60 Murray Street

2019 Energy Conservation & Demand Management Plan

Sinai Health System

Contents

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1. Executive summary

Sinai Health System's 60 Murray St. facility (60 Murray) is located in downtown Toronto, providing outpatient care, research and administrative functions. Associated annual costs for electricity and natural gas at the facility are approximately $550k.

As part of fulfilling Ontario Regulation 507/18 of the Electricity Act (1998), a detailed review of energy consumption at 60 Murray has been performed, and an updated Energy Conservation Demand Management Plan (ECDMP) has been generated to cover the 5-year period of Jan-2019 to Dec-2023.

A number of potential energy conservation measures (ECMs) have been identified, along with a forecast of total energy savings resulting from implementation. The annual savings for these initiatives total over $60k and 11% of annual utility expenditure, as summarized below:

ID #	Energy Conservation Measure	Electricity Savings (kWh/year)	Demand Savings (kW)	Natural Gas Savings (m3/year)	Total Cost Savings ($/year)	Estimated Project Cost($)	Estimated Capital Incentive ($)	Simple Payback Inc. Incentive (years)	Measure Life (years)	Savings as % of Site Cost
1)	Lighting LED Retrofits	154,737	31	-	$18,811	$56,000	$4,480	2.7	5	3.4%
2)	Lighting Controls Upgrade	161,464	-	-	$19,629	$85,000	$16,146	3.5	> 5	3.5%
3)	AHU 601 & 602 Night Time Setback	142,176	-	26,390	$19,889	$10,000	$0	0.5	> 5	3.6%
4)	Fully condensing boiler upgrade*	-	-	32,680	$3,225	$22,500	$3,000	6.0	> 5	0.6%
	Total	**458,377**	**31**	**59,070**	**$61,555**	**$173,500**	**$23,626**	**2.8**		**11.0%**

** denotes marginal savings measure*

60 Murray's central energy conservation goal is to reduce energy consumption, energy demand, operating costs and greenhouse gas emissions without impacting patient or staff comfort. Specific goals for 60 Murray are electricity and natural gas usage reduction through capital project implementation and improved employee awareness and training.

This report subsequently provides analysis of each of the major utilities, their usage and potential savings measures, along with a summary of the previous ECDMP and details of each project identified as part of the updated ECDMP.

2. Background

2.1 Total utility consumption and costs

Sinai Health System's 60 Murray St. facility (60 Murray) is located in downtown Toronto, providing outpatient care, research and administrative functions.

Total site utility usage, expenditure and associated GHG emissions for the period of January to December 2018 are provided in the table below:

Utility	Unit	Total Consumption	Total Cost (Ex. Tax)	Average Utility Unit Cost	GHGs Emitted (tCO2e)
Electricity	kWh	3,177,600	$ 472,466	$ 0.15	127
Natural Gas	m3	331,478	$ 86,551	$ 0.26	626
		TOTALS	**$ 559,017**		**753**

Figure 1: Jan-18 to Dec-18 utility consumption summary

Trending for utility usage, cost and GHG emissions over this same time period is provided below:

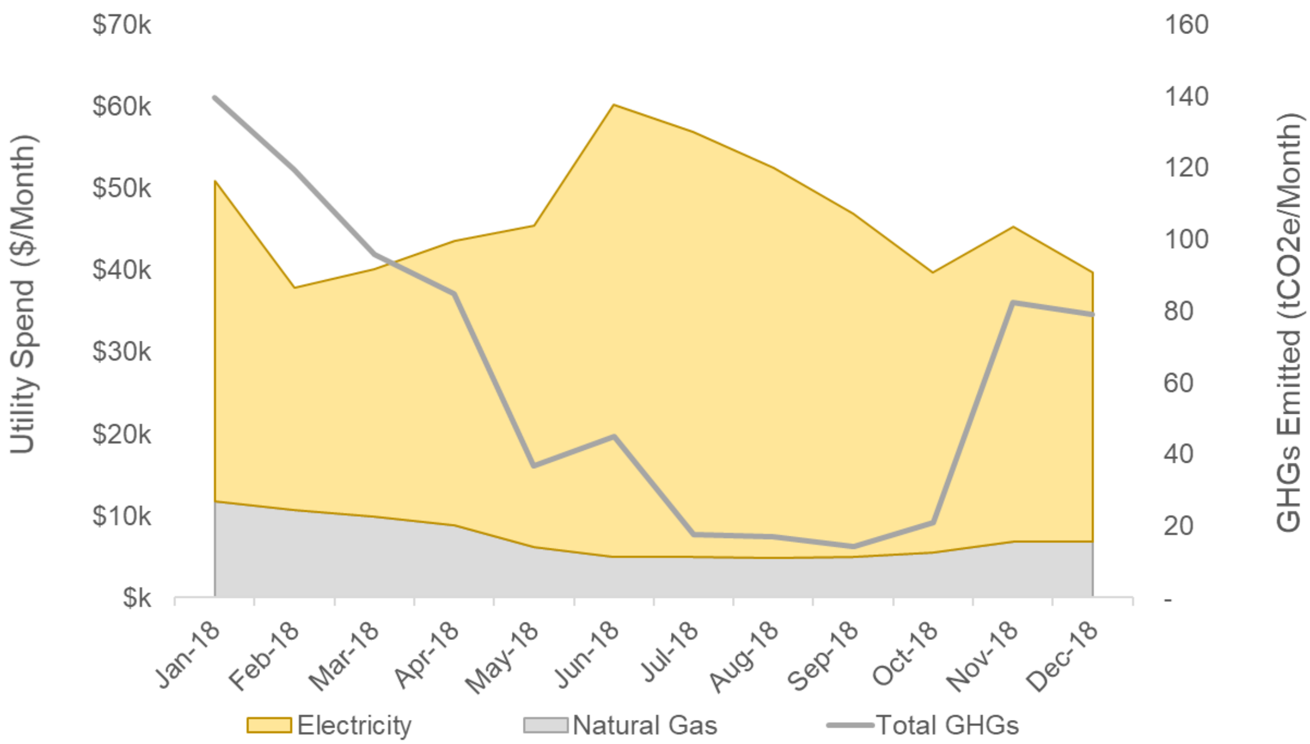

Figure 2: Utility spend and GHGs emissions trend, Jan-18 to Dec-18

2.2 Historical utility consumption

Utility consumption and costs for the most recent periods with available data are shown below for electricity and natural gas:

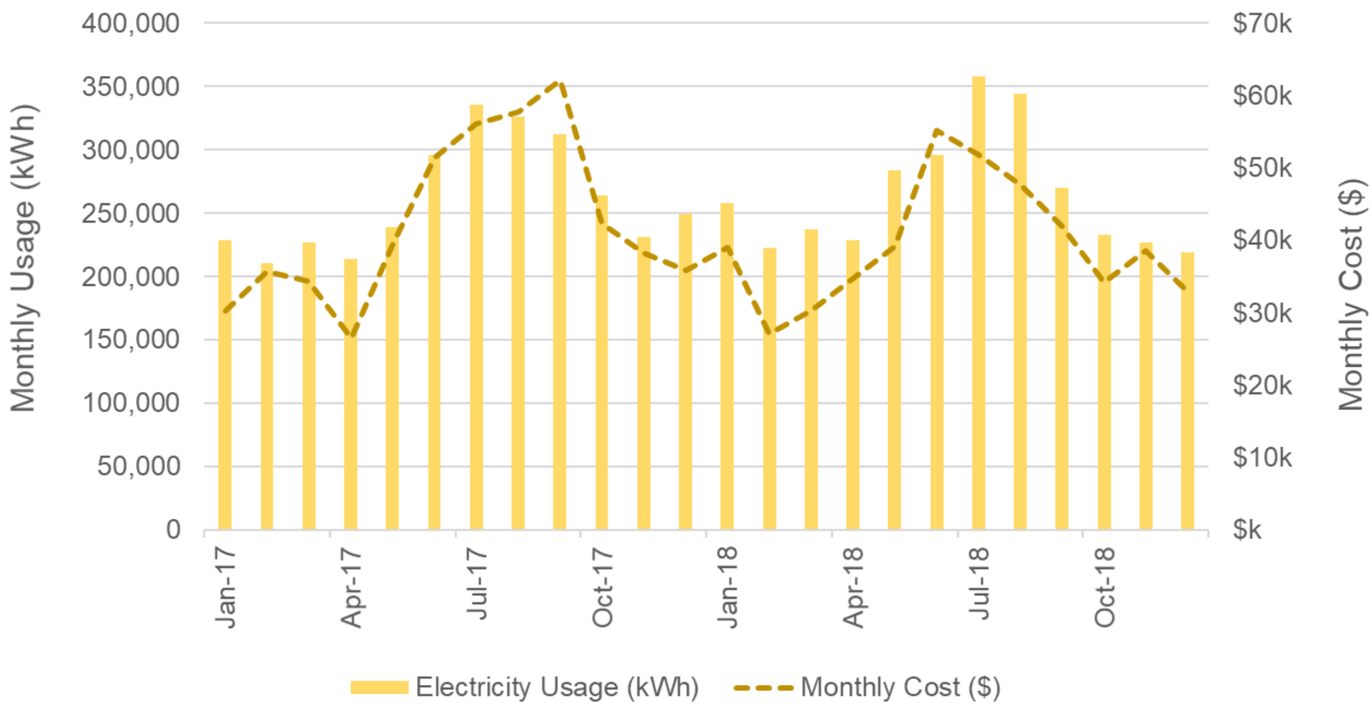

Figure 3: Historical electricity usage and cost

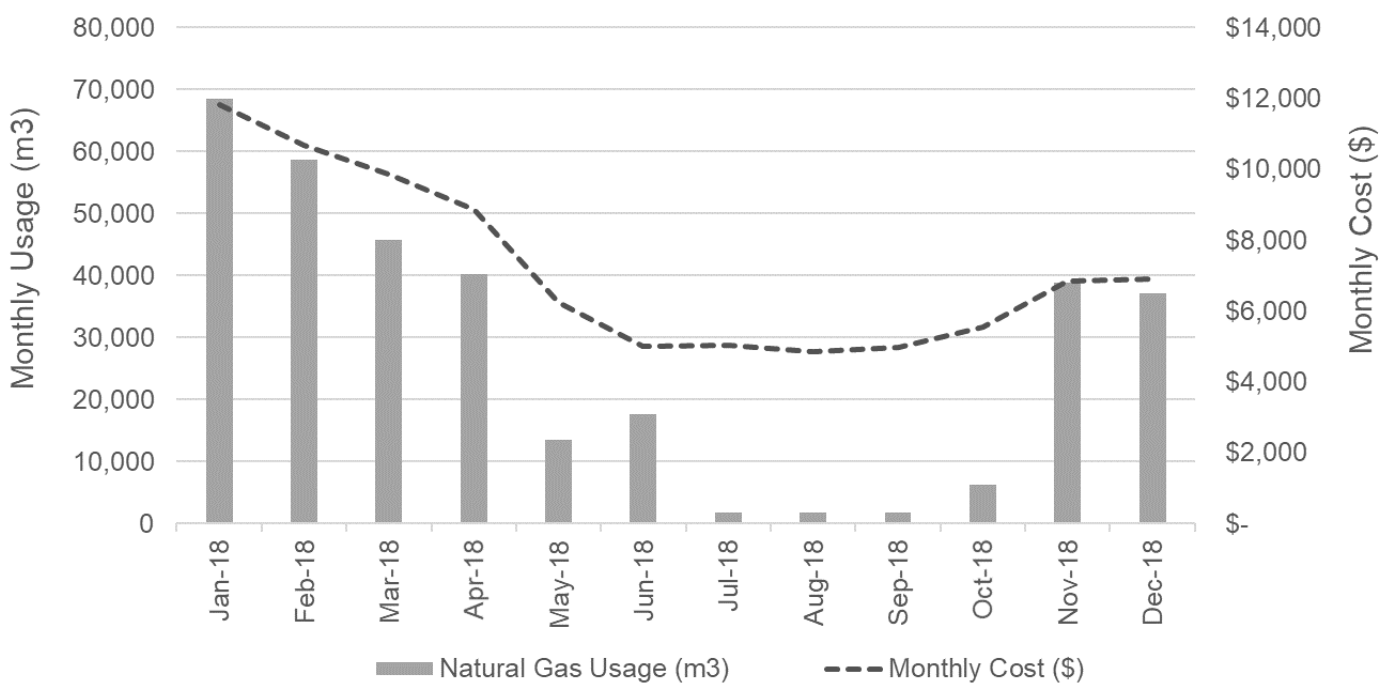

Figure 4: Historical natural gas usage and cost

Both electricity and natural gas usage appear to vary cyclically with outdoor air temperature, with natural gas usage increasing during colder months, and electricity usage increasing during warmer months. This high-level trend is expected given the site's space heating and cooling loads, as natural gas is used to heat incoming air during colder months, and electricity is used to operate a chiller system to cool incoming air during warmer months.

