2,290
% PF	91.4%	91.9%	87.0%	87.0%	87.0%	89.8%	89.8%	82.6%	76.7%	85.8%	85.8%	83.8%	86.6%
Cooling Degree-Days	0	0	17	8	124	228	349	264	113	20	0	0	1,122
Heating Degree-Days	457	386	211	180	14	0	0	0	13	107	284	379	2,032
Unit Cost ($/kWh)	$0.149	$0.147	$0.143	$0.182	$0.166	$0.167	$0.157	$0.130	$0.148	$0.143	$0.143	$0.137	$0.151

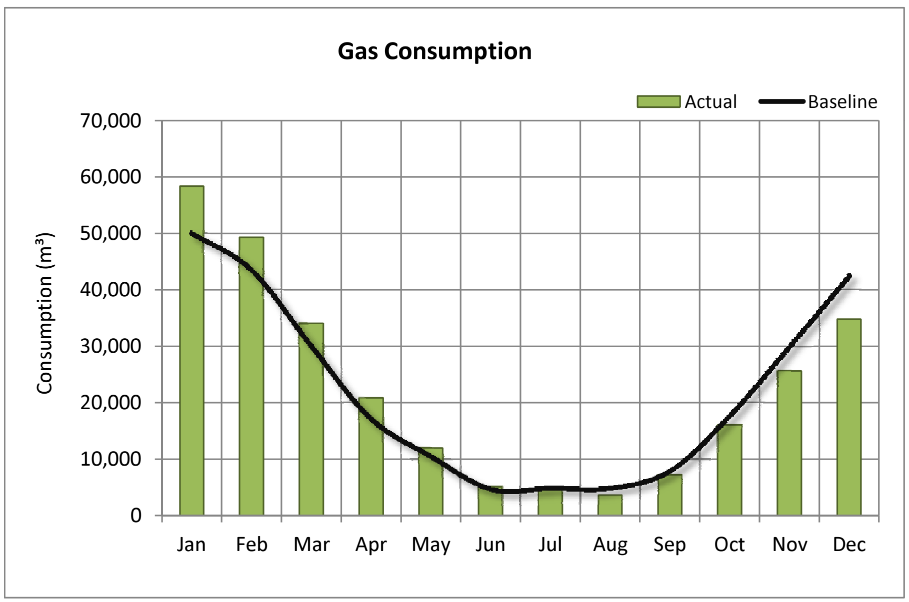
Year 2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$5,789	$6,972	$6,446	$6,431	$6,693	$7,069							$39,400
Consumption (kWh)	46,240	51,520	50,034	44,426	44,100	43,800							280,120
Demand (kW)	175	175	178	223	223	202							1,177
% PF	87.4%	87.4%	87.4%	91.0%	91.0%	84.8%							88.2%
Cooling Degree-Days	0	0	0	3	103	173							279
Heating Degree-Days	469	492	399	212	34	1							1,607
Unit Cost ($/kWh)	$0.125	$0.135	$0.129	$0.145	$0.152	$0.161							$0.141

