



DETAILED ENERGY ASSESSMENT

TABER & DISTRICT HOUSING FOUNDATION

CLEARVIEW LODGE

PROJECT NO.: C18-2353B
ISSUED: MONTH XX, 2018



3D ENERGY
LIMITED

EXECUTIVE SUMMARY

The energy analysis determined that the Taber and District Housing Foundation – Clearview Lodge has a weather normalized annual energy consumption of 8,580 GJ/year, an Energy Utilization Index (EUI) of 2.23 GJ/m², and associated greenhouse gas emissions of 692.1 tonnes of carbon dioxide equivalent (tCO₂e) per year. The Energy Star Portfolio Manager benchmark for senior care facilities is 1.04 GJ/m². This suggests a high potential for improvement.

The following Energy Conservation Measures (ECMs) were identified and analyzed. They are listed below in descending order of priority:

- ECM-2: DHW Tank Blanket
- ECM-4: High Efficiency Notched Fan Belts
- ECM-1: Low Flow Water Fixtures
- ECM-3: LED Lighting Upgrade
- ECM-7: Programmable Thermostats
- ECM-13: Condensing DHW-2
- ECM-12: Condensing DHW-1
- ECM-5: High Efficiency Air Filters (Not Recommended)
- ECM-6: DHW Pipe Heat Trap (Not Recommended)
- ECM-8: Door Seals and Sweeps (Not Recommended)
- ECM-9: DHW Pipe Insulation (Not Recommended)
- ECM-10: Roof Upgrade (Not Recommended)
- ECM-11: Condensing Boiler (Not Recommended)
- REM-1: Roof Solar Photovoltaic (Not Recommended)
- REM-2: Solar Hot Water (Not Recommended)

If implemented, the recommended ECMs would result in a reduction of 411 GJ of natural gas, 84,800 kWh of electricity, and 1,248 m³ of water per year. This is expected to provide \$14,690 in annual savings, and 75.6 tCO₂e of greenhouse gas emissions reduction. The approximate total implementation cost would be \$136,110 and an improved net present value of \$101,910 when compared to -\$159,560.

A summary of energy savings, GHG reduction, and financial data for the ECMs are displayed in Energy Conservation Summary **Table A** and **Table B**.

Energy Conservation Measure Summary

Table A: Energy Savings and GHG Reduction Summary

ECM Description	Annual Elec. Savings (kWh)*	Annual N.G. Savings (GJ)	Annual GHG Reductions (tCO ₂ e)	Lifetime (Years)	Lifetime GHG Reduction (tCO ₂ e)
ECM-1 Low Flow Water Fixtures	0	213	11	15	165.7
ECM-2 DHW Tank Blanket	0	1	0.0	24	1.1
ECM-3 LED Lighting Upgrade	79,800	-172	42	30	1,265.0
ECM-4 High Efficiency Notched Fan Belts	2,700	0	1.7	3	5.2
ECM-5 High Efficiency Air Filters	500	0	0.3	1	0.3
ECM-6 DHW Pipe Heat Trap	0	3	0.1	70	9.8
ECM-7 Programmable Thermostats	2,400	148	9.2	15	137.7
ECM-8 Door Seals & Sweeps	100	15	0.9	10	8.6
ECM-9 DHW Pipe Insulation	0	0	0.0	24	0.0
ECM-10 Roof Upgrade	0	76	3.9	30	117.5
ECM-11 Condensing Boiler	0	374	19	25	483.7
ECM-12 Condensing DHW-1	0	149	7.7	18	139.3
ECM-13 Condensing DHW-2	0	105	5.5	18	98.2
REM-1 Roof Solar Photovoltaic	114,200	0	73	25	1,827.2
REM-2 Solar Hot Water	-200	28	1.3	10	13.2
Proposed Case	84,800	411	75.6	27	2,053.6

* ECM savings in Table A and Table B are eligible savings using a reduction factor of 0.9.

Table B: Financial Analysis Summary

ECM	Description	Total Cost (\$)	Annual Cost Savings (\$)	Simple Payback (Years)	Baseline NPV (\$)	ECM NPV (\$)	Potential Rebate (\$)
ECM-1	Low Flow Water Fixtures	1,110	3,820	0.3	-	41,450	0
ECM-2	DHW Tank Blanket	100	10	10	-	3	0
ECM-3	LED Lighting Upgrade	106,130	7,740	14	-170,890	25,390	1,684
ECM-4	High Efficiency Notched Fan Belts	490	200	2.5	-300	60	0
ECM-5	High Efficiency Air Filters	390	40	9.8	-220	-360	0
ECM-6	DHW Pipe Heat Trap	680	20	34.0	-	-200	0
ECM-7	Programmable Thermostats	5,000	1,280	4	5,020	8,710	0
ECM-8	Door Seals & Sweeps	1,710	120	14	-	-720	0
ECM-9	DHW Pipe Insulation	250	0	-	-	-250	0
ECM-10	Roof Upgrade	33,750	570	59	-	-23,920	0
ECM-11	Condensing Boiler	168,920	2,800	60	2,790	-125,060	12,000
ECM-12	Condensing DHW-1	14,490	1,120	13	-780	-290	0
ECM-13	Condensing DHW-2	8,790	790	11	-620	1,220	0
REM-1	Roof Solar Photovoltaic	242,310	8,410	29	-	-110,360	60,578
REM-2	Solar Hot Water	19,810	200	99	-	-18,220	0
Proposed Case*		136,110	14,690	9.3	-159,560	101,910	1,684

* Overall values for the proposed case do not equal the sum of the ECMs because the simulation captures interactions between ECMs. Greyed-out ECMs are not included in the proposed model. Incentives are not guaranteed and so are not included in the proposed case.

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1 BACKGROUND

1.1 Team and Qualifications

Client Details		Municipal Climate Change Action Centre Details	
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Revision History

Revision	Date	Description
0	June 30, 2017	Issued for Client Use

1.2 Scope of Study

3D Energy Ltd has performed a detailed energy assessment meeting the ASHRAE Level 2 standards. The primary goal is to identify energy conservation measures that will facilitate planning for improved performance that will result in reductions in operating expenses and greenhouse gas emissions.

The energy audit followed the guidelines of an ASHRAE Level 2 energy audit, with the following requirements:

1. A quantitative description of the operation and energy use of the facility in its current state (baseline);
2. A comprehensive list of energy efficiency measures;
3. Estimated energy savings and greenhouse gas emission reductions for each measure and the total for all recommended measures;
4. An assessment of the cost-effectiveness of each measure;
5. A report of assumptions, references, and details of measurement and quantification procedures used for all recommended measures.

1.3 Methodology

The level of effort for a Level 2 energy audit is described in the American Society of Heating, Refrigerating, and Air-Conditioning Engineers' (ASHRAE) publication *Procedures for Commercial Building Energy Audits, Second Edition*¹. It addresses energy modeling without on-site measurement of equipment energy. Information on equipment operating schedules is obtained from facility operators and from observations made during the site visit. Equipment nameplate data is recorded or estimated for missing nameplates or inaccessible equipment.

In a calibrated energy simulation approach, savings are estimated through whole-facility energy simulation. The simulation software used is RETScreen Expert, which includes the interactions between ECMs in the calculations. The energy model is then calibrated with daily weather data from the same period as the energy consumption. Natural gas consumption is normalized using heating degree days, but electricity is not usually normalized unless large cooling loads or electric space heating is involved.

The simulation may be calibrated to an adjusted baseline rather than the available energy bills. This may be due to an expected change in building use, occupancy or equipment.

Equipment life is factored into the total energy savings, GHG reductions, and cost savings. HVAC equipment life is obtained from the *ASHRAE Equipment Life Expectancy Chart*². A weighted average that considers type (e.g. LED), daily runtime, and the annual usage schedule is used in estimating the life expectancy of a lamp. Life expectancies of all other equipment are obtained from manufacturers' data. The overall life expectancy of the proposed case is obtained from a weighted average of the ECMs.

The Net Present Value (NPV) of each ECM is calculated from the total installed cost and energy savings. The inflation rate, maintenance, and disposal costs are not included. A discount rate of 5% and a fuel escalation rate of 1% are applied. Equipment lifetimes determine the number of cash flow periods.

The baseline net present value is calculated using the replacement cost of baseline equipment with residual life expectancy in the associated year. The replacement year of the existing equipment is at the energy auditor's discretion and may include input by facility operators and equipment manufacturers.

Utility rate codes are referenced to calculate the savings rate of reduced electrical consumption and electrical demand.

When possible, a regression analysis is performed to calculate the savings rate of natural gas and/or water consumption. Regression analysis accounts for variable and fixed charges within the bills. More details on regression analysis may be found in the appendices.

1.4 Incentives

1.4.1 Business Energy Savings (BES) Program

Energy Efficiency Alberta's BES program offers incentives that encourage business, non-profit, and institutional facilities to install high-efficiency products. Rebates are available for certain specific interior and exterior lighting, heating, ventilation and air conditioning equipment, water heaters and others. The rebate could cover a portion of the capital cost of eligible equipment. Total incentives are limited to \$25,000 per building per year. An online pre-approval application must be submitted prior to installation which confirms that all planned retrofits are eligible for funding. Please see https://www.encyalberta.ca/app/uploads/Measures_EEA-BNI_July_2018-1.pdf to ensure that the equipment being purchased meets the Program Eligibility Criteria or e-mail bni@icf.com for additional clarity. Additional information on BES can be found at:

<https://www.encyalberta.ca/business-non-profit-and-institutional/>

1.4.2 Residential and Commercial Solar Program (RCSP)

The Residential and Commercial Solar Program offers rebates to homeowners, businesses and non-profits who install solar photovoltaic (PV) systems. Residential systems up to 15 kW are eligible for a rebate of \$0.75/watt (dc) - to a maximum of \$10,000 or 30% of system costs, whichever is less. Commercial systems up to 5 MW are also eligible for a rebate of \$0.75/watt (dc) - to a maximum of \$500,000 or 25% of system costs, whichever is less. The application for RCSP funding must be made online by either the facility owner or the installer before the installation commences. More information on the RCSP is available at: <https://www.encyalberta.ca/solar/>.

1.4.3 Custom Energy Solutions (CES)

Custom Energy Solutions helps industrial, institutional and commercial facilities improve productivity, save energy and save money by upgrading inefficient equipment and making other energy improvements. Facilities with over 10,000 tonnes of annual GHG emissions are eligible for incentives up to \$1 million per year and parent facilities implementing Custom Energy Solutions projects in multiple facilities are eligible for incentives up to \$2 million per year. Facilities with less than 10,000 tonnes are eligible for incentives up to \$250,000 per year for individual facilities and \$500,000 per year for parent facilities. Facilities defined as Large Final Emitters or customers or facilities that have opted into the Carbon Competitiveness Incentive Regulation are not eligible. More information can be found at: <https://www.encyalberta.ca/customsolutions/>

1.5 Limitations

This report was prepared by 3D Energy Ltd for the above listed client. It is based on available data, visual observation, and interviews with the client and site representatives. 3D Energy does not accept responsibility for any incorrect or inaccurate information presented by the three sources. All assumptions on conditions, performance, and costs are made solely to estimate the viability of the ECMs. Confirmation shall be made by the implementing party based on actual designs, conditions, and costs. The client shall indemnify and hold 3D Energy harmless from all claims by third parties arising from or relating to the use of this report in any manner whatsoever.

2 FACILITY CHARACTERISTICS



Figure 1: Clearview Lodge Front Main Entrance on the north wing

Located in the town of Taber in southern Alberta, the Clearview Lodge facility, administered by the Taber and District Housing Foundation, is a single storey building with a basement. It was constructed circa 1962 with expansion and upgrades done in 1971, 1994, 2000, and 2013. It has a total floor area of 3,845 m².

The site was assessed by Payam Esmaili and Joad Clement from 3D Energy on September 5th, 2018. Photographs were taken of the exterior, interior, heating equipment, lighting equipment, windows, doors and fans, among others. The facility staff were also interviewed on issues and concerns relating to the facility energy performance.

The senior care facility has an inner closed atrium and open courtyard separated by a central row of residential suites. The basement houses the mechanical room and storage area. The atrium which also serve as dining area has clerestory windows on all four sides.

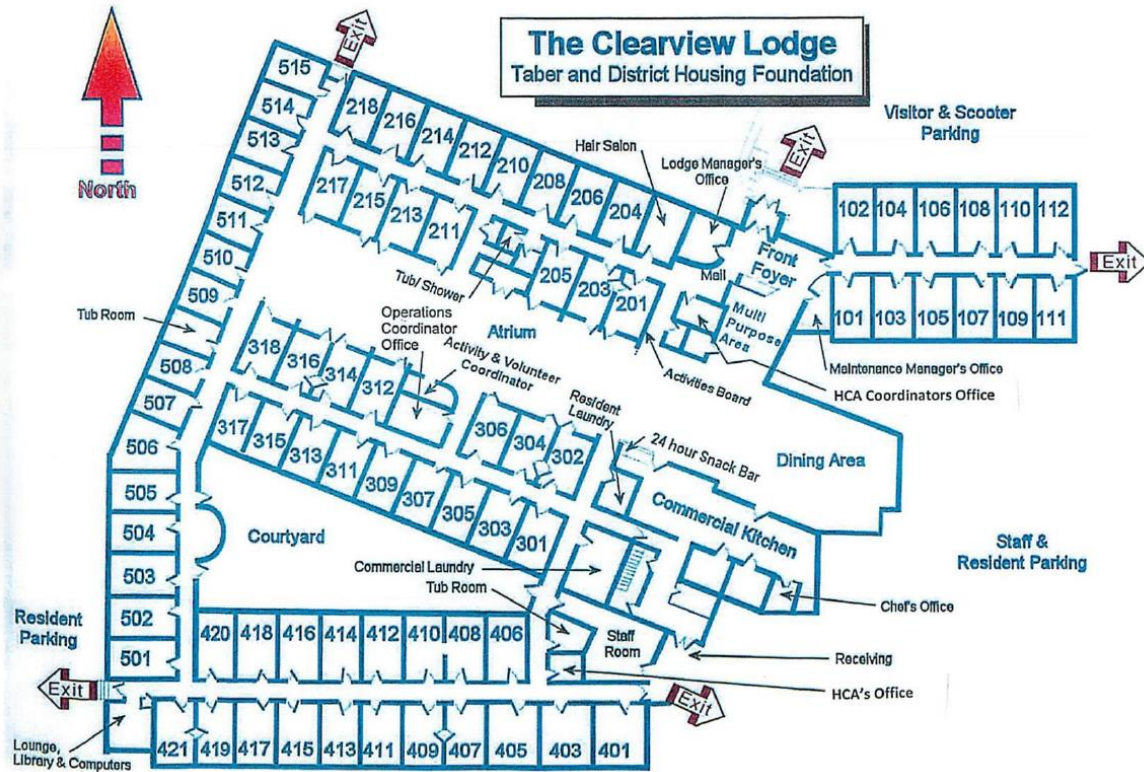


Figure 2: Floor Plan – Main Floor

2.1 Space Types and Occupancy Schedule

The main facility space types and occupancy schedules are described in **Table 1** below.

Table 1: Space Types and Occupancy

Space Type	Weekday Hours	Average People	Weekend Hours	Average People	Annual Events	Average People
Residential Suites	24 hr/day	84	24 hr/day	84	-	-
Atrium, Dining Area	6am-11pm	3-4 hr/day-person	6am-11pm	3-4 hr/day-person	-	-
Staff Room Area	24 hr/day	15	24 hr/day	15	-	-
Kitchen Area	6am-11pm	varies	6am-11pm	varies	-	-
Basement	8 hr/day	varies	8 hr/day	varies	-	-

2.2 HVAC Equipment Inventory

The heating and cooling equipment consists of a combination of the following equipment:

- Two Super Hot AAE-1440-N-M natural gas indirect-fired boilers (B-1, B-2), circulation pumps (P) and hydronic heating loops which supply hot water to the following facility elements:
 - Perimeter baseboard radiant fin tube heaters for the residential suites, east wall of the dining area, and kitchen area.
 - Force flow heaters (FF-1, FF-2) for the basement and crawlspaces.
 - Cabinet unit heater (UH-1 to 5) for the main floor common areas.
 - Heating coils of MUA-3 make-up air unit serving the central wing.
- Two Engineered Air indirect-fired Make-Up Air Units (MUA-1, MUA-2) models DJE100 and DJS60 which provide 100% outdoor air to the north, east, and south wing. The cooling systems are York YD180C00A2AAA5 and Carrier 38AUDA12A0M5-0A0A0 respectively.
- One Engineered Air LM-4-C hydronic heating Make-Up Air Unit (MUA-3) which provide 100% outdoor air to the central wing. MUA-3 also use the same cooling unit as MUA-2.
- One Engineered Air HE70 direct-fired Make-Up Air Unit (MUA-4) which provide 100% outdoor air to the kitchen. The cooling unit for MUA-4 is Engineered Air FWE93.
- Two Lennox GCS16-072-160-1Y Rooftop Units (RTU-1, RTU-2) which mix return air from the facility with fresh air from outside and provide heating and cooling to the atrium and dining areas. They are installed on the roof of the facility.
- One Carrier 48TCFA06A2M5A0B0A0 Rooftop Unit (RTU-3) which mix return air from the facility with fresh air from outside and provide heating and cooling to the staff room area. It is installed on the roof of the facility.
- Two AO Smith natural gas direct-fired storage type domestic hot water heaters (DHW-1, DHW-2) models HW-399 300 and BTRC120 110.



Figure 3: Boilers (Left), MUA (Center), RTU (Right)

2.2.1 Annual Fuel Utilization Efficiency

The efficiency of heating and cooling equipment degrades over time and can be calculated with the age of the equipment and a maintenance factor (M). The current Annual Fuel Utilization Efficiency (AFUE) factor is calculated using the following equation.³

$$AFUE_{\text{current}} = AFUE_{\text{original}} * (1-M)^{\text{age}}$$

Table 2 contains an inventory of the heating and cooling equipment observed during the site visit.

Table 2: HVAC Equipment Inventory

Tag	Equipment Description	Space Type/Zone	Capacity /Input (BTU/h, kW)	Base AFUE/ COP	Current AFUE/ COP	Notes
RTU-1	Natural Gas (indirect-fired) Rooftop Unit	Atrium and Dining Area	160,000/21.92	78.0%/2.85	71.2%/2.37	
RTU-2	Natural Gas (indirect-fired) Rooftop Unit	Atrium and Dining Area	160,000/21.92	78.0%/2.85	71.2%/2.37	
RTU-3	Natural Gas (indirect-fired) Rooftop Unit	Staff Room Area	150,000/17.29	78.0%/3.90	75.9%/3.70	
MUA-1	Natural Gas (indirect-fired) Make-Up Air unit	North & East Wing	1,000,000/52.75	78.0%/3.82	77.5%/3.78	
MUA-2	Natural Gas (indirect-fired) Make-Up Air unit	South Wing	500,000/33.82	78.0%/4.28	75.9%/4.05	
MUA-4	Natural Gas (direct-fired) Make-Up Air unit	Kitchen	462,000/37.69	90.0%/3.72	87.6%/3.53	
DHW-1	Natural Gas (direct-fired) Storage Water Heater	Basement	359,100	80%	78.1%	
DHW-2	Natural Gas (direct-fired) Storage Water Heater	Basement	120,000	80%	72.3%	
B-1	Natural Gas (indirect-fired) Boiler	Residential Suites & Kitchen	1,440,000	78%	70%	
B-2	Natural Gas (indirect-fired) Boiler	Residential Suites & Kitchen	1,440,000	78%	70%	
MUA-3	Hydronic Make-Up Air unit	Central Wing	322,106	-	-	
FF-1,2	Hydronic Unit Heater	Basement	30,500	-	-	
UH-1-3	Hydronic Unit Heater	Common Areas	37,900	-	-	
UH-4,5	Hydronic Unit Heater	Common Areas	29,400	-	-	

2.3 HVAC Controls, Distribution and Setpoints

2.3.1 HVAC Controls

The facility HVAC control systems consist of:

- Non-programmable electromechanical thermostats for the residential suites, common areas, kitchen, and basement.
- Programmable digital thermostats for the atrium, dining area, and staff room.
- There are no temperature setbacks currently assigned on all the thermostats including the programmable ones.
- A boiler control system including:
 - Lead/Lag control via a time clock alternates lead boiler operation.
 - Outdoor temperature reset: The boiler has an outdoor temperature sensor which allows it to reduce the supply/outlet temperature during the shoulder seasons. This will prevent zones from overheating and the system from short cycling. Hot water supply temperature setpoints of 93°C and 38°C are specified for outdoor dry bulb temperatures of -30°C and 21°C respectively.
 - Three-way control valves with a radiator/terminal unit bypass.
 - Tekmar boiler controller (unknown model) determines the high/low heating stages of the boilers.