2.3 Additional energy sources

60 Murray does not currently operate any renewable energy generation systems. No ground source or solar energy is harnessed at this time via systems operated by the public agency.

At present there are no plans to operate heat pump technology, thermal air technology or thermal water technology in the future outside of those noted in this report's proposed measures.

3. Utility consumption review

3.1 Electricity

3.1.1 Consumption and cost breakdown

Electricity consumption in 2018 was around 3.1 GWh at a cost of ~$470k before tax. Most of this cost (62%) was for Global Adjustment charges, as shown below:

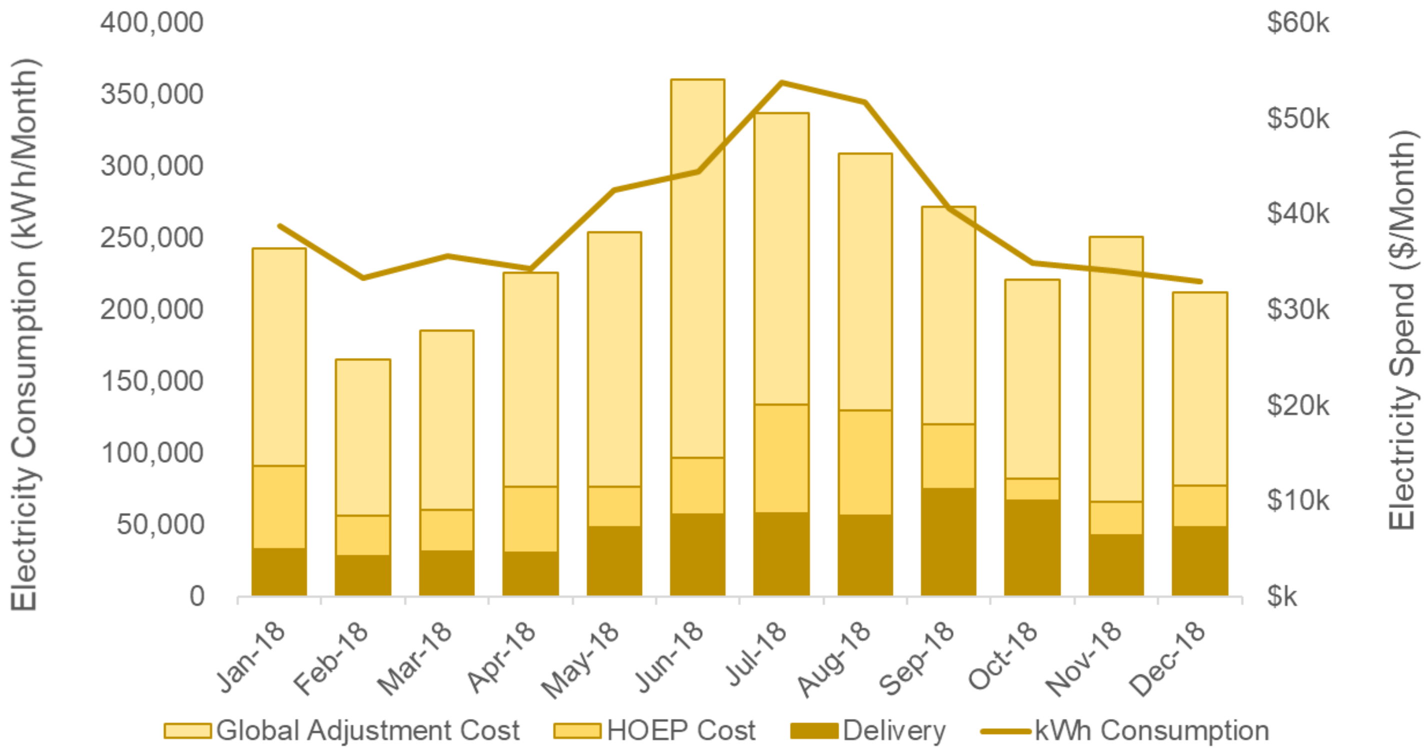

Figure 5: Electricity cost breakdown and consumption

Electricity for 60 Murray is currently distributed by Toronto Hydro on the 50 kW to 499 kW rate tariff, with the commodity component purchased from ECNG. Electricity charges are broken out below:

Description	Cost ($)	Cost Basis
Commodity Cost	Spot	per kWh
Global Adjustment	Variable	Monthly Class B Rate
Transmission Network	$2.6576	per Peak kW per 30 days
Transmission Connection	$2.3054	per Max kW per 30 days
Customer Charge	$51.50	per 30 days
Distribution Volumetric Rate	$8.1052	per kVA per 30 days

Note: Data from Toronto Hydro 50 kW to 499 kW Tariff (May 1, 2019), Ex. Rate Riders

Table 1: Electricity cost breakdown, 50 kW to 499 kW rate tariff

3.1.2 Electricity use drivers

Based on the large apparent effect of site cooling load on total electricity it was assumed that variation in hourly outdoor temperature (represented as cooling degree hours) would significantly explain variation in electricity consumption at the facility. A regression analysis was performed against this variable yielding the following equation:

Regression	Unit	Y-intercept	Coeff. #1	Coeff. #1 Value	R2
Electricity vs. CDHs	kWh	228,515	CDHs	13.12	89.75%