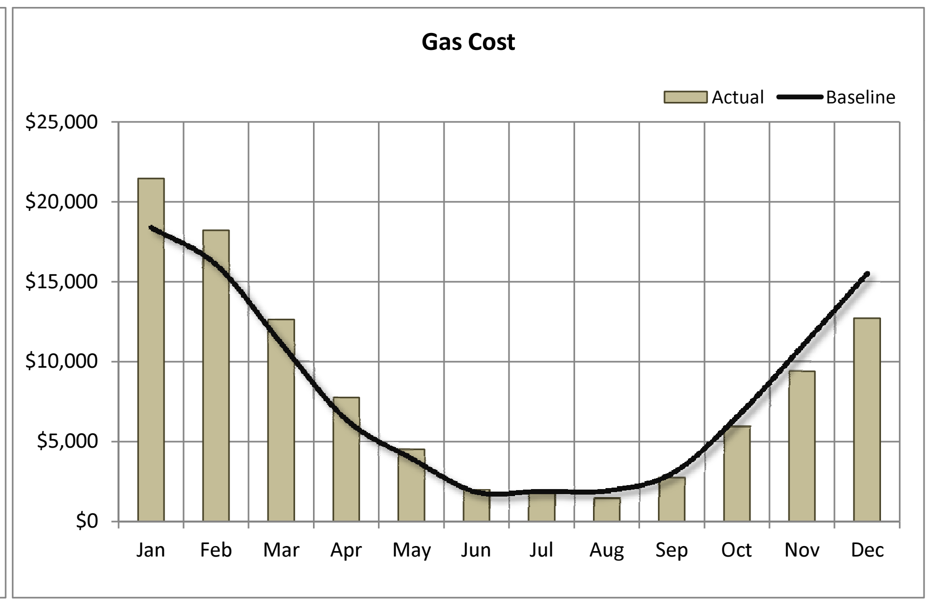
Prorated Bill

The National Ballet School
2012 Gas Consumption and Cost Savings

	Adjusted Baseline for 2012		Actual 2012		Variance	
	Consump (m^3)	Cost ($)	Consump (m^3)	Cost ($)	Consump (m^3)	Cost ($)
Jan	50,054	$18,390	58,400	$21,458	(8,346)	-$3,068
Feb	43,490	$16,054	49,337	$18,210	(5,847)	-$2,156
Mar	30,022	$11,128	34,067	$12,629	(4,045)	-$1,501
Apr	17,134	$6,363	20,882	$7,755	(3,748)	-$1,392
May	10,503	$3,950	12,007	$4,509	(1,504)	-$559
Jun	4,719	$1,844	5,115	$1,998	(396)	-$154
Jul	4,876	$1,927	4,531	$1,781	345	$146
Aug	4,876	$1,943	3,644	$1,450	1,232	$493
Sep	7,931	$3,020	7,239	$2,752	692	$268
Oct	17,711	$6,560	16,050	$5,948	1,661	$612
Nov	29,952	$10,980	25,634	$9,397	4,318	$1,582
Dec	42,486	$15,522	34,825	$12,724	7,660	$2,799
Total	263,753	$97,680	271,731	$100,610	(7,978)	-$2,930

Note: +=Savings () = Overrun





Finn Projects
(Synchronicity Projects Inc.)

The National Ballet School
Gas Ledger

Year 2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$23,014	$19,741	$16,863	$11,245	$5,542	$2,725	$2,109	$1,263	$980	$5,397	$10,714	$16,770	$116,362
Consumption (m^3)	56,850	48,884	41,354	27,038	12,957	6,250	4,764	2,784	2,207	14,427	29,250	45,851	292,616
Cooling Degree-Days	0	0	0	3	59	182	353	275	145	31	1	0	1,050
Heating Degree-Days	619	514	416	221	67	0	0	0	5	111	193	380	2,527
Unit Cost ($/$m^3$)	$0.405	$0.404	$0.408	$0.416	$0.428	$0.436	$0.443	$0.454	$0.444	$0.374	$0.366	$0.366	$0.398

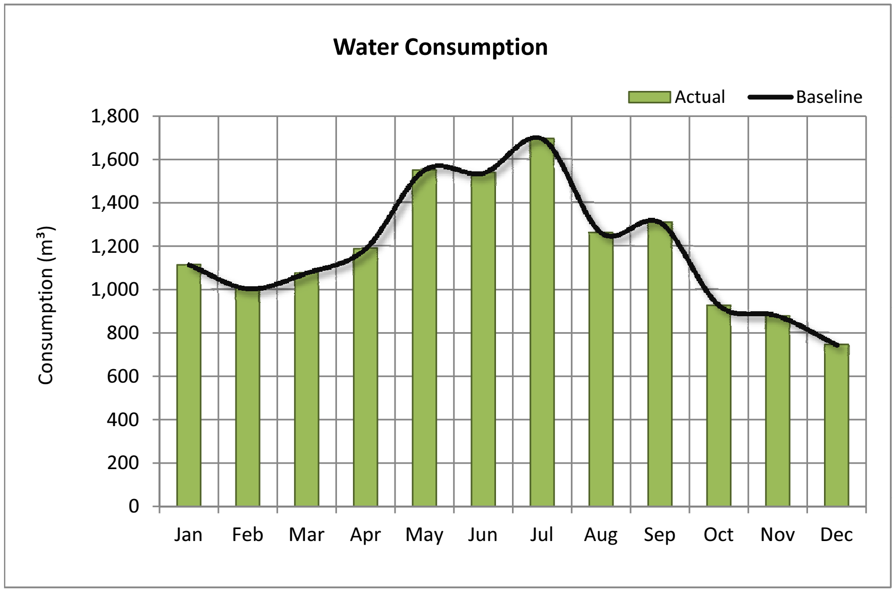
Year 2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$21,458	$18,210	$12,629	$7,755	$4,509	$1,998	$1,781	$1,450	$2,752	$5,948	$9,397	$12,724	$100,610
Consumption (m^3)	58,400	49,337	34,067	20,882	12,007	5,115	4,531	3,644	7,239	16,050	25,634	34,825	271,731
Cooling Degree-Days	0	0	17	8	124	228	349	264	113	20	0	0	1,122
Heating Degree-Days	457	386	211	180	14	0	0	0	13	107	284	379	2,032
Unit Cost ($/$m^3$)	$0.367	$0.369	$0.371	$0.371	$0.376	$0.391	$0.393	$0.398	$0.380	$0.371	$0.367	$0.365	$0.370