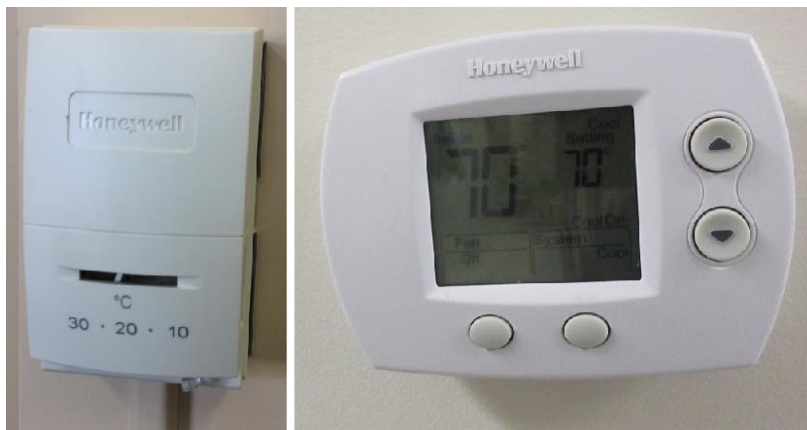


Figure 4: Non-programmable thermostat (Left), Programmable digital thermostat (Right)

2.3.2 Distribution

The facility uses a combination of the following heating and cooling distribution methods:

- Hydronic heating (serving perimeter baseboard heaters, force-flow, and cabinet heaters).
- High temperature hydronic perimeter baseboard radiators
- Conditioned forced air supplied to the spaces via wall registers and ceiling diffusers.

The facility zones have the following thermostat types, heating/cooling distribution methods, and temperature setpoints as seen in **Table 3**.

Table 3: HVAC Space Types and Setpoints

Space Type	Thermostat Type	Distribution Method	Mode	Occupied Setpoint °C	Unoccupied Setback °C	Site Temp °C
Residential Suites and Common Areas	Electromechanical Non-programmable	Hydronic Baseboard and Unit Heaters / MUA ductwork	Heat	21°C	21°C	21°C - 25°C
			Cool	-	-	
Atrium and Dining Area	Digital Programmable	RTU ductwork	Heat	21°C	21°C	24°C
			Cool	-	-	
Staff Room, Common and Service Areas	Digital Programmable	RTU ductwork	Heat	21°C	21°C	23°C
			Cool	-	-	
Kitchen	Electromechanical Non-programmable	Hydronic Baseboard Heaters / MUA ductwork	Heat	21°C	21°C	21°C
			Cool	-	-	
Basement	Electromechanical Non-programmable	Hydronic Force-Flow Heaters	Heat	21°C	21°C	21°C
			Cool	-	-	


Figure 5: Hydronic Unit Heater (Left), Hydronic Baseboard Heater (Right)

2.4 Ventilation

The facility ventilation system consists of a combination of the following elements:

- Packaged rooftop unit air intake dampers which operate when there is a demand for heating or cooling.
- Direct and Indirect fired makeup air units with 100% fresh air intake.
- Kitchen and washroom exhaust fans with constant air volume operation.

Table 4 summarizes the estimated total ventilation rates and minimum outdoor air flow rates according to Alberta Infrastructure Technical Design Requirements for senior care facilities with reference to the space types.

Table 4: Ventilation Air Flow Rates

Space Type	Alberta Infrastructure Tech Design OA rate (CFM)	Total Ventilation Rate (CFM)	Estimated OA Rate (CFM)	Estimated Exhaust Rate (CFM)
Residential Suites	9,448	13,448	13,448	0
Atrium & Dining Area	2,418	4,160	416	0
Staff Room Area	669	2,780	278	0
Kitchen	691	4,200	4,200	1,429
Basement	0	0	0	0
Total	13,226	24,588	18,342	1,429



Figure 6: Kitchen Roof-mount Exhaust Fan

2.5 Pumps, Fans and motors

The facility has a combination of the following pumps fans and motors;

- Make-up Air Unit (MUA) blower supply fans.
- Supply and return fans on rooftop units (RTU).
- Force flow fans (FFF) and unit heater fans (UH).
- Exhaust fans (EF) in washrooms and janitor room.
- Range hood fans (RHF) that exhaust to the exterior.
- Circulation pumps (P) for hydronic heating system.
- Recirculation pump (RP) for domestic hot water (DHW) heating system.
- Circulation pump for boiler hot water to MUA-3.

An inventory of pumps, fans and motors can be found in **Table 5** along with recorded or estimated efficiencies and schedules.

Table 5: Pumps, Fans and Motors

Tag	Equipment Description	Count	Power Rating (hp)	Motor Efficiency Level	Load Factor %	Flow Type	Estimated Annual Operating Hours
RTU-1	Rooftop Unit Blower	1	2	Standard	60%	Constant	2,270
RTU-2	Rooftop Unit Blower	1	2	Standard	60%	Constant	2,270
RTU-3	Rooftop Unit Blower	1	1-1/5	Standard	60%	Constant	755
MUA-1	Make-Up Air unit Blower	1	7-1/2	Standard	60%	Constant	8,760
MUA-2	Make-Up Air unit Blower	1	5	Standard	60%	Constant	8,760
MUA-3	Make-Up Air unit Blower	1	3	Standard	60%	Constant	8,760
MUA-4	Make-Up Air unit Blower	1	5	Standard	60%	Constant	8,760
FF-1,2	Unit Heater Blower	1	1/20	Standard	60%	Constant	518
UH-1-3	Unit Heater Blower	1	1/20	Standard	60%	Constant	2,270
UH-4,5	Unit Heater Blower	1	1/20	Standard	60%	Constant	2,270
EF-6	Exhaust Fan	1	7-1/2	Standard	60%	Constant	-
EF-5	Exhaust Fan	1	1/3	Standard	60%	Constant	-
EF-7	Exhaust Fan	1	1/6	Standard	60%	Constant	-
EF-8, 9	Exhaust Fan	2	1/6	Standard	60%	Constant	-
RTU-1	Rooftop Unit Condenser Blower	1	1/3	Standard	60%	Constant	2,927
RTU-2	Rooftop Unit Condenser Blower	1	1/3	Standard	60%	Constant	2,927
RTU-3	Rooftop Unit Condenser Blower	1	1/4	Standard	60%	Constant	148
MUA-1	MUA Condenser Blower	4	1/3	Standard	60%	Constant	371
MUA-2	MUA Condenser Blower	2	1/4	Standard	60%	Constant	585
MUA-4	MUA Condenser Blower	2	3/4	Standard	60%	Constant	184
EF-6	Roof-mount Kitchen Exhaust Fan	1	7-1/2	Standard	60%	Constant	-
EF-5	Dishwasher Exhaust Fan	1	1/3	Standard	60%	Constant	-
EF-7	Janitor's Room Exhaust Fan	1	1/6	Standard	60%	Constant	-
EF-8, 9	Washroom Exhaust Fans	2	1/6	Standard	60%	Constant	-

Tag	Equipment Description	Count	Power Rating (hp)	Motor Efficiency Level	Load Factor %	Flow Type	Estimated Annual Operating Hours
P-1, 2	Boiler Hot Water Pump	2	5	Efficient	60%	Constant	1,510
P-3	Boiler Hot Water Circulation Pump to MUA-3	1	1/4	Efficient	60%	Constant	1,834
RP-1, 2	DHW Recirculation Pump	2	197 W	Standard	60%	Constant	8,760



Figure 7: DHW Recirculation Pump (Left), Boiler Hot Water Pump (Center), Hot Water Circulation Pump to MUA-3 (Right)

2.6 Electrical

2.6.1 Interior Lighting

The interior lighting consists of a combination of lighting types as seen in **Table 6**. All interior lighting is controlled by manual switches. For residential suites, two representative units were visited in each zone of the building complex to determine the lighting system installed, and lighting data obtained were extrapolated for all residential suites.

Table 6: Interior Lighting Schedule

Fixture Type	Watts per Fixture (W)	Number of Fixtures	Total Wattage (W)
1x4' T8-surface 1-lamp	32	32	1,024
1x4' T12-surface 2-lamp 34W	72	132	9,504
1x4' T8-recessed 2-lamp	59	46	2,714
LED Exit Sign	4.1	4	16
Exit Sign (Incandescent)	40	6	240
BR40 LED Bulb	15	14	210
1x4' T8-surface 2-lamp	59	75	4,425
1x4' T12-surface 1-lamp 34W	43	14	602
PAR30 LED Bulb	11	297	3,267
A21 Incandescent 100W	100	19	1,900
MH Hi-Bay 400W	300	18	5,400
CFL (13W)	15	3	45
1x2' T12-surface 1-lamp	26	80	2,080
A19 Incandescent 60W	60	108	6,480
1x2' T8-surface 1-lamp	20	28	560
Total		876	38,467

Table 7: Zonal Lighting Power Densities

Space Type / Zone	Floor Area (m ²)	Lighting Power Density (W/m ²)	ASHRAE Benchmark (W/m ²)	Estimated Annual Operating Hours (h/yr)
Suites	1428	9.19	4.09	3,650
Suite WC	476	10.83	10.55	730
Hair Salon	23	17.25	6.46	782
Staff Areas	199	7.58	11.95	2,607
Resident Service	112	11.63	6.46	2,190.0
Hallways, Foyer	547	23.95	7.10	5,110
Kitchen	128	8.59	13.02	4,380
Common WC, tub, shower	57	10.40	10.55	1,095
Basement	294	2.81	4.52	365
Atrium Dining Area	581	1.88	9.58	6,205
Total	3,845	10.0 (Average)	7.06 (Average)	2,711 (Average)

The average lighting power density in the facility is 10.0 W/m², as seen in **Table 7**. A typical average LPD for similar facilities from ASHRAE 90.1 2013 is 7.06 W/m².



Figure 8: Interior Lighting

2.6.2 Exterior Lighting

The exterior lighting consists of a combination of lighting types as seen in **Table 8**. The metal halide (MH) wallpacks and high pressure sodium (HPS) fixtures are controlled by photocells, while the rest are controlled by manual switches.

Table 8: Exterior Lighting Schedule

Fixture Type	Watts per Fixture	Number of Fixtures	Total Wattage (W)
Pole Mounted MH	400	1	400
HPS 100W	130	2	260
MH 250W	295	3	885
A19 (60W eq) LED Bulb	9.8	2	20
MH 175W	200	5	1,000
CFL (21W)	25	2	50
Total		15	2,615



Figure 9: Exterior Lighting

2.6.3 Plug Loads

Equipment plug loads are estimated from NECB 2011 as shown in **Table 9**.

Table 9: Plug Load Power Ratings

Zone	Area (m ²)	ASHRAE Power Density Factor (W/m ²)	Plug Load (W)
Senior Care Facility	3,845	5	19,226



Figure 10: Plug Loads

2.7 Process and Miscellaneous Heat Loads

The following additional equipment is in the facility:

1. Natural gas fired range burners, fryer, and convection oven are used in the kitchen.
2. A walk-in freezer, walk-in cooler, and ice making machine are found in the kitchen area.
3. Several electric clothes washers and dryers are found in the resident and commercial laundry areas.
4. Mini split-type air conditioning units and a photocopying machine are also found in the staff room and offices.
5. Some of the residential suites have a portable air conditioning unit.

2.8 Facility Envelope

2.8.1 Opaque Walls

Engineering drawings show wall assemblies as listed in **Table 10**. Thermal properties of the constituent layers are obtained from standard engineering references (e.g. ASHRAE Fundamentals). RETScreen Expert software was used to calculate the effective R-values of the assemblies.

Table 10: Facility Wall Construction Summary

Above Grade Wall, W9 (1960)	Thickness (mm)	R-Value* (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.170
Stucco	38	0.302
Vapor Barrier	0.1524	0.037
Building Paper	6	0.068
Plywood	19	0.981
Wood Stud 38mm x 89mm, 406mm OC	38	0.939
Mineral Fiber Batt Insulation	51	6.924
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Interior Film Coefficient		0.681
Effective R-value	-	10.6
Above Grade Wall, W6 (1971)	Thickness (mm)	R-Value (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.170
Stucco	38	0.302
Vapor Barrier	0.1524	0.037
Building Paper	6	0.068
Plywood	19	0.981
Mineral Fiber Batt Insulation	89	12.083
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Interior Film Coefficient	-	0.681
Effective R-value	-	14.8

* Estimated based on RETScreen Expert with air layer thermal resistance obtained from EE4

Above Grade Wall, W4 (1994)	Thickness (mm)	R-Value (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.170
Stucco	38	0.302
OSB Sheathing	11	0.686
Wood Stud 38mm x 140mm, 406mm OC	140	1.429
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Interior Film Coefficient	-	0.681
Effective R-value	-	3.8
Above Grade Wall, W2 (2000)	Thickness (mm)	R-Value (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.170
Stucco	38	0.302
Building Paper	6	0.068
OSB Sheathing	9.5	0.593
Mineral Fiber Batt Insulation	137.16	18.622
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Interior Film Coefficient	-	0.681
Effective R-value	-	20.9
Above Grade Wall, W17 (2013)	Thickness (mm)	R-Value (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.170
Stucco	22	0.175
Building Paper	6	0.068
OSB Sheathing	9.5	0.593
Mineral Fiber Batt Insulation	137.16	18.622
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Interior Film Coefficient	-	0.681
Effective R-value	-	20.8
Below Grade Wall, W18 (2013)	Thickness (mm)	R-Value (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	12.242
Concrete	200	0.680
Air Layer	13	0.773
Concrete Block	190	0.899
Interior Film Coefficient	-	0.681
Effective R-value	-	15.3

For comparison, the National Energy Code for Buildings 2011 (NECB 2011) prescribes R-23 walls for Climate Zone 6, within which Taber is located. The walls appear to be in good physical condition.

2.8.2 Roof

The facility has a mix of gable type, hip-and-valley, and flat roof designs. The gable type and hip-and-valley roofs are assumed to have an attic vented through soffits. Engineering drawings show roof assemblies as listed in **Table 11**. Thermal properties of the constituent layers below the vented attic are obtained from standard engineering references.

Table 11: Roof Assembly Construction

Vented Attic Roof R1	Thickness (mm)	R-Value* (F°ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
Fiberglass Rigid Insulation	100	12.081
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Steel deck galvanized	1	negligible
Interior Film Coefficient	-	0.608
Effective R-value	-	13.3
Vented Attic Roof R2	Thickness (mm)	R-Value† (F°ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
Fiberglass Blown-in Insulation (Rsi-6.1)	238.8	34.763
Vapor Barrier	0.1524	0.037
Gypsum Board	15.9	0.564
Interior Film Coefficient	-	0.608
Effective R-value	-	36.1
Vented Attic Roof R3	Thickness (mm)	R-Value* (F°ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
Fiberglass Blown-in Insulation (Rsi-6.1)	238.8	34.763
Vapor Barrier	0.1524	0.037
Wood Trusses 38mm x 89mm, 1200mm OC	89	1.041
Gypsum Board	15.9	0.564
Interior Film Coefficient	-	0.608
Effective R-value	-	37.1
Vented Attic Roof R4, R8	Thickness (mm)	R-Value* (F°ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Interior Film Coefficient	-	0.608
Effective R-value	-	1.2
Vented Attic Roof R5	Thickness (mm)	R-Value* (F°ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
Fiberglass Batt Insulation	101.6	14.793
Vapor Barrier	0.1524	0.037
Gypsum Board	15.9	0.564
Interior Film Coefficient	-	0.608
Effective R-value	-	16.1
Vented Attic Roof R7	Thickness (mm)	R-Value* (F°ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
Fiberglass Batt Insulation	127	18.491
Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451
Interior Film Coefficient	-	0.608
Effective R-value	-	19.7

* Estimated based on RETScreen Expert with air layer thermal resistance obtained from EE4

† Estimated based on RETScreen Expert with air layer thermal resistance obtained from EE4

Vented Attic Roof R11	Thickness (mm)	R-Value* (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
Fiberglass Batt Insulation (R-40) in Wood Studs	279.4	38.758
Vapor Barrier	0.1524	0.037
Gypsum Board, 2 Layers	25.4	0.901
Interior Film Coefficient	-	0.608
Effective R-value	-	19.7
Flat Roof R12	Thickness (mm)	R-Value* (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.102
2-Ply SBS Roofing Membrane	4	0.134
Roofboard	25	2.581
Rigid Fiberglass Insulation	85	10.269
Polyisocyanurate Rigid Insulation	175	41.404
Vapor Barrier	0.1524	0.037
Plywood	19	0.981
Air Layer	139.7	1.382
Gypsum Board, 2 Layers	25.4	0.901
Interior Film Coefficient	-	0.608
Effective R-value	-	58.4

For comparison, the NECB 2011 prescribes R-31 roofs for Climate Zone 6. The roofs appear to be in good physical condition.



Figure 11: View of roof surface showing the Atrium clerestory windows

2.8.3 Fenestration

The facility has the following types of windows and doors, as described in **Table 12**. The doors appear to have inadequate or missing seals and sweeps, otherwise, the windows and doors appear to be in good overall condition.

Table 12: Window and Door Specifications

Window Type	Qty	Total Area (m ²)	U-Value (Btu/h)/ft ² /°F	Solar Heat Gain Coefficient
Operable, Vinyl frame, Double pane, 1/2" air space	72	182.83	0.59	0.76
Fixed, Vinyl frame, Double pane, 1/2" air space	40	97.72	0.59	0.76
Fixed, Wood frame, Double pane, 1/2" air space	2	1.63	0.59	0.76
Fixed, Aluminum frame no thermal break, Double pane, 1/2" air space	2	2.63	0.59	0.76
Door Type	Qty	Total Area (m ²)	U-Value (Btu/h)/ft ² /°F	
Aluminum no thermal break frame Glass, Double pane, 1/2" air space	3	7.34	0.59	
Insul steel/wood frame slab, Double pane, 1/2" air, 25% Glazing	1	1.90	0.26	
Insul steel/metal frame slab, Double pane, 1/2" air, 25% Glazing	2	5.81	0.48	
Insul steel/metal frame slab, No Glazing	1	1.65	0.37	
Insul steel/metal frame slab, Double pane, 1/2" air, 45% Glazing	1	1.77	0.56	

For comparison, the NECB 2011 prescribes U-values of 0.39 BTU/(ft²·°F·h) for windows and doors in Climate Zone 6.