Table 2 : Electricity regression results

Predicted electricity usage based on the above equation is plotted against actual site electricity consumption below for the period of April 2017 to December 2018:

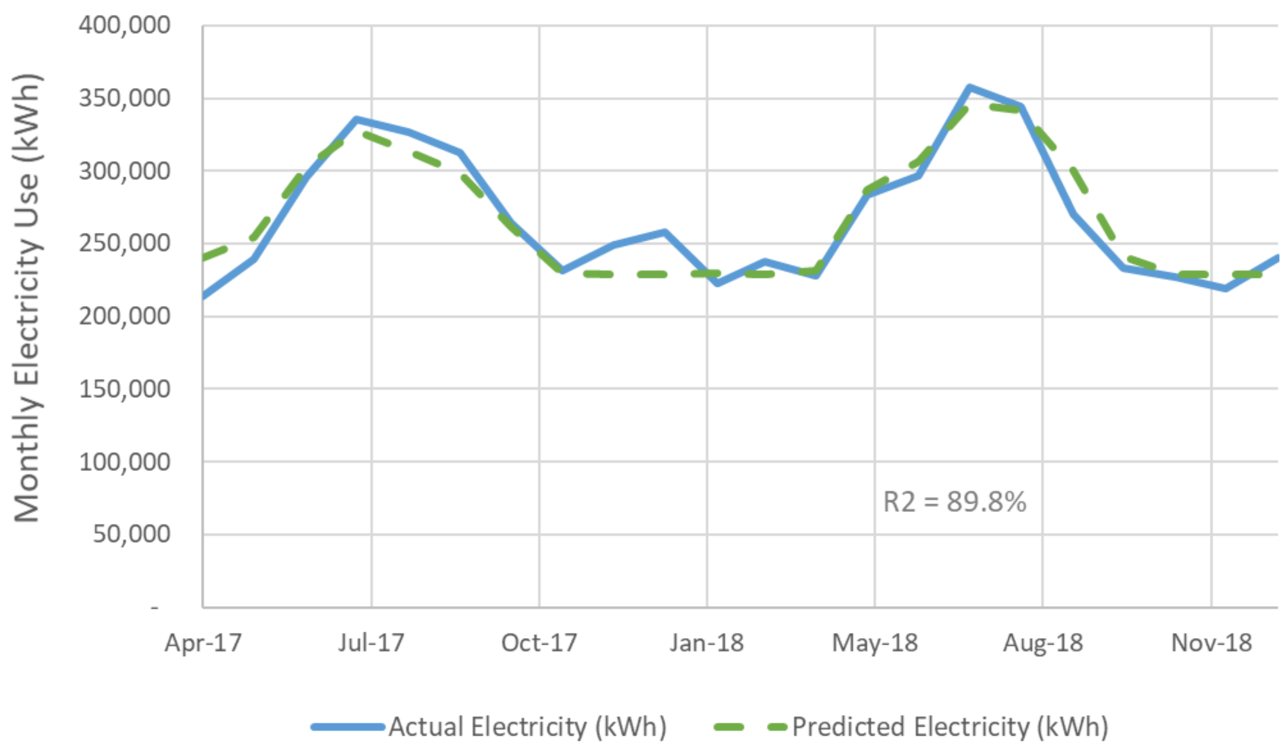

Figure 6 : Actual vs. predicted electricity consumption

The high coefficient of determination (R2) of 89.8% along with other statistical measures demonstrates that this equation can be used to model baseline electricity consumption moving forward and allow high-level savings quantification resulting from any electricity-reduction initiatives.

3.1.3 End-use breakdown

Electricity at 60 Murray is split between air handling, chillers and cooling system equipment, lighting, and other hospital loads. Air handling energy consumption is fairly low due to the reduced number of air changes required for this type of operation. About 16% of electricity consumed at the site is for operating a chilled water supply system, which provides cooling for all incoming air during warmer months. Electricity end-use consumptions have been calculated based on spot measurement data taken from the local building automation system, along with motor sizes, live VSD loading data and estimated loading/run hour data gathered during site visits.

The calculated electricity end-use breakdown for 2018 is provided below, broken out by asset class:

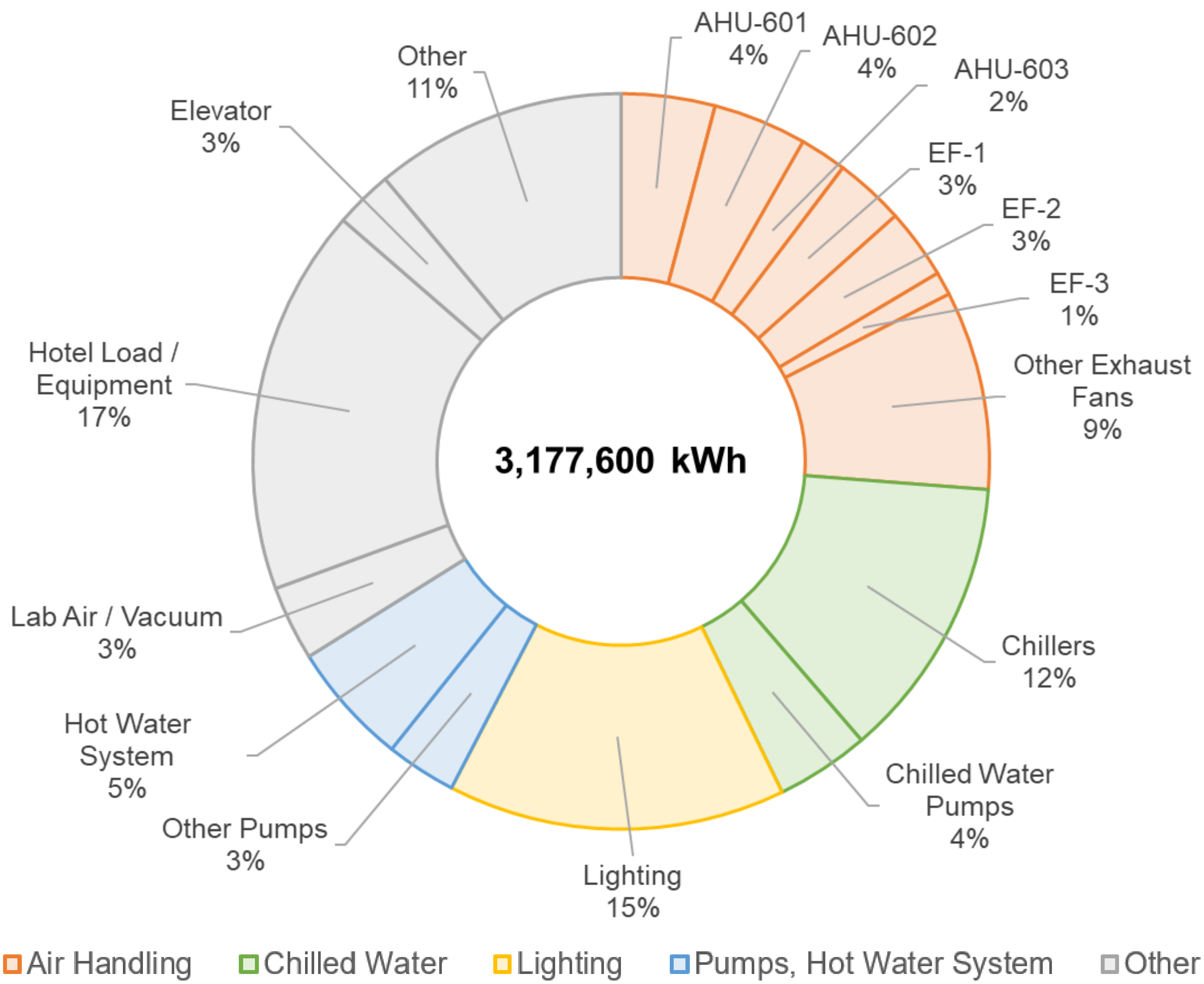

Figure 7 : Estimated 2018 electricity end-use breakdown

3.2 Natural gas

3.2.1 Consumption and cost breakdown

Natural gas consumption in 2018 was around 330,000 m3 at a cost of ~$86k before tax. Approximately 62% of this charge is made up by a static monthly charge from ECNG, with the remainder varying based on natural gas consumption:

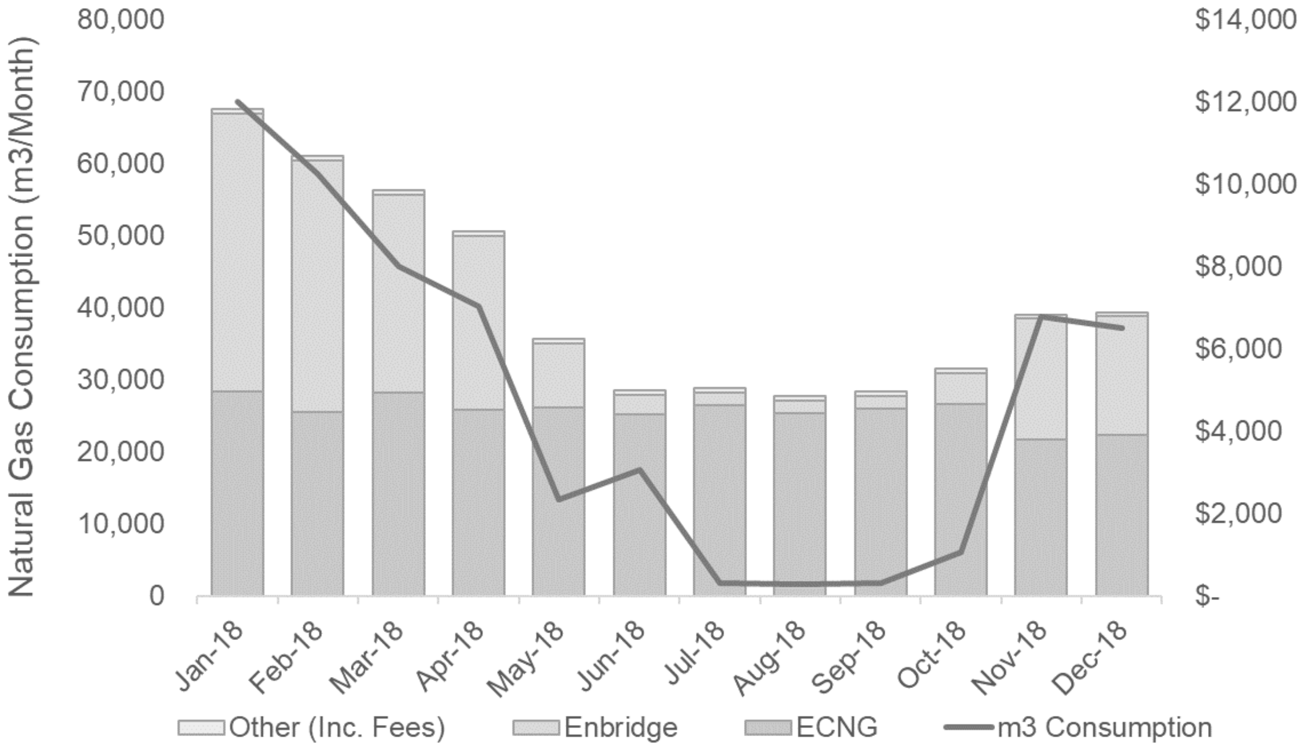

Figure 8: Natural gas cost breakdown and consumption

Natural gas for 60 Murray is currently purchased through a combination of Enbridge and ECNG. A detailed billing cost and rate breakdown was not available at time of report compilation.