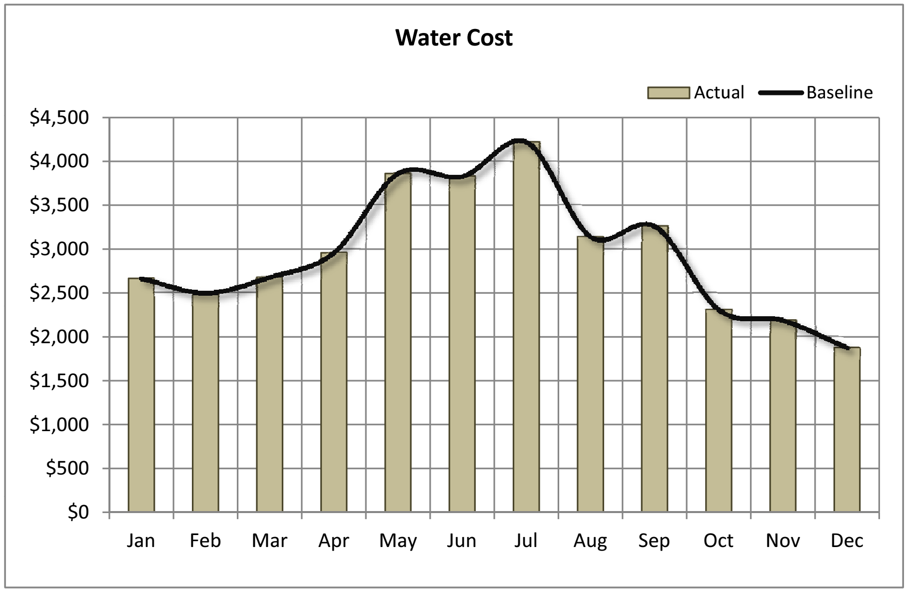
Year 2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$15,802	$15,357	$13,160	$8,140	$4,217								$56,676
Consumption (m^3)	43,263	41,999	35,871	21,979	11,140								154,251
Cooling Degree-Days	0	0	0	3	103								106
Heating Degree-Days	469	492	399	212	34								1,606
Unit Cost ($/$m^3$)	$0.365	$0.366	$0.367	$0.370	$0.379								$0.367

The National Ballet School
2012 Water Consumption and Cost Savings

	Adjusted Baseline for 2012		Actual 2012		Variance	
	Consump (m³)	Cost ($)	Consump (m³)	Cost ($)	Consump (m³)	Cost ($)
Jan	1,114	$2,667	1,114	$2,667	-	$0
Feb	1,004	$2,500	1,004	$2,500	-	$0
Mar	1,076	$2,679	1,076	$2,679	-	$0
Apr	1,188	$2,958	1,188	$2,958	-	$0
May	1,551	$3,862	1,551	$3,862	-	$0
Jun	1,538	$3,828	1,538	$3,828	-	$0
Jul	1,694	$4,217	1,694	$4,217	-	$0
Aug	1,261	$3,139	1,261	$3,139	-	$0
Sep	1,309	$3,258	1,309	$3,258	-	$0
Oct	926	$2,305	926	$2,305	-	$0
Nov	877	$2,184	877	$2,184	-	$0
Dec	744	$1,873	744	$1,873	-	$0
Total	14,282	$35,470	14,282	$35,470	-	$0

Note: +=Savings () = Overrun





Finn Projects
(Synchronicity Projects Inc.)