Figure 12: Windows on the East Wings

2.8.4 Floor

The residential suites, corridors, and foyer of the facility has carpeted floors while the staff offices, atrium, dining area, and kitchen has vinyl flooring which is all situated above an uninsulated and heated crawlspace 1,537 mm deep and sits approximately 900 mm below grade. The basement below the staff office area has concrete flooring. Engineering drawings show floor assemblies as listed in **Table 13**.

Table 13: Floor Assembly Construction

Carpeted Floor	Thickness (mm)	R-Value* (F°*ft ²)/(Btu/hr)
Exterior Film Coefficient	-	0.460
Carpet with Underlay	6.35	0.721
Plywood	7.94	0.410
Vapor Barrier	0.1524	0.037
OSB Decking	19	1.186
Interior Film Coefficient	-	0.801
Effective R-value	-	3.6

* Estimated based on RETScreen Expert

Vinyl Floor	Thickness (mm)	R-Value* (F°*ft²)/(Btu/hr)
Exterior Film Coefficient	-	0.460
Linoleum Flooring	2	0.067
Plywood	9.5	0.490
Vapor Barrier	0.1524	0.037
Hardwood Decking	19	0.674
Interior Film Coefficient	-	0.801
Effective R-value	-	2.5

2.8.5 Overall Facility Envelope Condition

Overall, the facility envelope appeared to be in good condition.

* Estimated based on RETScreen Expert

2.9 Water Fixture Inventory

Table 14 displays the water fixtures observed in the facility during the site visit.

Table 14: Water Fixture Inventory

Fixture Description	Count	Estimated or Recorded Flow Rate [gallons per minute (GPM), liters per minute (LPM), gallons per flush (GPF), liters per flush (LPF)]
Showerheads	20	9.3 LPM
Toilets	82	6 LPF
Tub faucets	3	8.3 LPM
Private Washroom faucet	39	8.3 LPM
Private Washroom faucet, low-flow	39	5.7 LPM
Public Washroom faucet	4	8.3 LPM
Kitchen and breakroom faucet	5	8.3 LPM



Figure 13: Water Fixtures

3 ENERGY COST ANALYSIS

3.1 Utility Bill Analysis

3.1.1 Electricity Consumption

The electricity bills from the retailer and the utility rate codes from the distributor are referenced to calculate the savings rates for electricity consumption. The electrical savings rate consists of an energy consumption rate from the electrical retailer combined with the variable portion of the transmission and distribution charges from the utility distributor. This savings rate is used in the financial analysis of proposed ECMs.

3.1.2 Electricity Demand

The utility rate codes from the distributor are referenced to calculate the savings rates for electricity demand. The “Demand Ratchet” calculates the billed demand to be the higher of the peak demand during the billing month, or 85% of the peak from the previous 12 months. Reducing this peak demand will result in significant monthly financial savings 12 months after the peak has occurred. Details of electrical rate code are displayed in **Appendix B: Utility Rate Code**.

3.1.3 Natural Gas

A regression analysis of the natural gas charges was performed to calculate the natural gas savings rate and remove the effect of fixed charges. The natural gas savings rate has been adjusted for the 2018 Carbon Levy. This savings rate is used in the financial analysis of proposed ECMs.

3.1.4 Water

The water bills from the local provider were referenced to calculate the savings rate for water.

Table 15: Utility Cost/Unit

Utility Type	Utility Provider	Savings Rate
Electricity Consumption	Retailer: Alberta Municipal Services Corporation	0.074 \$/kWh
Electricity Demand	Distributor: Fortis (Rate Code 61)	0.603 \$/kW/day
Natural Gas	Retailer: Alberta Municipal Services Corporation Distributor: Atco Gas	7.55 \$/GJ
Water	Service Provider: The Town of Taber	1.77 \$/m ³

3.2 Utility Cost Breakdown

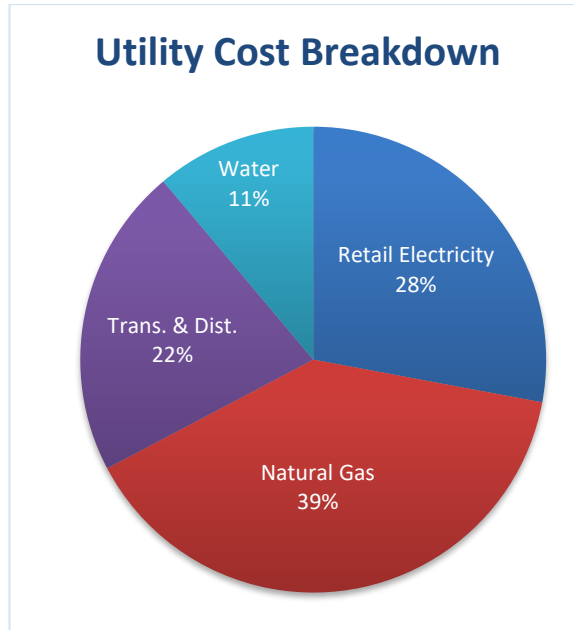


Figure 14: Utility Cost Breakdown

Table 16: Utility Cost Breakdown

Year	Electricity Consumption (\$)	Transmission and Distribution (\$)	Natural Gas (\$)	Water (\$)
2016	\$34,755	\$25,847	\$41,525	\$15,837
2017	\$36,937	\$29,413	\$54,835	\$14,792
2018 (Jan – July)	\$21,817	\$17,380	\$38,582	\$6,695
Average	\$36,468	\$28,192	\$51,351	\$14,532
% of Total	28%	22%	39%	11%

Figure 14 and **Table 16** show the relative costs of electrical consumption, electrical transmission and distribution, natural gas and water over the entire billing period.

Utility charges are dominated by natural gas charges which are driven by mostly by ventilation demand. Therefore, upgrades that reduce ventilation demand should be focused on.

4 ENERGY USE ANALYSIS

4.1 Electricity Consumption and Demand

The electrical consumption (lines in **Figure 15**) shows a slightly higher electrical consumption in the summer months due to an increase in run times on the air conditioning system with associated condenser blowers plus an increase in run times on the walk-in freezer, cooler and ice making machine.

The vertical bars in **Figure 15** represent the billed demand which is calculated using a “Demand Ratchet” clause. The billed demand is the higher of the peak demand during the billing month, or 85% of the peak from the previous 12 months. Reducing this peak demand will result in significant monthly financial savings.

Figure 15 also indicates that the demand of the facility peaked in June for the billing period analyzed. Any permanent reduction in peak demand will see significant savings.

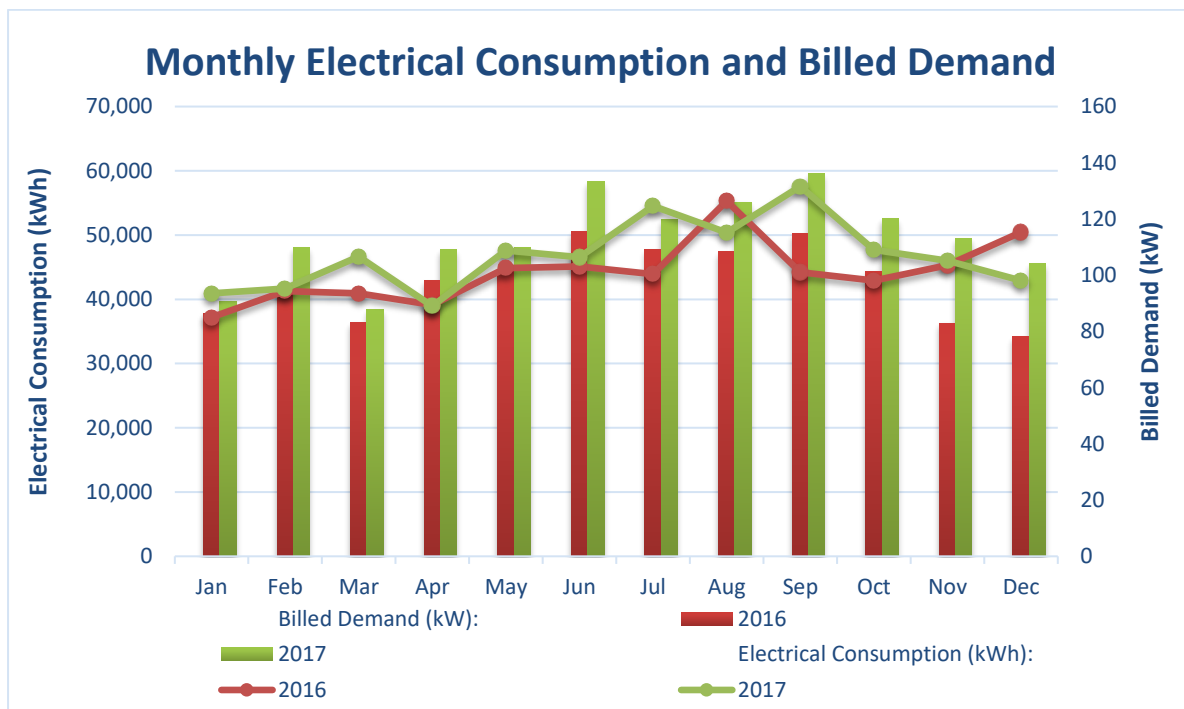


Figure 15: Monthly Electrical Consumption and Billed Demand

Table 17: Electrical Consumption and Demand Summary

Year	Electricity Consumption (kWh)	Peak Demand (kW)
2016	530,627	116
2017	561,479	136
Annual Average	546,053	-

4.2 Natural Gas Consumption

The natural gas consumption (**Figure 16**) displays a typical consumption curve common in facilities located within a colder climate. Greater natural gas consumption is witnessed during the winter months due to the increased heating demands from colder outdoor temperatures.

The lowest consumption levels are experienced during the summer months and may be attributed to domestic hot water heating and/or any other process loads.

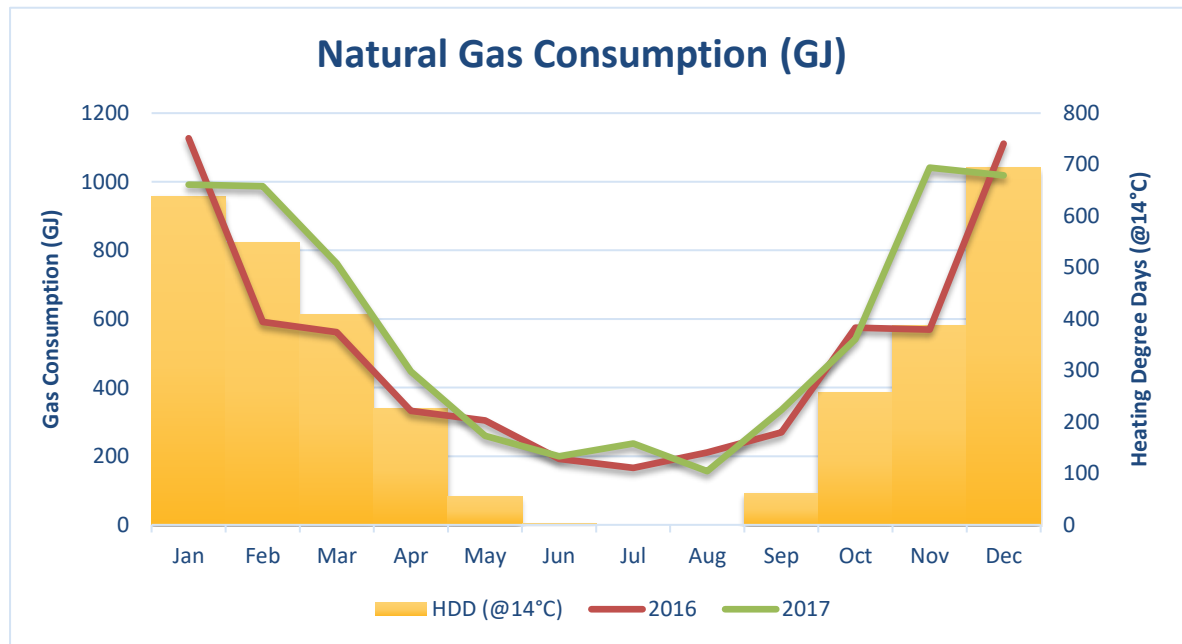


Figure 16: Monthly Natural Gas Consumption

Table 18: Natural Gas Summary

Year	Natural Gas Consumption (GJ)
2016	6,0010
2017	6,976
Annual Average	6,493

4.3 Water Consumption

The monthly water consumption is shown in **Figure 17**, while average annual water consumption is shown in **Table 19**. Using RETScreen and the facility occupancy patterns from **Table 1: Space Types and Occupancy**, an estimated daily use of 12,340 L/day or 12.3 m³/day of hot water was simulated for the baseline model. The remainder of the water is assumed to be used as cold water.

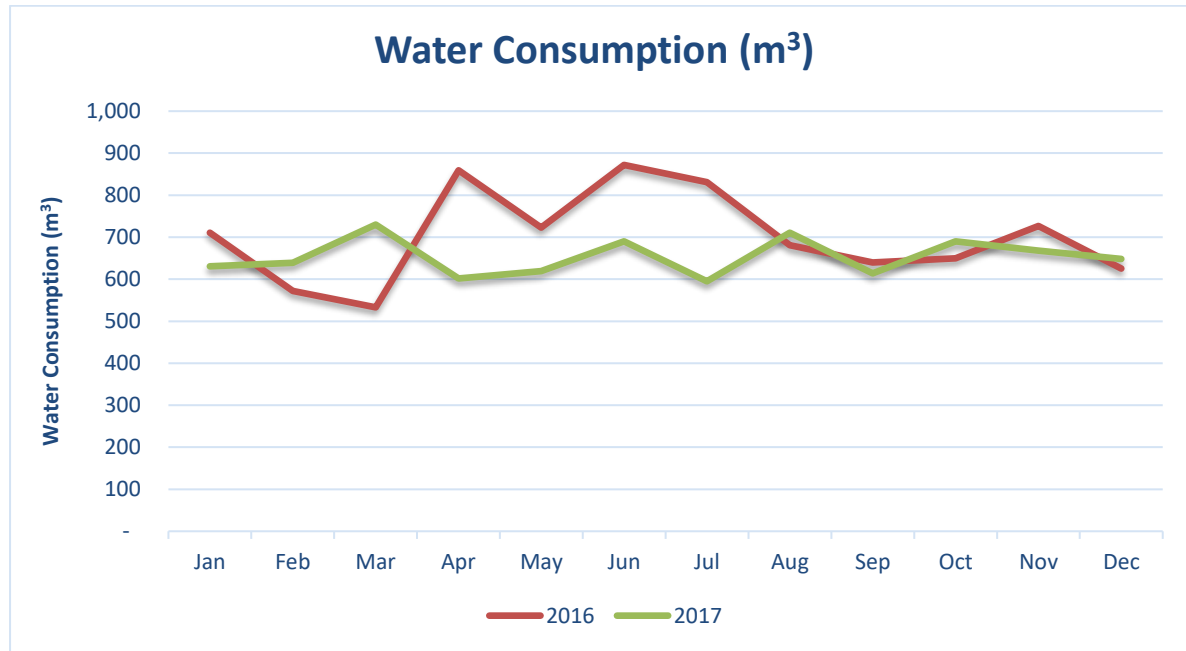


Figure 17: Monthly Water Consumption

Table 19: Water Consumption

Year	Water Consumption (m ³)
2016	8,424
2017	7,837
Annual Average	8,130

5 ADJUSTED BASELINE AND BENCHMARK

5.1 Weather Normalization

Natural Gas consumption is weather-normalized to ensure that any atypical heating degree day values during the billing period do not distort the energy consumption. The number of Heating Degree Days (HDD*) at 14 °C for the billing period is compared to a historical reference period (1983-2016) to determine an Adjustment Factor (See **Table 20**). An adjustment factor above 1.0 indicates that the billing period was hotter than the historical average while an adjustment factor below 1.0 indicates the billing period was cooler than the historical average. Electricity consumption is not usually weather-normalized because it is not wholly driven by heating or cooling degree days.

Table 20: Determination of Weather Adjustment Factor

Location	Year	Actual HDD	Average HDD	Average HDD 1983-2016	Adjustment Factor
Taber, AB	Jan 2016 - Dec, 2016	2,859	3,150	3,209	1.02
	Jan 2017 - Dec, 2017	3,441			

5.2 Adjusted Baseline Energy Use

A computer model of the facility was created in RETScreen Expert software to evaluate potential Energy Conservation Measures (ECMs). Model inputs were the facility envelope, space loads, HVAC systems, electrical loads, and controls as described in **Section 2**.

The energy consumption predicted by the energy simulation was calibrated to the actual consumption on the utility bills.

Adjustments to the baseline energy simulation were then made to account for the following:

- Missing/ broken equipment
- Planned changes to building occupancy schedule and space use
- Planned changes.

The results are shown in **Table 21**.

Table 21: Energy Model Calibration

	Electricity		Natural Gas		Total	
	kWh	% Difference	GJ	% Difference	GJ	% Difference
Weather Normalized Bills	546,053	–	6,614	–	8,580	–
Calibrated Energy Model	553,767	1.41%	7,002	5.87%	8,996	4.85%

The weather-normalized natural gas consumption (6,614 GJ/yr) and electricity consumption (546,053 kWh/yr) were used to calibrate the energy model. A difference of less than 10% between the adjusted baseline energy use and the simulated model is considered acceptable.

5.3 Changeover Temperature

The facility changeover temperature is the ambient temperature at which the building heating system is not required in order to reach the desired internal setpoint and can be calculated from the energy bills. It is dependant on the internal heat loads of the facility and the local weather conditions. The calculated changeover temperature for the energy simulation is 14°C.

5.4 Greenhouse Gas Emissions

The baseline GHG emissions for the ECMs are calculated from the adjusted baseline energy consumption. The annual equivalent greenhouse gas emissions for this facility is 710.8 tCO₂e.

The following emission factors are used to estimate the GHG emission reductions:

- 0.0518 tonnes of CO₂ per GJ of Natural Gas avoided
- 0.64 tonnes of CO₂ per MWh of Electricity avoided
- 0.00154 tonnes of CO₂ per L of Propane avoided

GHG reductions for the proposed case are shown in the Executive Summary section as well as in the individual ECM sections.

5.5 Energy Consumption Benchmarking

The adjusted energy consumption is compared to similar facilities in Canada using the Energy Use Intensity (EUI) expressed in GJ/m². EUI values are published in the Energy Star Portfolio Manager *Canadian Energy Use Intensity by Property Type*⁴. The publication gives the Site EUI and the Source EUI. Site EUI only accounts for consumption by the facility but Source EUI includes transmission and other losses. Only the Site EUI is applied to benchmarking in this case.

The normalized EUI of this facility is 2.23 GJ/m², while the median Energy Star Site EUI for senior care facilities in Canada is 1.04 GJ/m². This indicates that the facility consumes 115% more energy than an average senior care facility with similar characteristics. As shown in **Figure 18**, a substantial portion of the EUI is due to natural gas usage.