3.2.2 Natural gas use drivers

Regression analysis was performed against hourly outdoor temperature (represented as heating degree hours) to explain variation in gas consumption at the facility throughout the year. This analysis yielded the following equation:

Regression	Unit	Y-intercept	Coeff. #1	Coeff. #1 Value	R2
Natural Gas vs. HDHs	m3	1,856	HDHs	3.407	85.22%

Table 3 : Natural gas regression results

Predicted natural gas usage based on the above equation is plotted against actual site gas consumption for the period of January to December 2018:

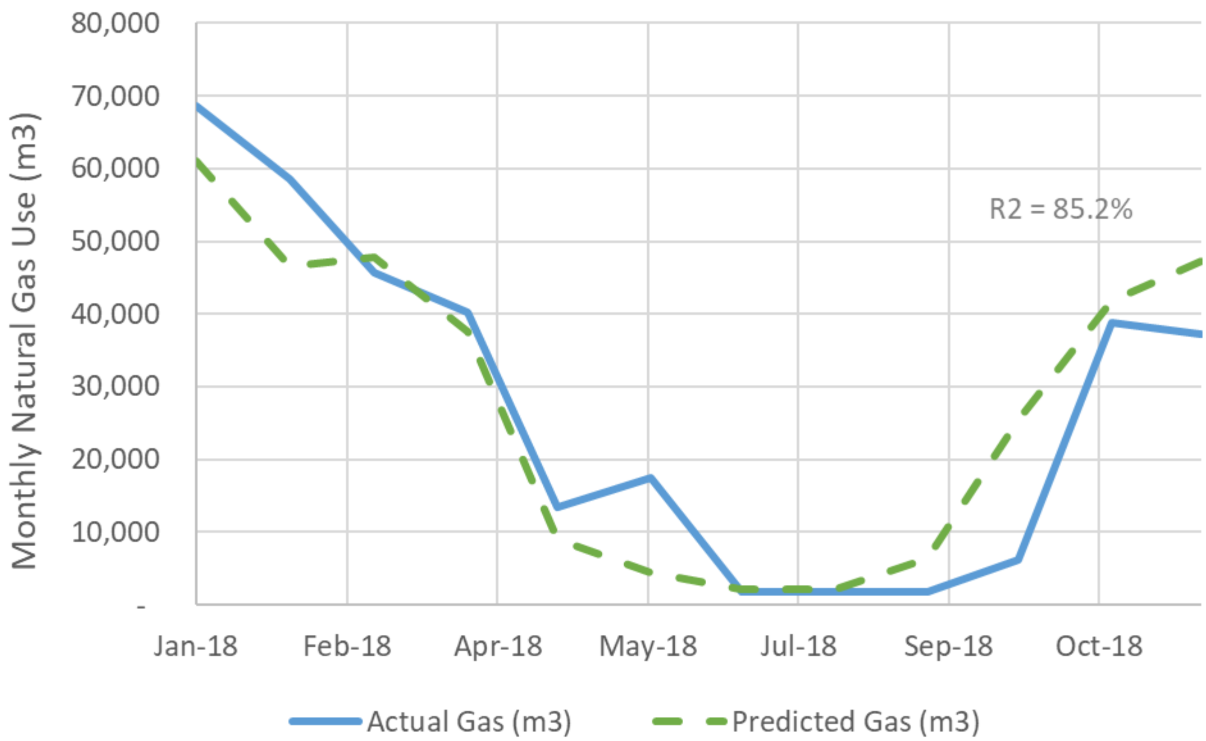

Figure 9 : Actual vs. predicted natural gas consumption

The relatively high coefficient of determination (R2) of 85.2% along with other statistical measures demonstrates that this equation can be used to model baseline natural gas consumption moving forward and allow high-level savings quantification resulting from any gas-reduction initiatives. This model could be improved in future with higher resolution natural gas data.

3.2.3 End-use breakdown

Natural gas is primarily used at 60 Murray as fuel for three hot water boilers; two of these boilers generate hot water which is sent to AHUs 601 and 602 for heating incoming air, with the third boiler generating domestic hot water which is used year-round throughout the facility. The remainder is used for direct-fired heating on AHU-03, which feeds the Bio-Marker and LTRI Lab exclusively.

A detailed hourly simulation has been generated for all known air handling units using air flow, relative humidity, return air % and temperature setpoint data gathered during site visits to estimate natural gas consumption. The calculated gas end-use breakdown for 2018 is provided below with natural gas energy converted to kWh, broken out by heating end-use:

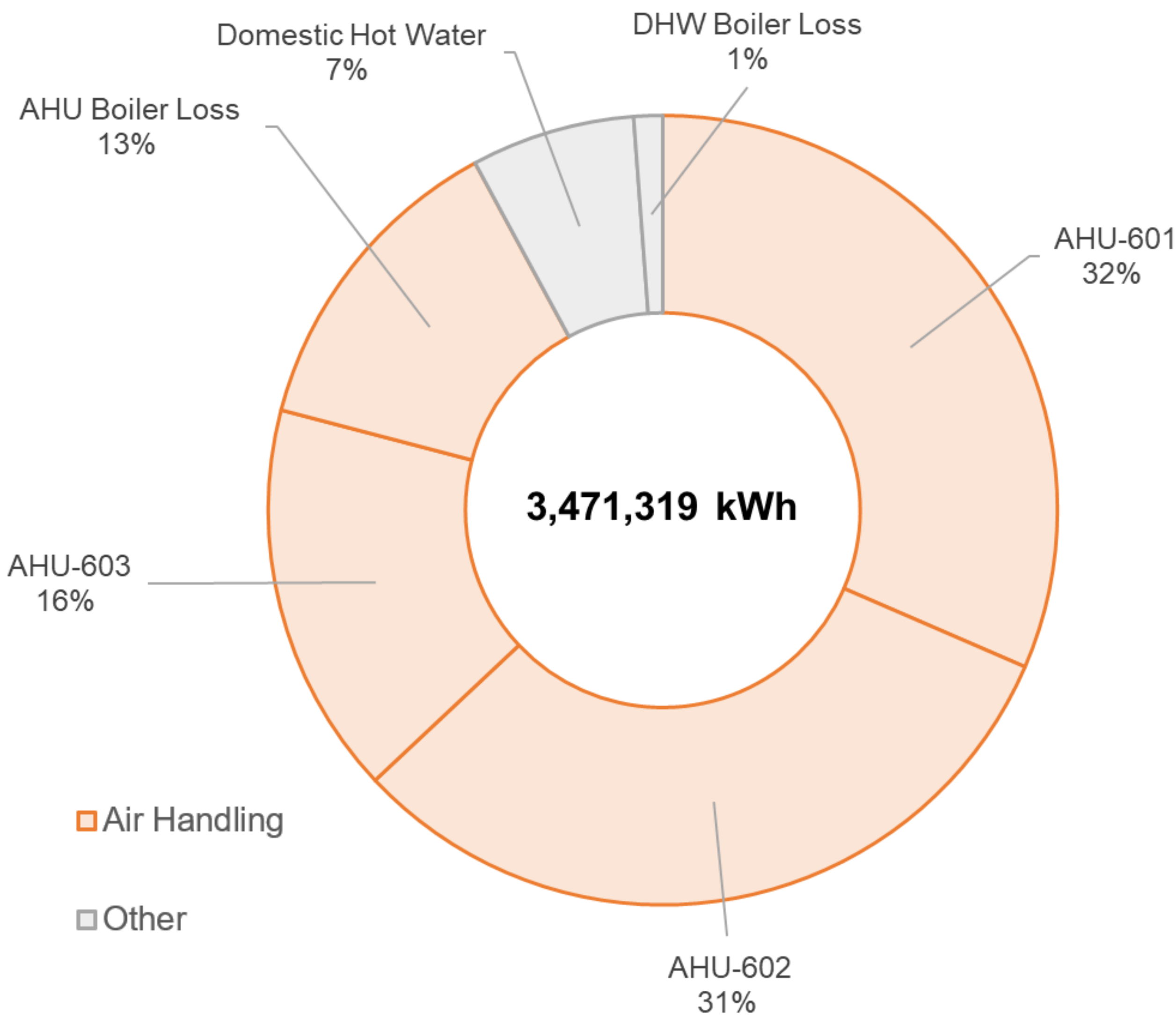

Figure 10 : Estimated 2018 natural gas end-use breakdown

4. Previous ECDMP (Jan-2014 to Dec-2018)

As part of fulfilling Regulation 397/11 of the Green Energy Act (2009), an Energy Conservation Demand Management Plan (ECDMP) was generated for 60 Murray in July 2014, covering the 5-year period of January 2014 to December 2018. Energy conservation measures (ECMs) were identified in this report and proposed for implementation.

4.1 Past ECMs Proposed

A number of "top-down" energy conservation targets were applied against 60 Murray's total utility cost and consumption values, to build a picture of potential achievable savings for the facility. These energy target savings are provided in the table below:

Area of Focus	Savings Target (%)	Cost Savings ($/year)
Electric Base	16%	$ 60,611
Electric Cooling	6%	$ 1,476
Thermal Heating	33%	$ 41,490
TOTAL		**$ 103,578**

Table 4: Past ECDMP energy target savings

A separate list of preliminary energy efficiency measures was then provided to demonstrate a pathway to achieve a portion of the target energy savings. A list of these proposed energy efficiency measures is shown below, along with budget cost and savings estimates for each:

ECM ID	Description	Budget Cost ($)	Cost Savings ($/year)	Estimated Incentive ($)	Simple Payback (Post-Incentive) (years)
1	Ventilation System Retrofit and Re-Balancing	$ 142,999	$ 29,178	$ 17,711	4.29
2	HVAC System Controls	$ 126,000	$ 32,487	$ 15,522	3.40
3	Heating Plant and System Controls	$ 97,500	$ 16,596	$ 3,298	5.68
4	Lighting System Improvements	$ 120,750	$ 18,294	$ 14,072	5.83
5	Departmental/Staff Engagement	$ 10,000	$ 3,031	$ 2,331	2.53
6	Energy Advisor/coordination (24 months)	$ 48,000	$ 29,178	$ -	1.65
TOTAL		**$ 545,249**	**$ 99,586**	**$ 52,934**	**4.9**

Table 5: Past ECDMP proposed energy efficiency measures

4.2 Past ECM Implementation

Lighting system improvements identified in the original ECDMP appear to have been made at the site, with controls available on building automation system screens to manage lighting in areas of the 2^{nd}, 4^{th}, 5^{th} and 6^{th} floors. It is not possible to claim specific savings resultant from this measure, however based on up-to-date lighting counts and observation of the system's configuration, it is estimated to have saved ~60,000 kWh/year or ~$7k/year in electricity costs at that time.

The remaining measures proposed in the original ECDMP required further study to qualify, including detailed air balancing and HVAC system diagnostics. Based on an updated review of the site's HVAC system, along with current setpoints (included in further detail in Section 5), it is expected that no measures were implemented or that any measures did not have persistence.

5. Updated ECDMP (Jan-2019 to Dec-2023)

As part of fulfilling Ontario Regulation 507/18 of the Electricity Act (1998), a detailed review of energy consumption at 60 Murray has been performed, and an updated ECDMP has been generated to cover the 5-year period of January 2019 to December 2023. A number of ECMs have been identified, along with a forecast of total energy savings resulting from implementation.

5.1 Energy Conservation Measures

5.1.1 Lighting technology upgrade

Lighting is estimated to account for approximately 15% of 60 Murray's electricity consumption. A high-level lighting count has been performed for the building and identified that current fixtures are a combination of fluorescent, halogen and LED models.

Upgrading all non-LED fixtures to LED equivalents would provide ongoing electricity demand and consumption savings. The preliminary economics of this project are shown below:

ID #	Energy Conservation Measure	Electricity Savings (kWh/year)	Demand Savings (kW)	Natural Gas Savings (m3/year)	Total Cost Savings ($/year)	Estimated Project Cost($)	Estimated Capital Incentive ($)	Simple Payback Inc. Incentive (years)	Measure Life (years)	Savings as % of Site Cost
1)	Lighting LED Retrofits	154,737	31	-	$18,811	$56,000	$4,480	2.7	5	3.4%

Figure 11 : Lighting technology upgrade preliminary economics

The lifetime of this measure largely depends upon the LED fixture type chosen; fluorescent lamp "swap-in" fixtures can have a rated life of up to 50,000 hours. A lifetime of 5 years can be assumed for this measure.

5.1.2 Lighting controls improvement

Some areas of lighting at 60 Murray appear to be well controlled, namely those on certain corridor areas of the 2nd, 4th, 5th and 6th floors. However analysis of the facility's nighttime baseload electricity demand against weekday peak demand indicate that a high nighttime baseload remains, potentially due to remaining lighting at the facility. This is further expected given the large number of distinct small rooms in the building, which are not likely to have occupancy sensors or other controls outside of employee switch-off.