The National Ballet School
Water Ledger

Year 2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$3,999	$3,428	$3,987	$2,707	$2,291	$2,662	$3,610	$1,874	$1,818	$2,755	$2,649	$2,665	$34,446
Consumption (m^3)	1,940	1,646	1,761	1,185	1,003	1,165	1,580	821	796	1,206	1,160	1,120	15,382
Cooling Degree-Days	0	0	0	3	59	182	353	275	145	31	1	0	1,050
Heating Degree-Days	619	514	416	221	67	0	0	0	5	111	193	380	2,527
Unit Cost ($/m³)	$2.061	$2.083	$2.264	$2.284	$2.285	$2.285	$2.284	$2.284	$2.284	$2.284	$2.284	$2.380	$2.239

Year 2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$2,667	$2,500	$2,679	$2,958	$3,862	$3,828	$4,217	$3,139	$3,258	$2,305	$2,184	$1,873	$35,470
Consumption (m^3)	1,114	1,004	1,076	1,188	1,551	1,538	1,694	1,261	1,309	926	877	744	14,282
Cooling Degree-Days	0	0	17	8	124	228	349	264	113	20	0	0	1,122
Heating Degree-Days	457	386	211	180	14	0	0	0	13	107	284	379	2,032
Unit Cost ($/m³)	$2.394	$2.490	$2.489	$2.489	$2.489	$2.489	$2.490	$2.490	$2.490	$2.489	$2.489	$2.517	$2.483

Year 2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Cost	$2,293	$2,071	$2,635	$2,490	$3,157								$12,645
Consumption (m^3)	839	758	971	918	1,164								4,649
Cooling Degree-Days	0	0	0	3	103								106
Heating Degree-Days	469	492	399	212	34								1,606
Unit Cost ($/m³)	$2.733	$2.733	$2.714	$2.713	$2.713								$2.720

Appendix B - Lighting Retrofit Summary

The following is a summary of the potential demand (kW) and consumption (kWh) savings that would result from the implementation of the proposed energy efficient lighting measures shown on the following page(s).

	Demand Savings (kW)	Consumption Savings (kWh)
Existing Lighting System*	174.9 kW	670,188 kWh
Proposed Lighting System	140.0 kW	532,557 kWh
Estimated Savings	34.9 kW	137,631 kWh

The estimated capital cost, available incentives and resulting simple payback are summarized below:

Financial Summary	
Estimated Capital Cost:	$106,300
Estimated Project Incentives**:	$10,300
Subtotal:	$96,000
Estimated Operating Savings***:	$18,300
Simple Payback:	5.2 yrs

NOTE: The above costs do NOT include HST.
* For areas where no access was available, we have made assumptions regarding the existing lighting.
** Incentives are based on the OPA's saveONenergy retrofit program. The estimated project incentive is a blend of both prescriptive and custom incentives.
*** Estimated operating savings are calculated using a blended hydro rate of $0.133/kWh.

The proposed energy efficient lighting measures are shown on the following page(s).

Appendix B - Lighting Retrofit Measures

The following is a summary of our observations of the existing lighting technology installed in the facility. Existing technology is categorized by type and recommended retrofit options are present below.