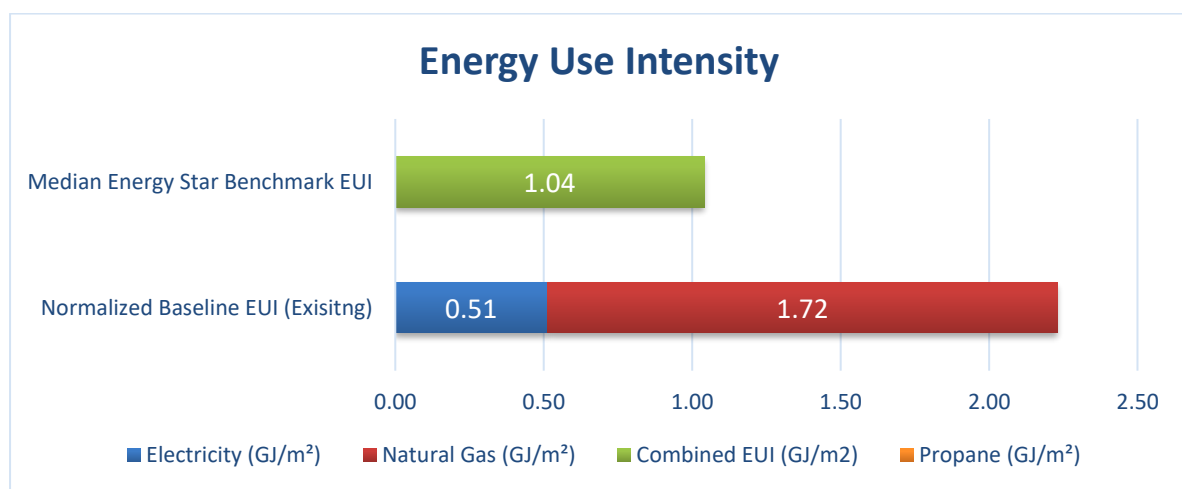


Figure 18: Energy Use Intensity

5.6 Energy End Use

The calibrated simulation shows that the following end uses (**Table 22**) are responsible for the facility total energy consumption (combined kWh and GJ) and shown by end use percentages in **Figure 19**.

Table 22: Baseline Energy End Use Breakdown

Energy Use	Modeled (GJ)	Percentage
Space Heat	1,428	16%
Lighting	697	8%
Ventilation	3,217	36%
Electrical Equipment	635	7%
Space Cooling	283	3%
Mechanical Equipment	378	4%
DHW	1,564	17%
Cooking	794	9%
Total	8,996	100%

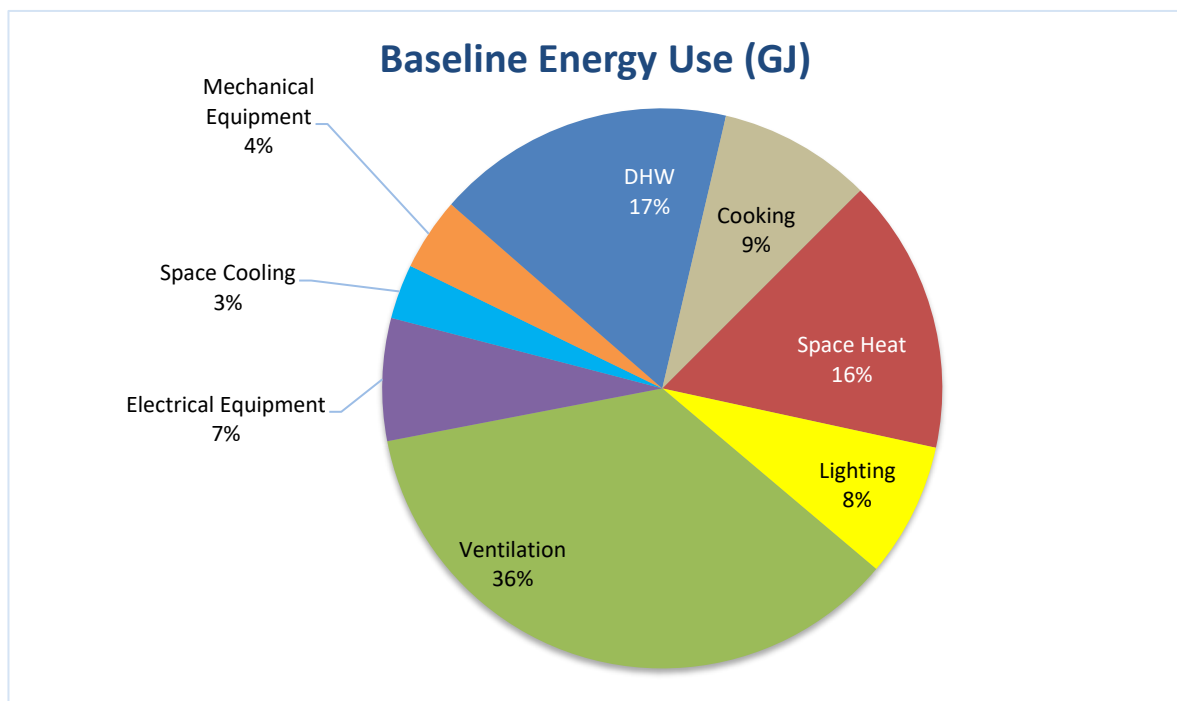


Figure 19: Categorized Facility Energy Uses (GJ)

6 ENERGY CONSERVATION MEASURES

No-cost/low-cost Energy Conservation Measures (ECMs): Those that save significant energy but require zero to small initial capital investments, typically up to \$1,000. Examples are programmable thermostats, increased temperature setback, low-flow sink aerators, and weatherization. Life cycle costing is not necessary for no-cost/low-cost ECMs.

Baseline NPV: Baseline net present value is based on the replacement of current equipment with equivalent equipment or equipment meeting the minimum applicable code at the end of its rated life. Applicable building codes are referenced to provide minimum performance levels and are found in the following table.

ECM NPV: The net present value of the energy conservation measure assumes replacement of the current equipment with high efficiency equipment in year one. These efficiencies may be equal to or above current code requirements.

Uncertainty: As specified in the *Quantification Protocol for Energy Efficiency in Commercial and Institutional Buildings*⁵, a factor is applied to energy savings to account for uncertainty. If the calculated uncertainty for an ECM is larger than 50%, an additional description would be included with recommendations on capital cost post-retrofit measurements that would reduce uncertainty. A constant uncertainty factor of 0.9 is prescribed by the NEET program.

Costing: Material and installation costs are estimated using RETScreen Expert, manufacturer quotes, or RS Means. This section may include corrections to facility deficiencies or components that are performing poorly compared to current standards. Additional costs may be included to account for specific installation issues or site location. All equipment life spans, material/installation costs, specified in retrofits or presented in the ECMs are for example and modelling purposes only.

Assumptions: For each ECM, all assumptions on performance, life span, replacement costs, schedule, and the efficiency of existing equipment will be stated.

Interactions: An ECM can affect the performance and characteristics of another ECM by altering the load profile and/or flow of energy. RETScreen Expert accounts for interactions between the ECMs. Overall energy and financial performance of the proposed case will be less than the sum of individual ECMs because of the interactions.

Equipment Selection: Proposed equipment for each ECM was selected based on existing site conditions and high efficiency equipment specifications. Manufacturers selected are for example purposes only. Any similar model and/or manufacture can be implemented based on external factors; however, performance may change if installed equipment differs from proposed equipment.

Adjusted Baseline: If equipment or components of a facility are broken or inoperable, they should be replaced prior to any upgrades to ensure proper facility function. If there is damaged equipment, it is assumed that it has been in that state throughout the billing period. To account for efficiency upgrades to damaged equipment, an adjusted baseline was created which simulates the broken equipment to be operating as originally designed. This allows for proper energy and cost savings comparisons between standard and high efficiency equipment.

Incentives and Rebates: Life cycle costing for an ECM and the proposed case excludes any financial rebates or incentives.

6.1 ECM-1: Low Flow Water Fixtures

6.1.1 Measure Boundary and Baseline

This ECM consists of replacing all existing faucets/aerators and shower heads with low-flow water fixtures. Reduced water usage in fixtures such as faucets and shower heads will reduce both water consumption and the amount of energy used to heat the water. An inventory of existing water fixtures can be found in **Table 14**. The total annual water consumption before and after water fixture upgrades along with the total estimated installed cost can be found in **Table 23**.

6.1.2 ECM Description

The following low flow fixtures are recommended for installation:

- **Low flow aerators:** Low flow aerators will reduce both hot and cold water consumption and can be installed on existing faucets. They can be installed by building staff and have a low initial cost of approximately \$10 each. They are recommended in cases where the existing faucets are in good condition and are not in need of replacement. Low flow aerators use a maximum of 1.9LPM (0.5 GPM) and will reduce water flow when compared to the standard flow rate of 8.3LPM (2.2 GPM).
- **Low flow showerheads:** low flow showerheads are recommended and consume 6.8LPM (1.8GPM) which is an improvement over standard showerheads that consume 9.3LPM (2.5GPM). They have an installed cost of approximately \$30/each⁶.

Table 23: Existing Equipment vs. Proposed Equipment

Existing Fixtures				
Description	Count (ea.)	Flow Rate (LPM/LPF)	Total Est. Annual Usage (m ³ /yr)	Installed Cost (ea.)
Washroom/Tub Sink Aerators	46	8.3	1,823	-
Washroom Sink Aerators, low-flow	39	5.7	601	-
Kitchen Aerators	5	8.3	15	-
Shower Heads	20	9.5	1,609	-
Total	-	-	4,048	-
Proposed Fixtures				
Description	Count (ea.)	Flow Rate (LPM/LPF)	Total Est. Annual Usage (m ³ /yr)	Installed Cost (ea.)
Washroom/Tub Sink Aerators	46	1.9 LPM	1,224	\$10
Kitchen Aerators	5	8.3LPM	10	\$10
Shower Heads	20	6.8 LPM	1,282	\$30
Total	-	-	2,517	\$1,110

6.1.3 Calculations, Assumptions, and Stipulated Data

There is moderate uncertainty within this ECM, as water usage is based on occupancy use. Hot water usage was estimated by RETScreen Expert using a residential building type and an occupancy of 84 residents, 29 full-time and casual employees, and 12 visitors/day. Interactions between sink aerator and shower head replacements with DHW energy use are considered in the energy model.

6.1.4 Energy & GHG Performance

Table 24: Fixture Upgrade ECM Summary

Description	Electricity	Natural Gas	Water	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,131 m ³	8,996 GJ
ECM Proposed Usage	553,800 kWh	6,765 GJ	6,744 m ³	8,759 GJ
Annual Energy Savings	0 kWh	237 GJ	1,386 m ³	237 GJ
Eligible Annual Energy Savings	0 kWh	213 GJ	1,248 m ³	213 GJ
Annual Eligible GHG Reductions	0.0 tCO ₂ e	11.0 tCO ₂ e	-	11.0 tCO ₂ e
Annual Cost Savings	\$ -	\$ 1,600	\$ 2,220	\$ 3,820
Lifetime Eligible Energy Savings	0 kWh	3,200 GJ	18,717 m ³	3,200 GJ
Description	Total			
Equipment Lifetime	15 Years			
ECM Total Cost	\$1,110			
Simple Payback	0.3 Years			
Baseline NPV	-			
ECM NPV	\$ 41,450			
Lifetime Cost Savings	\$ 57,300			
Lifetime GHG Reductions	165.7 tCO ₂ e			
GHG Abatement Rate	\$ 7/tCO ₂ e			

6.1.5 Recommendations

This ECM is recommended and is included in the proposed case. The initial capital investment of this ECM is \$1,110 and it will reduce energy consumption by roughly 213 GJ annually.

6.2 ECM-2: DHW Tank Thermal Blanket

6.2.1 Measure Boundary & Baseline

This ECM will consider the energy savings of installing a thermal blanket on the existing DHW tanks and insulating all hot water pipes. An increase in insulation around the water heater and piping will decrease the standby losses of the water tank and reduce its energy consumption.

An inventory of existing equipment can be found in **Table 25**. The total annual energy consumption before and after implementation along with the total estimated installed cost can be found in **Table 26**. There is a separate hot water storage tank supplied by the two DHW heaters through in-line circulation pumps. There was also an observed damper in the wall, which allowed fresh air into the basement mechanical and storage room for DHW heater and boiler combustion.

6.2.2 ECM Description

This ECM proposes the installation of the following equipment:

- One 91-gallon and one 71-gallon thermal blanket insulation with a thermal resistance of R-9. These blankets can be purchased for approximately \$50 and installed by building personnel.

Water tank insulation blankets are an inexpensive and effective way to increase the insulation value of the hot water tank and reduce standby losses. Hot water heating occurs when the temperature in the tank drops below a setpoint temperature, which usually ranges from 55-60°C. When hot water is not being used, heat from the tank dissipates to the surrounding room, causing the burner to engage. Added insulation will decrease the amount of energy needed to maintain the tank temperature by limiting these standby losses. The thermal blanket should not be installed over heating elements or electrical connections for safety reasons.

Table 25: DHW Tank Specifications

DHW Tank Specifications		
Description	Existing Equipment	Proposed Equipment
Equipment Type	2 DHW Heaters	DHW Tanks w/ Thermal Blanket
Count	2	2
Manufacturer	AO Smith	AO Smith
Model	HW-399 300 / BTRC120 110	HW-399 300 / BTRC120 110
Heater Capacity (BTU/hr)	359,100 / 120,000	359,100 / 120,000
Water Capacity (Gallons)	91 / 71	91 / 71
Energy Factor (%)	78.1 / 72.3	78.1 / 72.3
Estimated Thermal Resistance (R)	R-12 / R-12	R-21 / R-21
Estimated Water temperature (°C)	60°C	60°C
Storage Heat loss (Btu/hr)	178 / 124	102 / 71
Thermal Blanket Installed Cost (\$)	-	\$100

6.2.3 Assumptions and Interactions

Uncertainty is considered moderate but below 5% of the baseline energy use and less than 15% of the individual ECM. Insulation lifetime is estimated at 24 years, derived from ASHRAE Equipment Life Expectancy Chart.

6.2.4 Energy & GHG Performance

Table 26: Insulation on DWH Tank Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,800 kWh	7,001 GJ	8,995 GJ
Annual Energy Savings	0 kWh	1 GJ	1 GJ
Eligible Annual Energy Savings	0 kWh	1 GJ	1 GJ
Annual Eligible GHG Reductions	0.0 tCO ₂ e	0.0 tCO ₂ e	0.0 tCO ₂ e
Annual Cost Savings	\$ -	\$ 10	\$ 10
Lifetime Eligible Energy Savings	0 kWh	22 GJ	22 GJ
Description	Total		
Equipment Lifetime	24 Years		
ECM Total Cost	\$100		
Simple Payback	10 Years		
Baseline NPV	\$ -		
ECM NPV	\$ 3		
Lifetime Cost Savings	\$ 240		
Lifetime GHG Reductions	1.1 tCO ₂ e		
GHG Abatement rate	\$ 89/tCO ₂ e		

6.2.5 Recommendations

This ECM is recommended and is included in the proposed case. The initial capital investment of this ECM is \$100, and it will reduce energy consumption by roughly 1 GJ annually.

6.3 ECM-3 Lighting Upgrade

6.3.1 Measure Boundary & Baseline

Interior and exterior lighting consists of a combination of lighting types and control strategies, as described in **Section 2.6**. Lighting zones having different operational hours are composed of the residential suites, resident service areas, staff areas, hallways and foyer, kitchen, atrium and dining areas, tub rooms and common washrooms, basement, exit lights, and exterior lights. All light fixtures are controlled via manual switches except for the exterior wall pack light fixtures and exterior pole-mounted lights which are controlled by photocells.

6.3.2 ECM Description

All interior and exterior lights that are not LED will be replaced with LED fixtures and lamps. Lighting energy consumption is expected to decrease significantly. **Table 27** shows details of replacement lighting.

Table 27: Lighting Fixture Upgrade

Existing Fixture	Existing W per Fixture	Proposed Fixture	Proposed W per Fixture	Number of Fixtures	BES Rebate (\$)
1x4' T8-surface 1-lamp	32	4' LED Fixture	38	32	0
1x4' T12-surface 2-lamp 34W	72	4' LED Fixture	38	132	0
1x4' T8-recessed 2-lamp	59	1x4' LED Panel	32	46	1,012
Pole Mounted MH	400	Pole Mounted LED Flood	103	1	0
HPS 100W	130	Exterior Wall Fixture (30W)	30	2	50
MH 250W	295	Exterior Wall Fixture (70W)	70	3	120
MH 175W	200	Exterior Wall Fixture (50W)	50	5	200
CFL (21W)	25	A21 (100W eq) LED Bulb	19	2	6
Exit Sign (Incandescent)	40	LED Exit Sign	4.1	6	72
1x4' T8-surface 2-lamp	59	4' LED Fixture	38	75	0
1x4' T12-surface 1-lamp 34W	43	4' LED Fixture	38	14	0
A21 Incandescent 100W	100	A21 (100W eq) LED Bulb	19	19	57
MH Hi-Bay 400W	300	High Bay (400W) LED	223	18	0
CFL (13W)	15	A19 (60W eq) LED Bulb	9.8	3	5
1x2' T12-surface 1-lamp	26	2' LED Fixture	23	80	0
A19 Incandescent 60W	60	A19 (60W eq) LED Bulb	9.8	108	162
1x2' T8-surface 1-lamp	20	2' LED Fixture	23	28	0
Total Cost of ECM:		\$106,000	Total	574	\$1,684

6.3.3 Calculations, Assumptions, and Stipulated Data

Lighting wattages and facility schedules are known and were included in the model, resulting in a low simulation uncertainty.

6.3.4 Energy & GHG Performance

Table 28 contains a summary of the energy and financial performance of this ECM.

Table 28: Lighting Upgrade ECM Summary

Description	Electricity	Natural Gas	Peak Demand	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ		8,996 GJ
ECM Proposed Usage	465,100 kWh	7,193 GJ		8,867 GJ
Annual Energy Savings	88,700 kWh	-191 GJ	16 kW	128 GJ
Eligible Annual Energy Savings	79,800 kWh	-172 GJ	14 kW	115 GJ
Annual Eligible GHG Reductions	51.1 tCO ₂ e	-8.9 tCO ₂ e	-	42.2 tCO ₂ e
Annual Cost Savings	\$ 5,880	-\$ 1,290	\$ 3,150	\$ 7,740
Lifetime Eligible Energy Savings	2,394,000 kWh	-5,157 GJ	-	3,461 GJ
Description	Total			
Equipment Lifetime	30 Years			
ECM Total Cost	\$106,000			
Simple Payback	13.7 Years			
Baseline NPV	-\$ 170,890			
ECM NPV	\$ 25,390			
Lifetime Cost Savings	\$ 232,200			
Lifetime GHG Reductions	1,265.0 tCO ₂ e			
GHG Abatement Rate	\$ 84/tCO ₂ e			
ECM total Cost w/ Rebate	\$ 104,450			
ECM Simple Payback w/ Rebate	13.5 Years			
ECM NPV w/ Rebate	\$ 27,080			
ECM NPV at end of baseline life	\$ 31,970			

6.3.5 Recommendations

This ECM is recommended for implementation and is included in the proposed case. The initial capital investment of this ECM is approximately \$106,000 and it will reduce energy consumption by roughly 115 GJ annually.

6.4 ECM-4: High Efficiency Notched Fan Belts

6.4.1 Measure Boundary & Baseline

This ECM consists of replacing V-belts for the supply RTU and MUA fans with notched V-belts. Notched V-belts have higher efficiencies, and generally last longer than regular V-shaped belts. These belts do not require modification to the pulleys and can directly replace existing belts. Proposed V-belts were simulated to be installed by building maintenance staff.