Installing lighting controls in key areas, linking the controls back to the facility's building automation system or local occupancy sensors and controlling based on light level or setback schedule would reduce electricity consumption during sunny days and overnight, as well as in unoccupied rooms. The preliminary economics of this project are shown below:

ID #	Energy Conservation Measure	Electricity Savings (kWh/year)	Demand Savings (kW)	Natural Gas Savings (m3/year)	Total Cost Savings ($/year)	Estimated Project Cost($)	Estimated Capital Incentive ($)	Simple Payback Inc. Incentive (years)	Measure Life (years)	Savings as % of Site Cost
2)	Lighting Controls Upgrade	161,464	-	-	$19,629	$85,000	$16,146	3.5	> 5	3.5%

Figure 12 : Lighting controls improvement preliminary economics

This measure is expected to last over five years, however some level of ongoing review of the system will be required to ensure occupant comfort and energy savings are both optimized. Scheduling may also need to be updated periodically if and when the function of areas change.

5.1.3 Air handling unit setback

Detailed information on the quantity, layout and scheduling of the main air handling units (AHUs) at 60 Murray has been gathered from the site's building automation system (BAS). This has been combined with spot measurements, as-builts, and site visit data gathered during each of the main seasons to confirm BAS data, and understand general air flow, heating, humidifying and cooling trends throughout the year.

A detailed hourly simulation for each main AHU has been performed by applying motor size, setpoint temperatures, return air percentage, current heat reclaim savings and average air flow against outdoor temperature and relative humidity data for 2018; a summary of the results and other pertinent information is provided below:

Air Handling System	Area Fed	Annual Motor kWh	Annual Heating / Humidifying kWh	Annual Cooling kWh	Setback Enabled?	Return Air?	Heat Recovery?
AHU-601	South Wing	228,724	1,095,453	506,334	No	Yes	No
AHU-602	North Wing	228,724	1,095,453	506,334	No	Yes	No
AHU-603	Bio-Marker & LTRI Lab	98,024	559,352	261,272	No	No	Yes
	TOTALS	**555,472**	**2,750,258**	**1,273,939**			

Figure 13 : Current simulated energy consumption by air handling system

The facility currently has three AHUs; AHUs 601 & 602 serve the south and north wings of the building respectively and are similarly sized. Both units are equipped with return air ducting which appears to be in regular use. AHU 603 is smaller than the other two and feeds only the Bio-Marker and LTRI lab portions of the facility. This unit does not have return air, but does have heat recovery via a heat exchange loop with the system's exhaust ducting.

As noted above, none of the facility's AHUs currently have any automatic setback in place. An analysis of nighttime baseload indicates that a significant portion of the facility's electricity demand is still in use overnight when building occupancy is minimal, and AHUs and associated exhaust fans are estimated to contribute approximately 100 kW of this demand. Given that the majority of the facility is not occupied overnight, it should be possible to setback AHUs 601 and 602 and some associated exhaust fans without adversely affecting operation.

The required controls and variable speed drives are currently in place to allow this adjustment, and this change could be made gradually at little cost. The preliminary economics of this project are shown below:

ID #	Energy Conservation Measure	Electricity Savings (kWh/year)	Demand Savings (kW)	Natural Gas Savings (m3/year)	Total Cost Savings ($/year)	Estimated Project Cost($)	Estimated Capital Incentive ($)	Simple Payback Inc. Incentive (years)	Measure Life (years)	Savings as % of Site Cost
3)	AHU 601 & 602 Night Time Setback	142,176	-	26,390	$19,889	$10,000	$0	0.5	> 5	3.6%

Figure 14 : Air handling unit setback preliminary economics

Note that AHU-603 has been excluded from these savings as it is assumed that the lab may require consistent air changes at all times. If this is not the case, setback can also be performed on this unit to increase measure savings.

Savings associated with this measure have been calculated via simulation, assuming a conservative 35% air flow reduction through AHUs 601 and 602 from 8 PM to 5 AM each day. This measure is expected to last over five years, however will need to be re-visited periodically to ensure staff and patient comfort needs are met, and that energy savings have been maintained.

5.1.4 Fully condensing boiler upgrade

Hot water boilers #1, #2 and #3 are estimated to consume approximately 84% of facility natural gas and appear to all be non-condensing, with a rated efficiency of 85%. Details gathered from these units are listed below:

Boiler	End-use	Manufacturer	Fuel	Input (BTUH)
1	AHU Hot Water	RBI	Natural Gas	3,200,000
2	AHU Hot Water	RBI	Natural Gas	3,200,000
3	Domestic Water Heater	RBI	Natural Gas	2,000,000

Figure 15 : Domestic hot water boiler end-use and capacity

Replacing these units with new fully-condensing models could improve efficiency up to 95% and greater, reducing site natural gas requirements. The preliminary economics of this project are shown below:

ID #	Energy Conservation Measure	Electricity Savings (kWh/year)	Demand Savings (kW)	Natural Gas Savings (m3/year)	Total Cost Savings ($/year)	Estimated Project Cost($)	Estimated Capital Incentive ($)	Simple Payback Inc. Incentive (years)	Measure Life (years)	Savings as % of Site Cost
4)	Fully condensing boiler upgrade*	-	-	32,680	$3,225	$22,500	$3,000	6.0	> 5	0.6%

Figure 16 : Fully condensing boiler upgrade preliminary economics

Savings associated with this measure have been calculated assuming an 85% to 97% efficiency gain for each boiler based on AHU simulation results, standard replacement boiler manufacturer efficiencies and regression calculations. Note that the above savings calculations are for the marginal case, assuming boiler replacement with a standard non-condensing unit is already occurring. This measure is not recommended for standalone implementation based on energy savings alone. It is expected to last over five years.

6. Approval for ECDMP

X

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Senior Director, Building Operations

X

Dr. Gary Newton
Chief Executive Officer

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Title:	60 Murray Street 2019 ECDMP
Reference:	Proposal PR-8681 / Project PE1379
Revision:	v1
Revision Date:	24th June 2019

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