Existing Lighting	Retrofit Lighting	Qty. of Lamps	Demand Savings (kW)	Consumption Savings (kWh)
24" T5-24W Elec. ballast				
	24" T5-21W Elec. ballast	18	0.0	237
36" T12-30W Mag. ballast				
	36" T8-25W Elec. ballast	2	0.0	12
36" T8-25W Mag. ballast				
	36" T8-25W Elec. ballast w/ sensor	2	0.0	27
48" T12-34W Elec. ballast				
	48" T8-25W Elec. ballast	10	0.1	329
48" T12-34W Mag. ballast				
	48" T8-25W Elec. ballast	62	0.6	1,921
	48" T8-25W Elec. ballast w/ sensor	6	0.1	110
48" T12-60W Mag. ballast				
	48" T8-32W Elec. ballast HBF	8	0.3	1,332
48" T5-54W Elec. ballast				
	48" T5-44W Elec. ballast	654	4.9	16,821
	48" T5-49W Elec. ballast	51	0.3	1,489
48" T8-32W Elec. ballast				
	48" T8-25W Elec. ballast	3298	13.2	48,177
	48" T8-25W Elec. ballast w/ sensor	4	0.0	47
	LED-40W Outdoor Canopy Fixture w/	103	0.4	12,267
CFL-13W SI				
	LED-12W PAR30	68	0.0	214
	LED-12W PAR30 w/ sensor	3	0.0	0
CFL-15W PAR30				
	LED-13W PAR30	3	0.0	26
CFL-18W PL Elec. ballast				
	CFL-18W PL Elec. ballast w/ sensor	4	0.0	57
CFL-23W PAR38				
	LED-19.5W PAR38	1	0.0	15
CFL-23W SI				
	LED-12.5W SI	4	0.0	280
CFL-40W PL-L Elec. ballast				
	CFL-25W PL-L Elec. ballast	55	0.7	3,022
H-20W MR11				
	LED-3.5W MR11	11	0.2	795
H-35W MR16				
	LED-7W MR16	165	2.3	5,866
H-50W MR16				

Existing Lighting	Retrofit Lighting	Qty. of Lamps	Demand Savings (kW)	Consumption Savings (kWh)
	LED-7W MR16	92	2.9	13,217
	LED-7W MR16 w/ sensor	1	0.0	68
H-75W PAR38				
	LED-19.5W PAR38	11	0.5	1,094
H-90W PAR38				
	LED-19.5W PAR38	20	0.7	1,863
HPS-100W				
	LED-47W Flood	8	0.6	2,838
HPS-150W				
	LED-68W Outdoor Wall Fixture	1	0.1	521
I-100W SI				
	LED-12.5W SI	1	0.1	383
I-40W Candle				
	LED-3W Candle	15	0.4	1,297
I-60W SI				
	CFL-13W SI	4	0.1	240
	LED-6W BR20	8	0.3	315
MH-100W				
	LED-40W Outdoor Canopy Fixture	6	0.4	2,313
MH-150W				
	LED-38W Outdoor Wall Fixture	1	0.1	653
	LED-40W Outdoor Canopy Fixture	19	2.8	8,905
MH-250W				
	LED-68W Outdoor Wall Fixture	2	0.4	1,989
	LED-90W Flood	3	0.5	2,694
	T5HO 2 Lamp High Bay Fixture	10	1.6	5,344
MH-50W				
	LED-13W Outdoor Wall Fixture	1	0.1	258
MH-70W				
	LED-26W Outdoor Wall Fixture	2	0.1	596

Appendix B - Lighting Summary (Major Areas)

Ref #	Area	Estimated Yearly Consumption and Savings				Estimated Retrofit Cost (after Incentive)	Description
		Current Consumption	Retrofit Consumption	Savings	Cost Savings		
1	Parking Garage	28,325	7,154	21,171	$2,800.00	$26,897.44	**Current:** 175 metal halide in drive lanes and 32W T8 in perimeter. **Retrofit:** 40W LED Parking garage fixture to replace metal halide and T8 fixtures. All parking spots on occupancy sensors.
2	Pool	9,003	3,659	5,344	$700.00	$3,670.00	**Current:** 250W mercury vapor over pool, 13W CFL on walls. **Retrofit:** T5HO 2 lamp fixture to replace 250W mercury vapor fixtures.
3	Studios	155,407	130,213	25,194	$3,400.00	$18,492.59	**Current:** T5HO suspended fixtures with 54W lamps. T8 32W 4ft valance. 35W MR16 halogen. **Retrofit:** T5HO 44W lamps. T8 25W 4ft lamps. 7W LED MR16.
4	Academic Building	111,021	94,742	16,279	$2,200.00	$10,715.90	**Current:** 32W T8 4ft, halogens of various wattages, CFL lamps of various wattages. **Retrofit:** 25W T8 4ft lamps. LED equivalents for halogen lamps.
5	Lozinski House	25,304	18,708	6,596	$900.00	$2,448.45	**Current:** 54W T5HO in some offices, 32W T8 in other offices. Halogen and incandescent lamps of various wattages. **Retrofit:** 44W T5HO lamps and 25W T8 4ft lamps. LED lamps for all halogen and incandescent. Occupancy sensors in washrooms.

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