An inventory of existing equipment can be found in **Table 29**. The total annual energy consumption before and after implementation along with the total estimated installed cost are found in **Table 30**.

6.4.2 ECM Description

This ECM proposes installation of notched V-belts on the RTU supply fans, MUA supply fans, and MUA-4 condenser fan. Notched V-belts provide high efficiency operation compared to smooth v-belts, and cost approximately \$8/ft.

Belts provide a power-transmission system between motor drive shafts and equipment pulleys. The most common belt in use is the V-belt. This belt has a trapezoidal shape and is designed to create a wedge between itself and the pulley, reducing slip. It is important to maintain proper tension of the belt. Failure to do so can result in system slack, and increased slippage which can lead to vibration, and increased belt wear. Belt tension should be checked every 3 to 6 months, depending on usage.

Notched belts have a similar design to V-belts (**Figure 20**), where a trapezoidal cross section rests on the pulley. However, small grooves run perpendicular to the belt. These notches help the belts run cooler, and last longer, and are generally 2% more efficient than V-belts. Notched belts can be directly switched out for V-belts, without changes to the pulley system.



Figure 20: Notched V-Belt (Left), Regular V-Belt (Right)

Table 29: Existing and Proposed Equipment Specifications

Description	Existing Equipment	Proposed Equipment
Type	Smooth V-Belt	Notched V-Belt
Count (# of pulleys)	7	7
Approximate Belt Length/Pulley (in.)	104	104
Fan Efficiency (%)	65%	67%
Life Expectancy* (Years)	3	3
Replacement Year	0	0
Total Installed Cost (\$)	\$300	\$490

* ASHRAE Equipment List Life Expectancy Chart

6.4.3 Assumptions and Interactions

Minimal interactions will be seen between the drive belts and the respective motors, as these belts will slightly increase the motor system efficiency. An assumed increase of 2% was used when replacing regular V-belts with notched V-belts. This increase in efficiency is well documented⁷, resulting in a low uncertainty.

6.4.4 Energy & GHG Performance

Table 30: Notched V-Belts ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	550,800 kWh	7,002 GJ	8,985 GJ
Annual Energy Savings	3,000 kWh	0 GJ	11 GJ
Eligible Annual Energy Savings	2,700 kWh	0 GJ	10 GJ
Annual Eligible GHG Reductions	1.7 tCO ₂ e	0.0 tCO ₂ e	1.7 tCO ₂ e
Annual Cost Savings	\$ 200	\$ -	\$ 200
Lifetime Eligible Energy Savings	8,100 kWh	0 GJ	29 GJ
Description	Total		
Equipment Lifetime	3 Years		
ECM Unit Cost	\$ 70		
Number of Units	7		
ECM Total Cost	\$ 490		
Simple Payback	2.5 Years		
Baseline NPV	-\$ 300		
ECM NPV	\$ 60		
Lifetime Cost Savings	\$ 600		
Lifetime GHG Reductions	5.2 tCO ₂ e		
GHG Abatement rate	\$ 95/tCO ₂ e		

6.4.5 Recommendations

This ECM is recommended for implementation and is included in the proposed case. The initial capital investment of this ECM is \$490, and it will reduce energy consumption by roughly 10 GJ annually.

6.5 ECM-5: Air Filter Upgrade

6.5.1 Measure Boundary & Baseline

Air filters are commonly found within HVAC equipment in order to reduce the number of airborne particles within the air supply system. The three rooftop units and four make-up air units supplying ventilation air to the building all contain filters. These filters are assumed to be polyester panel filters.

6.5.2 ECM Description

Any filter will necessarily cause some airflow restriction, which results in a drop in air pressure as the air passes across it. This pressure drop requires more energy from the blower to move the air. Different types of filters will have a different amount of airflow restriction and pressure drop, depending on the design. Pleated filters offer a low pressure drop, as well as being able to filter a large number of particles (available with MERV ratings of 5 to 14). MERV ratings classify a filter with respect to the smallest particle size it can filter, with higher ratings able to filter smaller particles.

It is recommended to replace the existing filters with low pressure drop filters such as Camfil 30/30 MERV 8 high-capacity pleated panel filters. These filters claim to last twice as long⁸ as other filters and results to approximately 64% lower air pressure drop across the filter compared to similar filters from other manufacturers⁹. The lower pressure drop results to lower fan power requirements of approximately 0.45%. These filters cost approximately \$14 each and are expected to last up to 12 months. It is estimated that the facility requires a total of 28 filters.



Figure 21: Camfil 30/30 pleated filter

6.5.3 Calculations, Assumptions, and Stipulated Data

Uncertainty for this ECM is moderate, as the pressure drop rating and corresponding fan power draw reduction of the proposed filter was estimated from manufacturer data. Replacing HVAC air filters will affect the fan power draw for the RTU and MUA blowers. Supply fan load factors were reduced by 0.45% to simulate the reduced pressure drop. For the baseline case, a \$8 per filter price was simulated with a lifespan of 6 months.

6.5.4 Energy & GHG Performance

Table 31: Air Filter Upgrade ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,300 kWh	7,002 GJ	8,994 GJ
Annual Energy Savings	500 kWh	0 GJ	2 GJ
Eligible Annual Energy Savings	500 kWh	0 GJ	2 GJ
Annual Eligible GHG Reductions	0.3 tCO ₂ e	0.0 tCO ₂ e	0.3 tCO ₂ e
Annual Cost Savings	\$ 40	\$ -	\$ 40
Lifetime Eligible Energy Savings	500 kWh	0 GJ	2 GJ
Description	Total		
Equipment Lifetime	1 Year		
ECM Unit Cost	\$ 14		
Number of Units	28		
ECM Total Cost	\$ 390		
Simple Payback	9.8 Years		
Baseline NPV	-\$ 220		
ECM NPV	-\$ 360		
Lifetime Cost Savings	\$ 40		
Lifetime GHG Reductions	0.3 tCO ₂ e		
GHG Abatement rate	\$ 1,219/tCO ₂ e		

6.5.5 Recommendations

This ECM is not recommended for implementation and is not included in the proposed case. The initial capital investment of this ECM is \$390, and it will reduce energy consumption by roughly 2 GJ annually.

6.6 ECM-6: DHW Piping Heat Traps

6.6.1 Measure Boundary & Baseline

Hot water from the domestic hot water (DHW) heater tank is delivered and circulated to a separate hot water storage tank before going to the load. The hot water circulation pumps operate at all times to maintain the hot water temperature in the separate storage tank. Incoming cold water is also straight piped into the DHW heater tank, and no heat traps are present.

6.6.2 ECM Description

Heat traps are a piping configuration which can be installed directly before the cold-water inlet, and directly after the hot water outlet of the separate storage tank (within 2.4 meters of the tank). A heat trap piping arrangement keeps the hot water from traveling throughout the piping system, which minimizes tank losses. Heat transfers from hot to cold until equilibrium is reached, and the thermal energy within the tank can travel down the cold and hot water lines, which causes the tank to burn more fuel to maintain water temperature.

Heat traps work on the principle of fluid densities relative to temperature, which can also be described as thermosiphoning. An upside-down u-shaped piping configuration is installed, as seen in Figure 15. Since hot water is less dense than cold water, the hot water gets trapped within the heat traps, and cannot continue down the supply or demand lines. These heat traps must also be insulated with 1" thick R-25 to R-28.5 rated insulation. Another heat trap design uses a small fitting which is attached to the hot-water outlet, and cold-water inlet. This fitting acts as a check valve, and when water passes through one way, the valve opens; when water stops flowing, the valve closes, and eliminates thermos-siphoning through a thermal break.

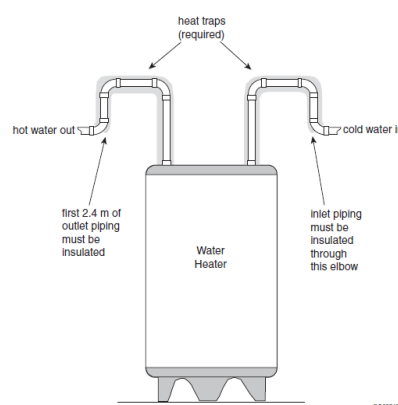


Figure 22: Heat Trap Configuration

It is recommended to install heat traps on the cold water inlet of the two DHW heaters and in the hot water outlet of the separate storage tank. Either heat trap design can be installed, as they provide the same function. For the simulation, the u-shape type heat traps were used because of increased durability. The total installed cost of these heat traps is roughly \$681 which corresponds to \$5/ft of 1" copper pipe, \$0.6/ft of foam pipe insulation, \$4/piece of 1" copper elbow, and \$200 labor cost/heat trap.

6.6.3 Calculations, Assumptions, and Stipulated Data

Heat traps will interact with DHW heating; uncertainty within this ECM is moderate, and actual energy savings of heat traps is not well documented¹⁰. A piping heat loss reduction of 40% was factored to the bare pipe baseline heat loss calculated from 3EPlus software. An estimated energy savings was simulated in the model based on this piping heat loss reduction, heat trap pipe length, and annual hours of operation.

6.6.4 Energy & GHG Performance

Table 32: Heat Trap ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,800 kWh	6,999 GJ	8,993 GJ
Annual Energy Savings	0 kWh	3 GJ	3 GJ
Eligible Annual Energy Savings	0 kWh	3 GJ	3 GJ
Annual Eligible GHG Reductions	0.0 tCO ₂ e	0.1 tCO ₂ e	0.1 tCO ₂ e
Annual Cost Savings	\$ -	\$ 20	\$ 20
Lifetime Eligible Energy Savings	0 kWh	189 GJ	189 GJ
Description	Total		
Equipment Lifetime	70 Years		
ECM Total Cost	\$680		
Simple Payback	34.0 Years		
Baseline NPV	\$ -		
ECM NPV	-\$ 200		
Lifetime Cost Savings	\$ 1,400		
Lifetime GHG Reductions	9.8 tCO ₂ e		
GHG Abatement Rate	\$ 69/tCO ₂ e		

6.6.5 Recommendations

This ECM is not recommended for implementation and is not included in the proposed case. The initial capital investment of this ECM is \$680, and it will reduce energy consumption by roughly 3 GJ annually.

6.7 ECM-7: Programmable Thermostats

6.7.1 Measure Boundary & Baseline

This ECM will look at replacing the existing thermostats in the service and common areas with programmable thermostats so that nightly temperature setbacks can be auto-programmed for unoccupied hours. These areas include the foyer, multi-purpose area, mall, hair salon, offices, kitchen, laundry areas, tub rooms, exercise area, and library. This ECM also includes setting up a setback temperature schedule for the existing programmable thermostats controlling the three RTUs that serve the atrium, dining area, staff room, and basement. Temperature schedules can be found in **Table 33**.

6.7.2 ECM Description

It is proposed to introduce a night setback temperature strategy during the unoccupied hours in the above-mentioned zones of the building to prevent unnecessary energy consumption. To do this, it is recommended that the existing 16 non-programmable thermostats in the above-mentioned areas be upgraded to programmable thermostats. These thermostats cost approximately \$350 installed. This would allow the heating schedules to be programmed to the occupancy pattern of each zone, including the zones served by existing programmable thermostats. This way, the HVAC system will operate less frequently during unoccupied hours. All temperature schedules were created based on occupancy schedules displayed in **Table 33**, with an additional 1 hour of heating/cooling prior to building operating hours to ensure comfortable space temperatures upon occupant arrival.



Figure 23: Programmable Thermostat

Table 33: Temperature Setpoint and Schedules

Zone	Existing Occupied			Existing Unoccupied		
	Heating	Cooling	Schedule	Heating	Cooling	Schedule
Atrium and Dining Area	21°C	23°C	119 hrs/wk	21°C	23°C	119 hrs/wk
Staff Room and Service Areas	21°C	23°C	52 hrs/wk	21°C	23°C	52 hrs/wk
Common Areas	21°C	23°C	140 hrs/wk	21°C	23°C	140 hrs/wk
Kitchen	21°C	23°C	84 hrs/wk	21°C	23°C	84 hrs/wk
Basement	21°C	23°C	56 hrs/wk	21°C	23°C	56 hrs/wk
Zone	Proposed Occupied			Proposed Unoccupied		
	Heating	Cooling	Schedule	Heating	Cooling	Schedule
Atrium and Dining Area	21°C	23°C	119 hrs/wk	18°C	26°C	119 hrs/wk
Staff Room and Service Areas	21°C	23°C	52 hrs/wk	18°C	26°C	52 hrs/wk
Common Areas	21°C	23°C	140 hrs/wk	21°C	23°C	140 hrs/wk
Kitchen	21°C	23°C	84 hrs/wk	18°C	26°C	84 hrs/wk
Basement	21°C	23°C	56 hrs/wk	16°C	26°C	56 hrs/wk

6.7.3 Assumptions and Interactions

Within the model, programmable thermostats interact with all HVAC equipment. Energy savings are based on heating/cooling setpoints described above, and all interactions are simulated using RETScreen Expert. With 16 thermostats to be replaced, a volume discount of \$600 was assumed.

Uncertainty is considered moderate and is estimated to have an impact of less than 5% of the baseline energy use and less than 15% of any individual ECM. The life expectancy of thermostats is assumed to be around 15 years.

6.7.4 Energy & GHG Performance

Table 34: Programmable Thermostat ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	551,100 kWh	6,838 GJ	8,822 GJ
Annual Energy Savings	2,700 kWh	164 GJ	174 GJ
Eligible Annual Energy Savings	2,400 kWh	148 GJ	156 GJ
Annual Eligible GHG Reductions	1.5 tCO ₂ e	7.6 tCO ₂ e	9.2 tCO ₂ e
Annual Cost Savings	\$ 180	\$ 1,100	\$ 1,280
Lifetime Eligible Energy Savings	36,000 kWh	2,214 GJ	2,344 GJ
Description	Total		
Equipment Lifetime	15 Years		
ECM Unit Cost	\$ 350		
Number of Units	16		
ECM Total Cost	\$ 5,000		
Simple Payback	3.9 Years		
Baseline NPV	\$ 5,020		
ECM NPV	\$ 8,710		
Lifetime Cost Savings	\$ 19,200		
Lifetime GHG Reductions	137.7 tCO ₂ e		
GHG Abatement rate	\$ 36/tCO ₂ e		

6.7.5 Recommendations

This ECM is recommended for implementation and is included in the proposed case. The initial capital investment of this ECM is \$5,000 and it will reduce energy consumption by roughly 156 GJ annually.

6.8 ECM-8: Door Seals & Sweeps

6.8.1 Measure Baseline

The facility has:

1. Approximately 42 m of door seals and
2. Approximately 9 m of bottom door sweeps for exterior man doors.

The existing door seals are inadequate or in poor condition and it is recommended to install/replace them all.

6.8.2 ECM Description

This energy conservation measure includes replacing all damaged and worn door seals and door sweeps in the facility. Poor door seals increase the infiltration and exfiltration rates, causing heat losses and longer equipment run times. Door seals and sweeps have a life expectancy of 5-10 years depending on use. They should be inspected and replaced periodically, as needed.

The effect of replacing door and window seals was investigated by varying the infiltration rate in the simulation file from medium to tight. The typical door leak range is between 2 and 12 L/s. Each new door seal and sweep was assumed to reduce air leakage by 3 to 5 L/s per door.

Implementation costs vary with material and labour. This analysis assumes total costs of 30 \$/m for perimeter seals and 50 \$/m for bottom sweeps. A total of 42 m of seals and 9 m of sweeps were simulated for a total installed cost of \$1,710.

6.8.3 Calculations, Assumptions, and Stipulated Data

Uncertainty for this ECM is low. Energy savings were calculated using architectural drawings, site photos, and energy model representation of the building. This ECM interacts with the building HVAC system. All interactions are simulated in RETScreen Expert software.

6.8.4 Energy and GHG Performance

Table 35 contains a summary of the energy and financial performance of this ECM.

Table 35: Door Seals & Sweeps ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,700 kWh	6,985 GJ	8,978 GJ
Annual Savings	100 kWh	17 GJ	17 GJ
Annual Eligible Savings	100 kWh	15 GJ	16 GJ
Annual Eligible GHG Reduction	0.1 tCO ₂ e	0.8 tCO ₂ e	0.9 tCO ₂ e
Annual Cost Savings	\$ 10	\$ 110	\$ 120
Lifetime Eligible Savings	1,000 kWh	153 GJ	157 GJ

Description	Total
Equipment Lifetime	10 Years
ECM Total Cost	\$ 1,710
Simple Payback	14.3 Years
Baseline NPV	\$ -
ECM NPV	-\$ 720
Lifetime Cost Savings	\$ 1,200
Lifetime GHG Reductions	8.6 tCO ₂ e
GHG Abatement rate	\$ 200/tCO ₂ e

6.8.5 Recommendations

This ECM is not recommended for implementation and is not included in the proposed case. The initial capital investment of this ECM is \$1,710 and it will reduce energy consumption by roughly 16 GJ annually.

6.9 ECM-9: Insulated Hot Water Pipes

6.9.1 Measure Boundary & Baseline

This ECM will consider the energy savings of insulating all hot water pipes. Installing insulation around the water piping will decrease the standby losses of the water tank and reduce its energy consumption.

An inventory of existing equipment can be found in **Table 25**. The total annual energy consumption before and after implementation along with the total estimated installed cost can be found in **Table 26**. There is a separate hot water storage tank supplied by the two DHW heaters through in-line circulation pumps.

6.9.2 ECM Description

This ECM proposes the installation of the following equipment:

- One-inch thick pipe insulation for all uninsulated hot water supply piping. Piping insulation can be installed for approximately \$15/ft.

Bare hot water pipes disperse heat to the ambient air through conduction and radiation. Heat loss in piping can be drastically reduced when properly fitted with pipe insulation. Mechanical room piping is found indoors and is not directly being wasted to the exterior environment, however, heat is being lost to the room rather than being transferred to the desired load and is therefore still considered as heat loss.

Table 36: Pipe Insulation Specifications

Description	Existing Equipment	Proposed Equipment
Pipe Type	Copper	Copper
Nominal Pipe Size (In.)	1.5	1.5
Insulation Type	None	1" Fiberglass
Linear Feet (ft)	7.75	8.83
Pipe Temperature (°C)	60°C	60°C
Ambient Temperature (°C)	21°C	21°C
Annual Operating Hours	8,760	8,760
Pipe Heat Loss (Btu/hr/ft.)	53.35	12.03
Total Cost (\$)	-	\$250

6.9.3 Assumptions and Interactions

Pipe length and diameter was estimated from mechanical room photos and room dimensions. Energy savings were calculated using the values displayed in the table above. 3E Plus software was used to determine heat losses through the pipes.

Uncertainty is considered moderate but below 5% of the baseline energy use and less than 15% of the individual ECM. Insulation lifetime is estimated at 24 years, derived from ASHRAE Equipment Life Expectancy Chart.

6.9.4 Energy & GHG Performance

Table 37: Pipe Insulation ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,800 kWh	7,002 GJ	8,996 GJ
Annual Savings	0 kWh	0 GJ	0 GJ
Annual Eligible Savings	0 kWh	0 GJ	0 GJ
Annual Eligible GHG Reduction	0.0 tCO ₂ e	0.0 tCO ₂ e	0.0 tCO ₂ e
Annual Cost Savings	\$ -	\$ -	\$ -
Lifetime Eligible Savings	0 kWh	0 GJ	0 GJ
Description	Total		
Equipment Lifetime	24 Years		
ECM Total Cost	\$250		
Simple Payback	-		
Baseline NPV	\$ -		
ECM NPV	-\$ 250		
Lifetime Cost Savings	\$ -		
Lifetime GHG Reductions	0.0 tCO ₂ e		
GHG Abatement rate	\$ 0/tCO ₂ e		

6.9.5 Recommendations

This ECM is not recommended for implementation and is not included in the proposed case. The initial capital investment of this ECM is \$250, and savings on annual energy consumption is negligible.

6.10 ECM-10: Roof Upgrade

6.10.1 Measure Boundary & Baseline

This ECM consists of installing additional insulation to the roof below the ventilated attic space for roof type R8. The existing insulation for roof R8 is above the attic space where it would serve minimal insulation due to the ventilation of the attic space. The proposed building roof area simulated for additional insulation is the north and central wing of the residential suites, spanning 7,182 ft². Heating/cooling in these zones will be affected. An inventory of the existing roof assemblies can be found in **Table 38**. The total annual energy consumption before and after implementation along with the total estimated installed cost can be found in **Table 39**.

6.10.2 ECM Description

This ECM proposes installation of the following:

- Spray-applied loose-fill fiberglass insulation that sits overtop of existing ceilings within attic spaces. Loose-fill fiberglass insulation has a thermal resistance of R-2.9/inch and an installed cost of \$0.50/board-foot.

Improving the quality of the ceiling insulation and air tightness on a building can result in reduced energy consumption for heating and cooling, reduced condensation and moisture, reduced drafts, enhanced building durability, and improved indoor air quality.

Table 38: Roof Assembly

Baseline Roof R8 Elements	Thickness (mm)	R-Value (F°*ft ² *hr/Btu)	Proposed Roof R8 Elements	Thickness (mm)	R-Value (F°*ft ² *hr/Btu)
Exterior Film Coefficient	-	0.102	Exterior Film Coefficients	-	0.102
			Spray-Applied Loose-fill Fiberglass	238.8	27.119
Vapor Barrier	0.1524	0.037	Vapor Barrier	0.1524	0.037
Gypsum Board	12.7	0.451	Gypsum Board	12.7	0.451
Interior Film Coefficient	-	0.608	Interior Film Coefficient	-	0.608
Effective R-Value		1.2	Effective R-Value		28.3

6.10.3 Assumptions and Interactions

Uncertainty within this ECM is considered medium as engineering drawings were available, but it was difficult to verify the actual roof construction on site. Insulation has an expected life of over 100 years if it is kept dry and has no physical damages to it. The simulation estimated a 30-year lifetime to be conservative, however, energy savings and insulation effectiveness will be present thereafter.

6.10.4 Energy & GHG Performance

Table 39: Roof Insulation Upgrade ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,800 kWh	6,918 GJ	8,912 GJ
Annual Energy Savings	0 kWh	84 GJ	84 GJ
Eligible Annual Energy Savings	0 kWh	76 GJ	76 GJ
Annual Eligible GHG Reductions	0.0 tCO ₂ e	3.9 tCO ₂ e	3.9 tCO ₂ e
Annual Cost Savings	\$ -	\$ 570	\$ 570
Lifetime Eligible Energy Savings	0 kWh	2,268 GJ	2,268 GJ
Description	Total		
Equipment Lifetime	30 Years		
ECM Total Cost	\$33,750		
Simple Payback	59.2 Years		
Baseline NPV	\$ -		
ECM NPV	-\$ 23,920		
Lifetime Cost Savings	\$ 17,100		
Lifetime GHG Reductions	117.5 tCO ₂ e		
GHG Abatement rate	\$ 287/tCO ₂ e		

6.10.5 Recommendations

This ECM is not recommended for implementation and is not included in the proposed case. The initial capital investment of this ECM is \$33,750, and it will reduce energy consumption by roughly 76 GJ annually.

6.11 ECM-11: Condensing Boiler with Low-Temperature Radiators

6.11.1 Measure Boundary & Baseline

This ECM consists of replacing the existing mid-efficiency boilers with new high-efficiency condensing boilers as well as replacing the current hydronic perimeter radiators with low-temperature radiators. This includes removal of the boilers and radiators as well as installation of the new equipment.

An inventory of existing equipment can be found in **Table 40**. The total annual energy consumption before and after implementation along with the total estimated installed cost are found in **Table 41**.

6.11.2 ECM Description

This ECM proposes installation of the following equipment:

- Condensing boilers: Two Peerless Purefire PF-1500 condensing boilers with fully modulating burners with a peak AFUE of 96.5% and an installed cost of \$92,200.
- Low-temperature distribution: Low temp radiators utilize low-temperature supply water to provide similar heating profiles as high-temperature radiators. These low-temp radiators can be installed for approximately \$120/ft.
- Controls: new Tekmar boiler controls have outdoor temperature reset, warm weather shutdown, and circulation pump controls. Boiler controls have an estimated installed cost of \$2,000.

Non-condensing boilers have seasonal efficiencies in the range of 70% to 78%. Poorly-maintained boilers may have much lower seasonal efficiencies, usually in the range 55% to 69%. With new technologies, condensing boilers can be rated as high as 98% efficient. However, such a high efficiency is difficult to achieve in a retrofit scenario.

Condensing boilers achieve high efficiencies by returning water at lower temperatures than conventional boilers. This low return water temperature results in the condensation of acidic, corrosive flue gases. The dew point (i.e., the temperature at which condensation commences) of vapour in the flue gases is achieved at a boiler return water temperature of about 54°C (130°F). Return water temperatures for conventional boilers is kept at 66-71°C (150-160°F), thus avoiding the onset of condensation of the acidic flue gases.

Condensing boilers utilize the latent energy in the flue gases by returning water at below 54°C (130°F). As depicted in **Figure 24**¹¹, a return water temperature of 54°C gives an efficiency of about

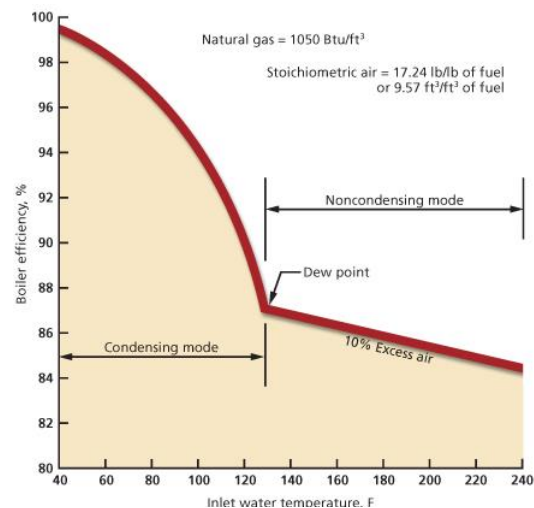


Figure 24: 2008 ASHRAE Handbook Condensing Boiler Efficiency Curves

86%. If return water temperatures less than 38°C (100°F) are reached, efficiencies of 94% or greater are achieved.

The high-temperature radiators in the facility need high-temperature supply water to properly function. Since supply water in condensing boiler applications is lower than conventional systems, low temperature radiators need to be installed.

Table 40: Boiler and Baseboard Radiator Specifications

Description	Existing Equipment	Baseline Equipment	Proposed Equipment
Boiler Type	Non-Condensing Boiler		Condensing Boiler
Boiler Count (#)	2	2	2
Boiler Model	Super Hot AAE-1440	Super Hot AAE-1440	Peerless Purefire PF-1500
Boiler Capacity (Btu/hr)	1,440,000	1,440,000	1,500,000
Boiler AFUE (%)	69.5%	85%	94.5%
Life Expectancy*	25	25	25
Baseboard Radiator Type	High Temperature Radiators		Low Temperature Radiators
Baseboard Count (ft.)	624	624	624
Baseboard Model #	unknown	unknown	HE24075W 4' BSBD 3/4
Replacement Year	-	2	0
Boiler Installed Cost (\$/kBtu)	-	\$29,500	\$92,192
Baseboard Installed Cost (\$/ft)	-	-	\$74,724
Total Installed Cost (\$)	-	\$29,500	\$168,916

6.11.3 Assumptions and Interactions

Existing boiler run times were estimated to be 940 hours/year while proposed boiler runtimes were estimated to be 749 hours/year. Uncertainty is estimated to have an impact of less than 5% of the baseline energy use and less than 15% of any individual ECM.

Equipment lifetime was gathered from ASHRAE Equipment Life Expectancy Chart, which prescribed 25 years for a properly maintained boiler. Costing was gathered from equipment supplier quotes and on-line catalog prices.

* ASHRAE Equipment List Life Expectancy Chart

6.11.4 Energy & GHG Performance

Table 41: Condensing Boiler & Low-Temperature Radiator ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,800 kWh	6,587 GJ	8,581 GJ
Annual Energy Savings	0 kWh	415 GJ	415 GJ
Eligible Annual Energy Savings	0 kWh	374 GJ	374 GJ
Annual Eligible GHG Reductions	0.0 tCO ₂ e	19.3 tCO ₂ e	19.3 tCO ₂ e
Annual Cost Savings	\$ -	\$ 2,800	\$ 2,800
Lifetime Eligible Energy Savings	0 kWh	9,338 GJ	9,338 GJ
Description	Total		
Equipment Lifetime	25 Years		
ECM Total Cost	\$168,920		
Simple Payback	60.3 Years		
Baseline NPV	\$ 2,790		
ECM NPV	-\$ 125,060		
Lifetime Cost Savings	\$ 70,000		
Lifetime GHG Reductions	483.7 tCO ₂ e		
GHG Abatement rate	\$ 349/tCO ₂ e		
ECM total Cost w/ Rebate	\$ 156,920		
ECM Simple Payback w/ Rebate	56.0 Years		
ECM NPV w/ Rebate	-\$ 113,060		
ECM NPV at end of baseline life	-\$ 105,470		

6.11.5 Recommendations

This ECM is not recommended for implementation and is not included in the proposed case. The initial capital investment of this ECM is \$168,920, and it will reduce energy consumption by roughly 374 GJ annually.

6.12 ECM-12: Condensing DHW-1 Heater

6.12.1 Measure Boundary and Baseline

This ECM will consider replacing the existing storage type DHW-1 heater with high efficiency condensing DHW storage water heater. The proposed heater will heat and store water more efficiently, resulting in reduced energy consumption.

An inventory of existing, baseline equipment replacement, and proposed equipment can be found in **Table 42**. The total annual energy consumption before and after implementation along with the total estimated installed cost can be found in **Table 43**.

6.12.2 ECM Description

This ECM proposes installation of the following equipment:

- DHW-1 Condensing storage type water heater: A.O Smith Cyclone Mxi BTH-400 condensing water heaters with modulating burner and a thermal efficiency of 95%. These storage tanks have an installed cost of approximately \$14,487.

The current water heater can be directly switched out for a condensing power vented water heater. Condensing water heater capture heat which would otherwise be used to carry exhaust gasses up the flue stack. When this heat is recaptured from the flue gas, water will condense out of it, and must be pumped/drained to the nearest drain due to the acidic characteristics of the condensate. Subsequently, the flue gas must be power vented by a fan, as it is no longer hot enough to rise on its own.



Figure 25: Proposed Water Heater (Section View)

Table 42: Water Heater Specifications

Description	Existing Equipment	Baseline Equipment	Proposed Equipment
Type	Non-Condensing Water Heater		Condensing Water Heater
Count (ea.)	1	1	1
Model	A.O Smith HW-399	A.O Smith HW-399	A.O Smith Mxi BTH-400
Capacity (Btu/hr)	359,100	399,000	195,000 - 399,900
EF (%)	78.1%	80%	93%
Storage Capacity (gal.)	91 (estimated)	91 (estimated)	119
Life Expectancy* (years)	14.8	18	18
Heating Mode	Single Stage	Single Stage	Fully Modulating
Replacement Year	2033	2036	2036
Blower Motor Capacity (W)	-	-	6
Total Installed Cost (\$)	-	\$10,054	\$14,490

* ASHRAE Equipment List Life Expectancy Chart

6.12.3 Assumptions and Interactions

Uncertainty within this ECM is considered moderate, as efficiency for the existing water heater and wattage of the proposed water heaters power vent fan was estimated. This uncertainty is estimated to have an impact of less than 5% of the baseline energy use and less than 15% of any individual ECM.

The life expectancy of water heaters has been assumed to be 18 years on average with proper maintenance according the ASHRAE Equipment Life Expectancy Chart.

6.12.4 Energy & GHG Performance

Table 43: Condensing Water Heater ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,800 kWh	6,836 GJ	8,830 GJ
Annual Energy Savings	0 kWh	166 GJ	166 GJ
Eligible Annual Energy Savings	0 kWh	149 GJ	149 GJ
Annual Eligible GHG Reductions	0.0 tCO ₂ e	7.7 tCO ₂ e	7.7 tCO ₂ e
Annual Cost Savings	\$ -	\$ 1,120	\$ 1,120
Lifetime Eligible Energy Savings	0 kWh	2,689 GJ	2,689 GJ
Description	Total		
Equipment Lifetime	18 Years		
ECM Total Cost	\$14,490		
Simple Payback	12.9 Years		
Baseline NPV	-\$ 780		
ECM NPV	-\$ 290		
Lifetime Cost Savings	\$ 20,160		
Lifetime GHG Reductions	139.3 tCO ₂ e		
GHG Abatement Rate	\$ 104/tCO ₂ e		

6.12.5 Recommendations

This ECM is recommended for implementation and is included in the proposed case. The initial capital investment of this ECM is \$14,490, and it will reduce energy consumption by roughly 149 GJ annually.

6.13 ECM-13: Condensing DHW-2 Heater

6.13.1 Measure Boundary and Baseline

This ECM will consider replacing the existing storage type DHW-2 heater with high efficiency condensing DHW storage water heater. The proposed heater will heat and store water more efficiently, resulting in reduced energy consumption.

An inventory of existing, baseline equipment replacement, and proposed equipment can be found in **Table 44**. The total annual energy consumption before and after implementation along with the total estimated installed cost can be found in **Table 45**.

6.13.2 ECM Description

This ECM proposes installation of the following equipment:

- DHW-2 Condensing storage type water heater: A.O Smith Cyclone Mxi BTH-120 condensing water heaters with modulating burner and a thermal efficiency of 95%. These storage tanks have an installed cost of approximately \$8,791.

The current water heater can be directly switched out for a condensing power vented water heater. Condensing water heater capture heat which would otherwise be used to carry exhaust gasses up the flue stack. When this heat is recaptured from the flue gas, water will condense out of it, and must be pumped/drained to the nearest drain due to the acidic characteristics of the condensate. Subsequently, the flue gas must be power vented by a fan, as it is no longer hot enough to rise on its own.



Figure 26: Proposed Water Heater (Section View)

Table 44: Water Heater Specifications

Description	Existing Equipment	Baseline Equipment	Proposed Equipment
Type	Non-Condensing Water Heater		Condensing Water Heater
Count (ea.)	1	1	1
Model	A.O Smith BTRC-120	A.O Smith BTRC-120	A.O Smith Mxi BTH-120
Capacity (Btu/hr)	120,000	120,000	78,000 – 120,000
EF (%)	72.3%	80%	93%
Storage Capacity (gal.)	71	71	60
Life Expectancy* (years)	4.6	18	18
Heating Mode	Single Stage	Single Stage	Fully Modulating
Replacement Year	2023	2036	2036
Blower Motor Capacity (W)	-	-	6
Total Installed Cost (\$)	-	\$5,960	\$8,791

* ASHRAE Equipment List Life Expectancy Chart

6.13.3 Assumptions and Interactions

Uncertainty within this ECM is considered moderate, as efficiency for the existing water heater and wattage of the proposed water heaters power vent fan was estimated. This uncertainty is estimated to have an impact of less than 5% of the baseline energy use and less than 15% of any individual ECM.

The life expectancy of furnaces has been assumed to be 18 years on average with proper maintenance according the ASHRAE Equipment Life Expectancy Chart.

6.13.4 Energy & GHG Performance

Table 45: Condensing Water Heater ECM Summary

Description	Electricity	Natural Gas	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,996 GJ
ECM Proposed Usage	553,800 kWh	6,885 GJ	8,879 GJ
Annual Energy Savings	0 kWh	117 GJ	117 GJ
Eligible Annual Energy Savings	0 kWh	105 GJ	105 GJ
Annual Eligible GHG Reductions	0.0 tCO ₂ e	5.5 tCO ₂ e	5.5 tCO ₂ e
Annual Cost Savings	\$ -	\$ 790	\$ 790
Lifetime Eligible Energy Savings	0 kWh	1,895 GJ	1,895 GJ
Description	Total		
Equipment Lifetime	18 Years		
ECM Total Cost	\$8,790		
Simple Payback	11.1 Years		
Baseline NPV	-\$ 620		
ECM NPV	\$ 1,220		
Lifetime Cost Savings	\$ 14,220		
Lifetime GHG Reductions	98.2 tCO ₂ e		
GHG Abatement Rate	\$ 90/tCO ₂ e		

6.13.5 Recommendations

This ECM is recommended for implementation and is included in the proposed case. The initial capital investment of this ECM is \$8,790, and it will reduce energy consumption by roughly 105 GJ annually.

7 RENEWABLE ENERGY MEASURES

This section covers measures on the generation of renewable energy. The ECMs have the potential to generate energy onsite. Some renewable energy measures are recommended contingent upon other non-renewable measures being implemented first. This will be stated in each renewable ECM, wherever applicable.

7.1 REM-1 Photovoltaic Panel Installation

7.1.1 Measure Boundary & Baseline

The Taber and District Housing Foundation – Clearview Lodge does not have any renewable energy sources. The building's electricity is provided entirely by the electricity grid. A grid-connected solar photovoltaic (PV) system could be an ideal renewable energy source due to the available roof area exposed to the sun. Portions of the building's roofs are well suited for solar PV installation.

7.1.2 ECM Description

It is proposed that a solar PV array is installed on the building. A solar PV system would consist of solar modules on the roof and inverters tied into the main breaker panel. When the sun is shining on the array, the solar modules produce energy and the building will draw electricity from the PV system. If the PV system is producing more energy than the building demands, the excess energy is exported back onto the electrical grid, and the building will receive a credit on its bill. When the system is not producing sufficient energy to meet the electricity demand, the building draws electricity from the grid as it does today and would be billed on the amount of electricity drawn from the grid.



Figure 27: Proposed Solar Layout

The size and cost of the recommended PV system considers available shade-free rooftop space, roof slope and orientation, and the building's estimated annual electricity consumption after all other proposed ECM's have been implemented. Additional model de-rates were input into the analysis to address shading, snow accumulation, soiling, degradation and inverter efficiencies which will reduce the overall energy generation capability of the PV system.

Reducing the building's energy consumption should always be considered before installing energy generation equipment. It is generally more cost effective to reduce electricity consumption prior to sizing the PV system, as doing so will reduce the required system size and cost. The size for the proposed PV system for the Taber and District Housing Foundation – Clearview Lodge is limited by the available shade-free areas of the roof.

The roof sections considered for PV installation are shown on the aerial view in **Figure 27**. The recommended PV system is 98.9 kW, producing approximately 126,900 kWh annually, and covering roughly 28% of the building's expected annual electrical use after all proposed electrical upgrades have been implemented. Proposed Solar PV modules specifications can be seen in **Table 46**.

Table 46: Proposed equipment description

Description	Proposed Equipment
Type	Trina Solar
Count (ea.)	271
Model # (Manufacturer)	TALLMAX M PLUS-DE14A (II)
Rated power (W/panel)	365
Rated DC power capacity (kW)	98.9 kW
Azimuth (°)	203, 180, 202
Tilt from horizontal (°)	18.4 & 22.5
Life Expectancy* (years)	25
Cost/Watt (\$)	\$2.45/Watt

7.1.3 Calculations, Assumptions, and Stipulated Data

The roof slopes of 18.4° and 22.5° were based on site photos and Google maps satellite imagery. Solar PV design software was used to calculate losses due to shading, wire loss, inverter losses, snow, dust, etc. The size of the suggested solar PV array in this ECM assumes that all recommended ECM's proposed in this report will be implemented prior to the installation of the PV array.

Financial analysis was carried out assuming that 100% of the solar energy produced by the PV array will be used on-site as the facility operates 24/7.

7.1.4 Energy & GHG Performance Analysis

Table 47 below summarizes the energy savings, GHG emission reductions, and the economics of this ECM. See **Appendix D** for Helioscope results.

Table 47: Photovoltaic System Installation ECM Summary

Description	Electricity	Natural Gas	Total
Usage after implementation of proposed ECMs	459,600 kWh	6,545 GJ	8,200 GJ
ECM Energy Use- Proposed	332,698 kWh	6,545 GJ	7,743 GJ
Annual Energy Savings	126,900 kWh	0 GJ	457 GJ
Annual Eligible Energy Savings	114,200 kWh	0 GJ	411 GJ
Annual Eligible GHG Reductions	73.1 tCO ₂ e	0.0 tCO ₂ e	73.1 tCO ₂ e
Annual Cost Savings	\$ 8,410	\$ -	\$ 8,410
Lifetime Eligible Energy Savings	2,855,000 kWh	0 GJ	10,278 GJ

* ASHRAE Equipment List Life Expectancy Chart

Description	Total
Equipment Lifetime	25 Years
ECM Unit Cost	2.45
Number of Units	98,900
ECM Total Cost	\$ 242,310
Simple Payback	28.8 Years
Baseline NPV	\$ -
ECM NPV	-\$ 110,360
Lifetime Cost Savings	\$ 210,250
Lifetime GHG Reductions	1,827.2 tCO ₂ e
GHG Abatement Rate	\$ 133/tCO ₂ e
ECM total Cost w/ Rebate	\$ 181,730
ECM Simple Payback w/ Rebate	21.6 Years
ECM NPV w/ Rebate	-\$ 49,790

7.1.5 Recommendations

It is anticipated that rebate funding for solar PV installation may be available from the Alberta Residential and Commercial Solar Program (RCSP). For commercial buildings, the rebate available is up to 25% of the total cost or \$500,000, whichever is less.

This ECM would achieve a poor NPV with or without funding and is not recommended. The unshaded south-facing roof areas only cover 28% of the facility's expected electrical energy usage even after all electrical ECMs are implemented. This ECM is not included in the proposed case.

Implementation of this ECM will result in an annual electricity savings of 114,200 kWh and annual greenhouse gas emissions reductions of 73.1 tCO₂e.

3D Energy has not carried out a structural review of the roof to assess its capacity to bear the solar PV load. A structural engineer would perform the assessment. Some solar contractors can provide this service at a reasonable cost during the initial feasibility review.

7.2 REM-2 Solar Hot Water

7.2.1 Measure Boundary & Baseline

The existing hot water systems consist of two storage-type water heaters and a separate storage tank with a total heating capacity 479,100 Btu/h, storing approximately 380 Gal of water. The two water heaters operate at a heating efficiency of 78% and 72%. Solar thermal collectors could be an ideal renewable resource due to the large water heating load within the building, as well as the solar exposed roof section.

7.2.2 ECM Description

The Taber and District Housing Foundation – Clearview Lodge does not have any renewable energy sources currently. Solar thermal has many applications for heating. It is most commonly used for hot water heating, but space heating can also be implemented with the installation of low temperature radiators. Solar thermal systems usually circulate antifreeze from the solar collectors, and exchange heat to the water storage tank; the water can then be distributed to different applications. Solar thermal applications provide the most benefit when pre-heating water, or for low temperature applications, include pools or carwashes. Two types of collectors are available on the market: flat plate, and evacuated tube collectors. Flat plate collectors are more efficient when in locations where temperature differences between the surrounding area, and collector itself are lower (warmer climates). Evacuated tube collectors are more efficient in lower temperature settings, such as Alberta winters, due to the vacuum tubes, which minimize heat loss.

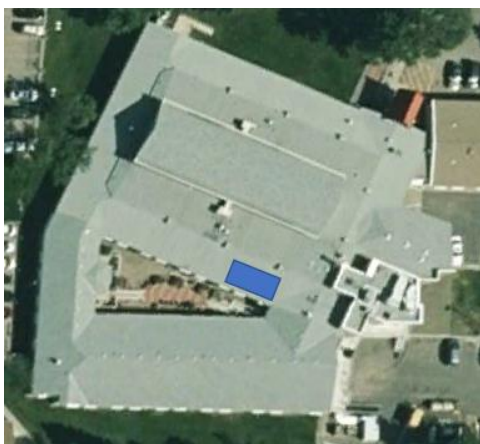


Figure 28: Aerial view of the Proposed Solar Hot Water Collectors

The housing facility has large, southern roof sections that would be suitable for installation of a solar thermal evacuated tube array. The array consists of parallel rows of transparent glass tubes. Each tube contains a glass outer tube and a metal absorber tube attached to a fin. The fin coating absorbs solar energy, but the vacuum inhibits convective heat loss. A glycol based indirect system should be installed. Glycol would be circulated through the piping network to the solar collectors when a temperature differential 4°C above current storage tank temperature is present. To enable solar hot water heating to the secondary storage tank, heat exchangers should be installed between the glycol loop and the water stored in the tank. The water heaters are capable of heating water to 60°C when solar thermal does not provide adequate performance.

The reduction of energy consumption is always the first logical step prior to installing a generation system. It is generally most cost effective to reduce consumption before installing solar water heaters. The proposed solar water collector system is sized and modelled on the assumption that all other proposed efficiency upgrades have been implemented. In this case, the savings related to this system are based on the thermal blankets for the storage tanks and the low flow water fixtures being implemented. Capital expense for solar is minimized by this approach.

The section of roof considered is the south-facing roof area above the central wing that would be nearest to the water storage tanks in the basement, shown on the aerial view in **Figure 28**. This represents an area of approximately 14 m² and can support a total installed peak generating capacity of 6.7 kW. An installed cost was estimated at \$1,425/m², which includes the heat exchanger. Proposed solar thermal specifications can be seen in **Table 48**.

Table 48: Solar Hot Water System Specifications

Description	Proposed Equipment
Type	Evacuated Tube Collector
Count (Collector Modules)	3 modules (72 tubes)
Model # (Manufacturer)	Vitosol 200T-SP2A ¹² (Viessmann)
Fr (tau alpha) Coefficient	0.5
Fr UL Coefficient	1.42
Temperature Coefficient for Fr UL	0.005
Azimuth (°)	21°
Tilt from horizontal (°)	14°
Life Expectancy* (years)	10
Solar Collector Area, m ²	13.9
Installed Cost (\$)	\$1,425/m ²

7.2.3 Calculations, Assumptions, and Stipulated Data

Interactions will be seen between solar thermal collectors, and water heating. Roof area was measured during site visit and verified using Google Earth, minimizing the risk of uncertainty. The estimated water consumption after water conserving measure implementation is estimated to be 6,744 m³ and the proposed solar hot water system thermal is estimated to produce 28.8 GJ of water heating.

* Veissman Vitosol 200-T Warranty

7.2.4 Energy & GHG Performance

Table 49: Solar Hot Water ECM Summary

Description	Electricity	Natural Gas	Total
Usage after implementation of proposed ECMs	459,600 kWh	6,545 GJ	8,200 GJ
ECM Energy Use- Proposed	459,795 kWh	6,514 GJ	8,169 GJ
Annual Energy Savings	-200 kWh	31 GJ	30 GJ
Eligible Annual Energy Savings	-200 kWh	28 GJ	27 GJ
Annual Eligible GHG Reductions	-0.1 tCO ₂ e	1.4 tCO ₂ e	1.3 tCO ₂ e
Annual Cost Savings	-\$ 10	\$ 210	\$ 200
Lifetime Eligible Energy Savings	-2,000 kWh	279 GJ	272 GJ
Description	Total		
Equipment Lifetime	10 Years		
ECM Total Cost	\$ 19,810		
Simple Payback	99.1 Years		
Baseline NPV	\$ -		
ECM NPV	-\$ 18,220		
Lifetime Cost Savings	\$ 2,000		
Lifetime GHG Reductions	13.2 tCO ₂ e		
GHG Abatement Rate	\$ 1,504/tCO ₂ e		

7.2.5 Recommendations

This ECM is not recommended for implementation and is not included in the proposed case. The initial capital investment of this ECM is \$19,810, and it will reduce energy consumption by roughly 27 GJ annually.

8 RECOMMENDED MEASUREMENT AND VERIFICATION

Measurement and verification (M&V) is the process of monitoring and recording energy use within a facility to quantify the savings delivered by energy efficiency upgrades. In its most basic form, M&V can be accomplished by tracking monthly energy billing information. ENERGY STAR Portfolio Manager is a free online program that can be used to track energy and water consumption, monitor building greenhouse gas emissions, and benchmark the performance of a facility.

The historical energy bills and calculated energy use intensity (EUI) form a baseline to which future energy performance can be compared. It is highly recommended Portfolio Manager is used to track monthly energy billing information. Contact us for assistance with setting up or navigating the Portfolio Manager program.

More detailed M&V is recommended and can be accomplished by installing monitoring equipment for the main electrical breaker panel, and gas utility meter to record and display real-time energy use data for the facility. This is commonly referred to as submetering and can be applied to monitor the energy use of a whole facility, part of a facility, or individual equipment.

Submeters measure and log building energy consumption data and make it visible remotely through an online monitoring platform. This makes tracking energy use simple and helps to identify sources of energy waste as well as opportunities for energy savings.

Additionally, dashboards can be set up in lobby areas to display facility energy use and targets and to encourage occupants to participate in meeting annual energy goals. The figure shows an example of an energy use dashboard displaying hours of high electricity use.

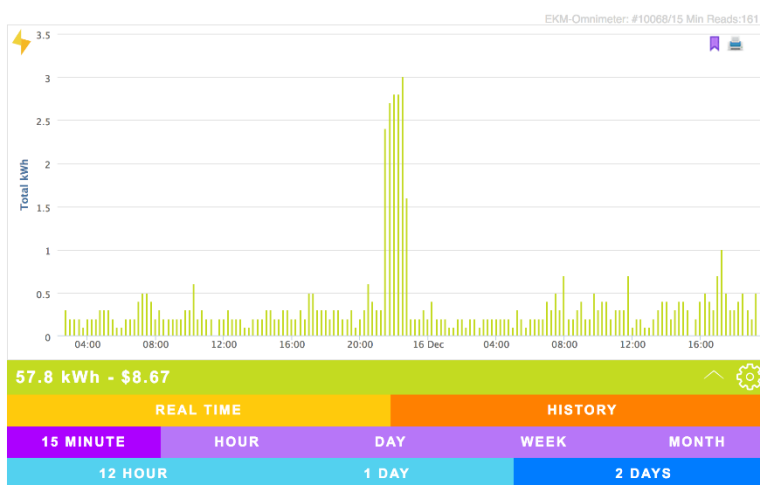


Figure 29: Dashboard displaying electrical energy use

It is recommended that electrical submeters with a web-based monitoring system be installed on the main electrical breaker panel feed conductors and the main natural gas supply line so that the facility's electricity and natural gas use can be monitored on-site or remotely. This monitoring system would benefit the facility by:

1. Providing a simple method of ensuring all non-essential systems are off when the building is unoccupied to avoid unnecessary energy use and cost.
2. Logging historical energy use data to verify and quantify the effects of implemented ECMs.
3. Allowing malfunctioning building equipment to be identified before failure occurs.
4. Monitoring energy production from any future renewable energy systems installed on the facility.

9 PROPOSED CASE

9.1 Proposed Model

This section outlines the effect of the proposed ECMs on the energy use breakdown, energy costs, and greenhouse gas emissions. The proposed or project model considers all interactions between ECMs, and usually shows less savings than the summation of individual ECMs. The summary of the baseline model can be found in **Appendix E: Proposed Case Model**.

9.2 Recommended ECMs

An ECM should be recommended for implementation if it provides energy savings as well as a financial benefit. Net Present Value calculations have been performed for the proposed measures in each ECM, as well as a baseline case relating to the eventual replacement of the equipment involved in that ECM, if applicable. If the ECM has a greater NPV than its baseline case, it is recommended for immediate implementation. In some cases, if the ECM is implemented immediately, it will not have a greater NPV than the baseline case; but if implemented in the year that the baseline equipment will need replacing, it will have a greater NPV. In this case the ECM is recommended for implementation upon the existing equipment reaching the end of its rated life. Finally, there may be ECMs that are recommended despite not having a greater NPV. This may be the case where there is a deficiency in the current building that requires correcting. This may also be the case if there is a measure that the client has specifically requested or is desirable for other reasons such as improved occupant comfort or esthetics.

Considering the repair of deficiencies and economic feasibility as the primary selection criteria, the recommended order of implementation is:

1. ECM-2: DHW Tank Blanket
2. ECM-4: High Efficiency Notched Fan Belts
3. ECM-1: Low Flow Water Fixtures
4. ECM-3: LED Lighting Upgrade
5. ECM-7: Programmable Thermostats
6. ECM-13: Condensing DHW-2
7. ECM-12: Condensing DHW-1
8. ECM-5: High Efficiency Air Filters (Not Recommended)
9. ECM-6: DHW Pipe Heat Trap (Not Recommended)
10. ECM-8: Door Seals and Sweeps (Not Recommended)
11. ECM-9: DHW Pipe Insulation (Not Recommended)
12. ECM-10: Roof Upgrade (Not Recommended)
13. ECM-11: Condensing Boiler (Not Recommended)
14. REM-1: Roof Solar Photovoltaic (Not Recommended)
15. REM-2: Solar Hot Water (Not Recommended)

ECM-1,2,4 have low upfront costs and are relatively easy to install and should be prioritized. ECM-3,7,12,13 are then prioritized according to economic benefits considering ECM and baseline NPV. Time, funding, or other justification may be needed to make implementing ECM-5,6,8,9,10,11 and REM-1,2 more attractive.

9.2.1 Energy Analysis

Table 50 contains a summary of the energy and financial performance of the proposed case.

Table 50: Proposed Model ECM Analysis

Description	Electricity	Natural Gas	Water	Peak Demand	Total
Adjusted Baseline Usage	553,800 kWh	7,002 GJ	8,131 m ³		8,996 GJ
Proposed Energy Use	459,600 kWh	6,545 GJ	6,744 m ³		8,200 GJ
Annual Energy Savings	94,200 kWh	457 GJ	1,386 m ³	16 kW	796 GJ
Eligible Annual Energy Savings	84,800 kWh	411 GJ	1,248 m ³	14 kW	717 GJ
Annual Eligible GHG Reductions	54.3 tCO ₂ e	21.3 tCO ₂ e	-	-	75.6 tCO ₂ e
Annual Cost Savings	\$ 6,240	\$ 3,080	\$ 2,220	\$ 3,150	\$ 14,690
Lifetime Eligible Energy Savings	2,304,200 kWh	11,176 GJ	33,907 m ³	-	19,471 GJ
Description	Total				
Equipment Lifetime	27 Years				
Proposed Total Cost	\$ 136,110				
Simple Payback	9.3 Years				
Baseline NPV	-\$ 159,560				
Proposed NPV	\$ 101,910				
Lifetime Cost Savings	\$ 399,170				
Lifetime GHG Reductions	2,053.6 tCO ₂ e				
GHG Abatement Rate	\$ 66/tCO ₂ e				
Total Cost w/ Rebate	\$ 134,430				
Simple Payback w/ Rebate	9.2 Years				
Proposed NPV w/ Rebate	\$ 103,590				

9.2.2 Final Comments

This proposed case contains seven energy measures and results in an improved net present value of \$101,910 when compared to the baseline case net present value of -\$159,560. The measures are estimated to cost \$136,110, payback within 27 years, while reducing annual electricity and natural gas consumption by 84,800 kWh and 411 GJ and saving \$14,690 per year.

9.3 Energy Consumption Benchmarking

With the proposed ECMs, the facility EUI would be reduced to 2.04 GJ/m² from 2.23 GJ/m², which translates into an approximate decrease of 8% in facility energy consumption (**Figure 30**).

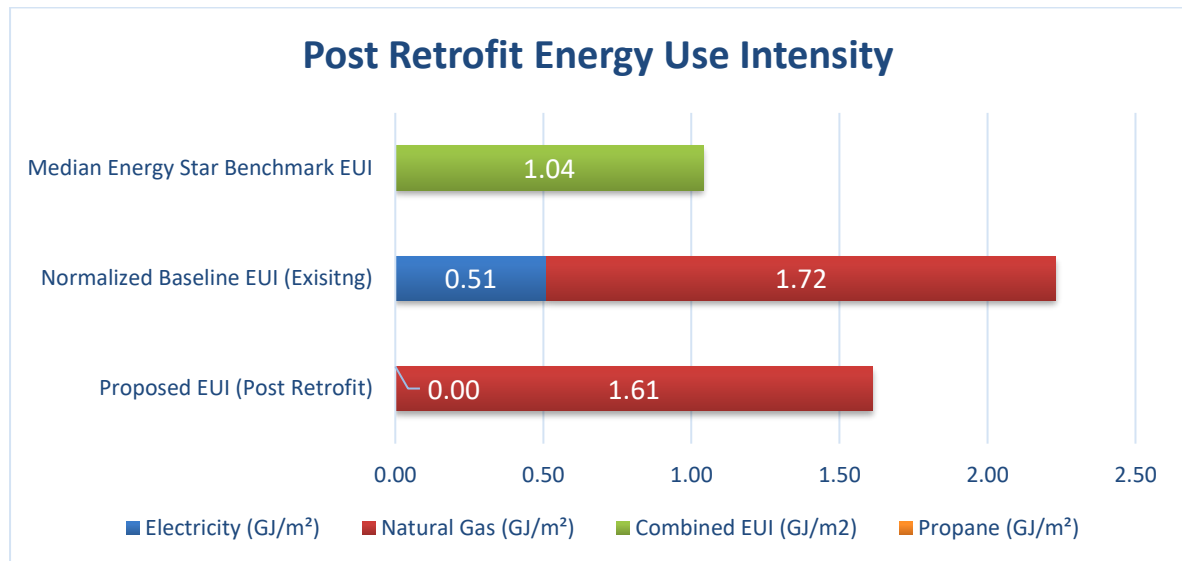


Figure 30: Proposed EUI

9.4 Greenhouse Gas Emission Benchmarking

The proposed facility achieves a 11% reduction in greenhouse gas emissions of over of the existing facility (**Figure 31**).

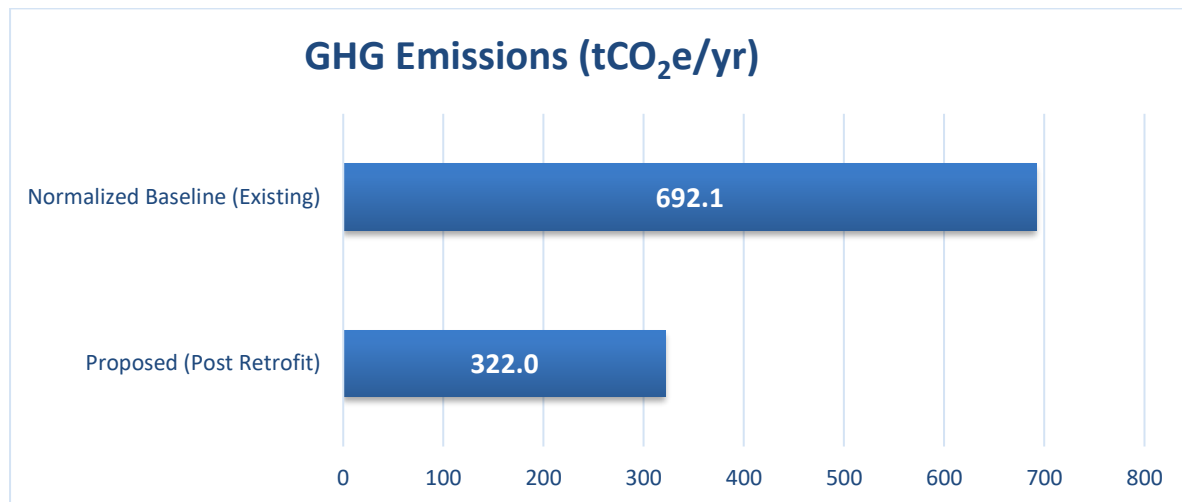


Figure 31: Proposed GHG Reduction

9.5 Energy End Use Breakdown

Comparing the two graphs (**Figure 32**) reveals approximately 8% in energy savings. Most of the savings come from domestic hot water heating, space heating, and lighting. Installing low flow water fixtures, DHW tank blankets, and condensing water heaters attain a 4% annual energy reduction. Installing programmable thermostats results to a 1% annual energy reduction. LED lighting reduces electricity consumption by 296 GJ/yr equivalent to a 3% annual energy reduction. Facility ventilation air flow rates were maintained to comply with the requirements of Alberta Infrastructure Facilities on Continuing Care Homes.

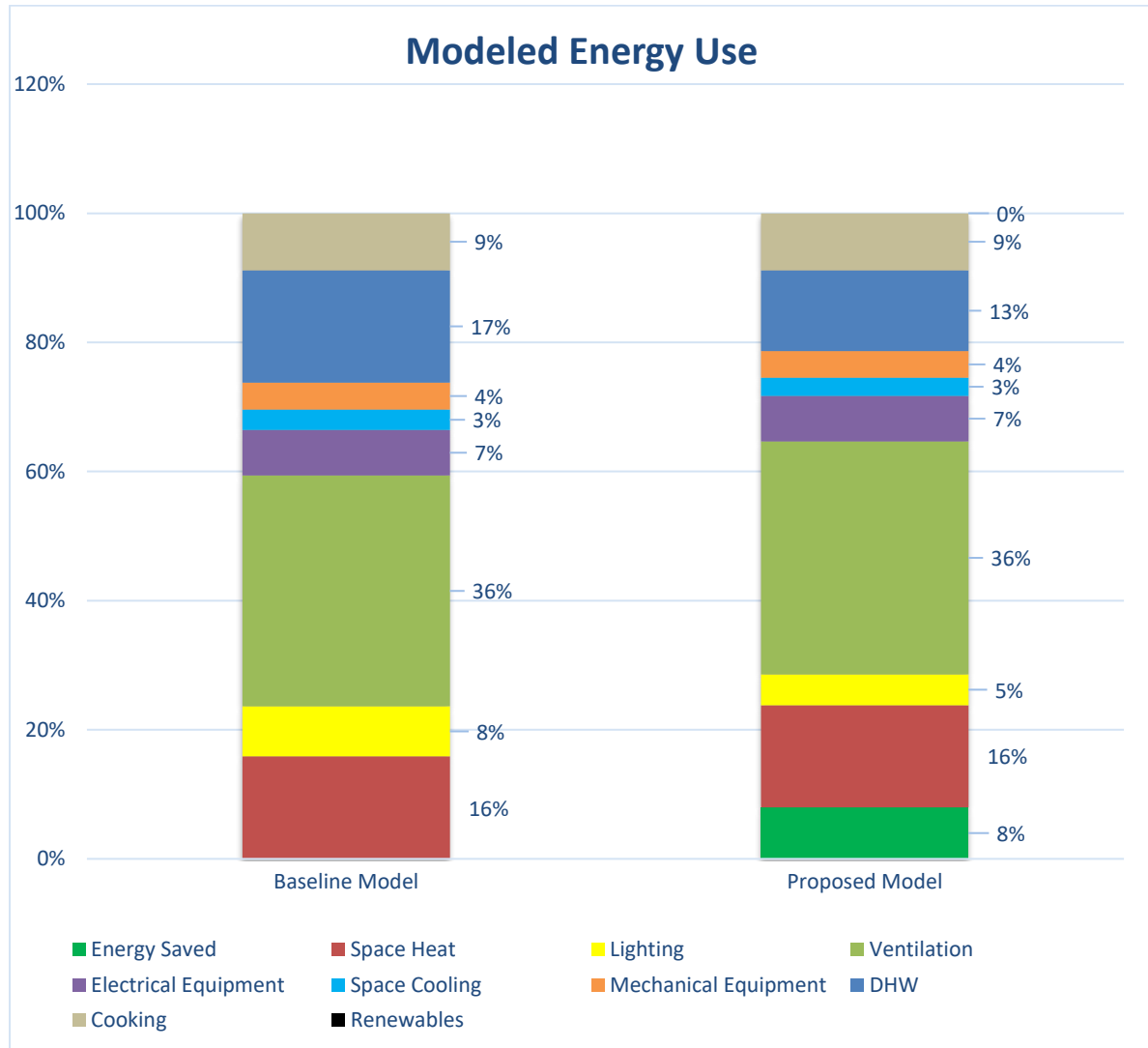


Figure 32: Categorized Energy Consumption for Baseline and Proposed Case

10 ENERGY CONSERVATION MEASURES SUMMARY

Table 51 summarizes the Energy Conservation Measures for this facility.

Table 51: Energy Savings and GHG Reduction Summary

ECM Description	Annual Elec. Savings (kWh)*	Annual N.G. Savings (GJ)	Annual GHG Reductions (tCO ₂ e)	Lifetime (Years)	Lifetime GHG Reduction (tCO ₂ e)
ECM-1 Low Flow Water Fixtures	0	213	11	15	165.7
ECM-2 DHW Tank Blanket	0	1	0.0	24	1.1
ECM-3 LED Lighting Upgrade	79,800	-172	42	30	1,265.0
ECM-4 High Efficiency Notched Fan Belts	2,700	0	1.7	3	5.2
ECM-5 High Efficiency Air Filters	500	0	0.3	1	0.3
ECM-6 DHW Pipe Heat Trap	0	3	0.1	70	9.8
ECM-7 Programmable Thermostats	2,400	148	9.2	15	137.7
ECM-8 Door Seals & Sweeps	100	15	0.9	10	8.6
ECM-9 DHW Pipe Insulation	0	0	0.0	24	0.0
ECM-10 Roof Upgrade	0	76	3.9	30	117.5
ECM-11 Condensing Boiler	0	374	19	25	483.7
ECM-12 Condensing DHW-1	0	149	7.7	18	139.3
ECM-13 Condensing DHW-2	0	105	5.5	18	98.2
REM-1 Roof Solar Photovoltaic	114,200	0	73	25	1,827.2
REM-2 Solar Hot Water	-200	28	1.3	10	13.2
Proposed Case[†]	84,800	411	75.6	27	2,053.6

* ECM savings in Table A and Table B are eligible savings using a reduction factor of 0.9.

[†] Overall values for the proposed case do not equal the sum of the ECMs because the simulation captures interactions between ECMs. Greyed-out ECMs are not included in the proposed model. Incentives are not guaranteed and so are not included in the proposed case.

Table 52 summarizes the financial analysis for this facility.

Table 52: Financial Analysis Summary

ECM	Description	Total Cost (\$)	Annual Cost Savings (\$)	Simple Payback (Years)	Baseline NPV (\$)	ECM NPV (\$)	Potential Rebate (\$)
ECM-1	Low Flow Water Fixtures	1,110	3,820	0.3	-	41,450	0
ECM-2	DHW Tank Blanket	100	10	10	-	3	0
ECM-3	LED Lighting Upgrade	106,130	7,740	14	-170,890	25,390	1,684
ECM-4	High Efficiency Notched Fan Belts	490	200	3	-300	60	0
ECM-5	High Efficiency Air Filters	390	40	10	-220	-360	0
ECM-6	DHW Pipe Heat Trap	680	20	34	-	-200	0
ECM-7	Programmable Thermostats	5,000	1,280	4	5,020	8,710	0
ECM-8	Door Seals & Sweeps	1,710	120	14	-	-720	0
ECM-9	DHW Pipe Insulation	250	0	-	-	-250	0
ECM-10	Roof Upgrade	33,750	570	59	-	-23,920	0
ECM-11	Condensing Boiler	168,920	2,800	60	2,790	-125,060	12,000
ECM-12	Condensing DHW-1	14,490	1,120	13	-780	-290	0
ECM-13	Condensing DHW-2	8,790	790	11	-620	1,220	0
REM-1	Roof Solar Photovoltaic	242,310	8,410	29	-	-110,360	60,578
REM-2	Solar Hot Water	19,810	200	99	-	-18,220	0
Proposed Case		136,110	14,690	9.3	-159,560	101,910	1,684

11 APPENDICES

11.1 Appendix A: Historical Energy Billing Data

Date	Natural Gas		Electricity		Water	
	Usage (GJ)	Total Bill (\$)	Usage (kWh)	Total Bill (\$)	Usage (m ³)	Total Bill (\$)
Jan-16	1126.76	\$7,139.67	37202.37	\$4,361.16	711	\$1,335.78
Feb-16	591.54	\$4,878.88	41270.18	\$4,705.29	572	\$1,088.36
Mar-16	561.46	\$3,978.65	40922.94	\$4,547.64	533	\$1,018.94
Apr-16	332.29	\$3,338.35	39157.7	\$4,640.30	859	\$1,599.22
May-16	304.06	\$2,314.63	44865.86	\$5,194.31	723	\$1,357.14
Jun-16	192.19	\$1,930.44	45095.49	\$5,398.75	872	\$1,622.36
Jul-16	166.06	\$925.89	43916.04	\$5,218.76	831	\$1,549.38
Aug-16	210.65	\$1,377.73	55306.18	\$6,112.45	681	\$1,282.38
Sep-16	270.16	\$1,595.50	44201.17	\$5,326.93	640	\$1,209.40
Oct-16	574.56	\$3,390.37	42926.11	\$5,080.34	650	\$1,227.20
Nov-16	569.17	\$4,312.55	45330.66	\$4,830.53	727	\$1,364.26
Dec-16	1110.62	\$6,342.79	50432.08	\$5,185.71	625	\$1,182.70
Jan-17	991.22	\$7,621.62	40917.19	\$4,714.74	631	\$1,193.38
Feb-17	987.06	\$7,734.28	41654.94	\$4,939.99	639	\$1,207.62
Mar-17	762.53	\$6,432.70	46647.12	\$5,078.07	730	\$1,369.60
Apr-17	446.59	\$5,024.64	38944.49	\$4,811.50	602	\$1,141.76
May-17	259.59	\$2,961.38	47623.04	\$5,579.10	619	\$1,172.02
Jun-17	199.9	\$1,916.06	46579.63	\$5,845.57	690	\$1,298.40
Jul-17	237.34	\$1,940.83	54507.62	\$6,253.10	595	\$1,129.30
Aug-17	156.49	\$1,086.99	50385.27	\$6,112.56	711	\$1,335.78
Sep-17	334.89	\$1,769.64	57575.62	\$6,691.04	614	\$1,163.12
Oct-17	541.04	\$3,750.11	47722.86	\$5,767.44	690	\$1,298.40
Nov-17	1041.13	\$6,672.12	46024.28	\$5,458.67	668	\$1,259.24
Dec-17	1018.48	\$7,924.35	42896.89	\$5,098.42	648	\$1,223.64
Jan-18	980.12	\$8,311.41	48994.48	\$5,709.81	130	\$301.60
Feb-18	1181.86	\$8,666.64	41901.47	\$5,191.41	280	\$568.60
Mar-18	985.56	\$8,574.36	43392.04	\$5,014.68	598	\$1,134.64
Apr-18	613.34	\$5,436.42	40660.57	\$5,053.80	620	\$1,173.80
May-18	396.09	\$3,707.45	48875.12	\$5,720.94	593	\$1,287.72
Jun-18	258.53	\$2,217.26	48323.27	\$6,337.00	559	\$1,065.22
Jul-18	200.62	\$1,668.52	51625.29	\$6,169.52	614	\$1,163.12

11.2 Appendix B: Utility Rate Code

SITE ID:0040262188007 Close Window

Basic Information					
Date	MDM	WSP	Settlement Agent	Site ID	Municipality
2012-07-06	FORTIS	FORTIS WIRES	FORTIS	0040262188007	TABER

Legal Address Scheme			
Lot	Lot Range ID	Block	Government Plan ID
null	null	null	null

Rural Address								
Legal Subdivision Code	LSD Quadrant	Quarter Section Code	Lot	Section	Township	Range	Meridian	Rural House Number
null	null	null	null	null	null	null	null	null

Urban Address								
Unit Definer	Unit Number	House Number	Street Pre-Direction	Street Name	Street Type Code	Street Direction	City Quadrant	City/Town Name
null	null	4730	null	50	AVE	null	null	TABER

Miscellaneous Information						
Area Name	Cluster Correlation Key	Unformatted Address	Site Reference	Micro Generation	Tariff Rate Code	Meter Number
WO 65050922 OI 1131220	null	null	null	N	61	0000000000001371925



FortisAlberta Inc.
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RATE 61 GENERAL SERVICE

Effective: April 1, 2018

Availability: Rate 61 is available to Points of Service that do not qualify for other specific rates, with Operating Demands of 2,000 kW or less.

Rate 61

	Transmission Component	Distribution Component	Total Distribution Tariff
Service Charge for the first 50 kW of Capacity	\$0.12081 /kW-day	\$0.26797 /kW-day	\$0.38878/kW-day
For the next 450 kW of Capacity	\$0.12081 /kW-day	\$0.12023 /kW-day	\$0.24104/kW-day
For all kW of Capacity greater than 500 kW	\$0.12081 /kW-day	\$0.09186 /kW-day	\$0.21267/kW-day
For all kWh delivered	0.3964¢/kWh	—	0.3964¢/kWh
For all kW of Peak Metered Demand	\$0.26925 /kW-day	—	\$0.26925/kW-day

The kW of Capacity is the greatest of:

1. the highest Metered Demand in the billing period;
2. 85% of the highest Metered Demand in the 12 month period including and ending with the billing period;
3. the Contract Minimum Demand as specified by the Terms and Conditions;
- or
4. the Rate Minimum of 50 kW.

The Peak Metered Demand is the highest Metered Demand in the billing period.

The Metered Demand is the greater of:

- i) the registered demand in kW, or
- ii) 90% of the registered demand in kVA.

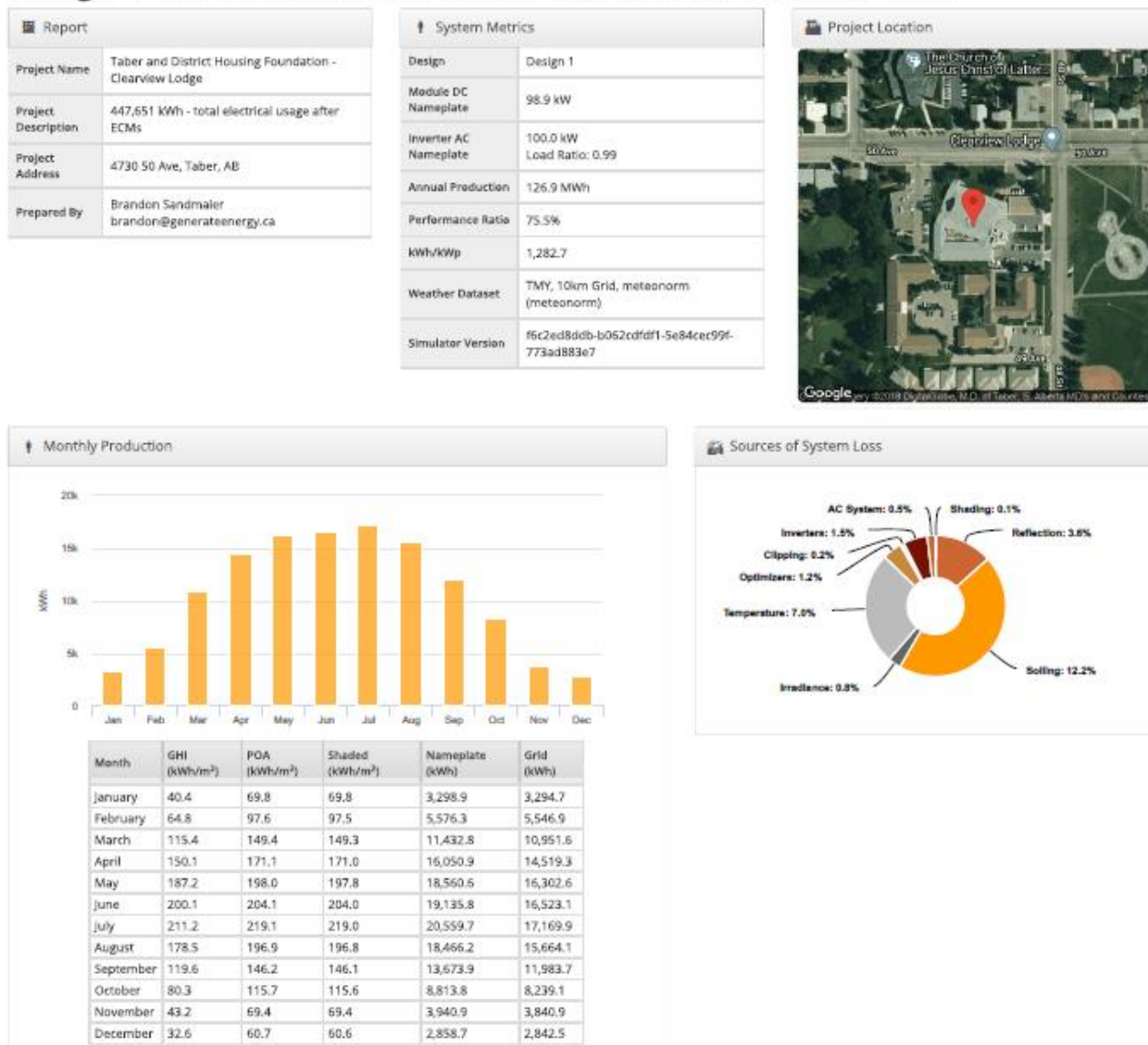
11.3 Appendix C: Life Cycle Cost Analysis Factors

A fuel escalation factor of 1% and a discount rate of 5% are used in the Life Cycle Cost Analysis of the ECMs.

Life Cycle costing for ECMs and proposed case requires using a weighted average to calculate the average lifespan of ECMs with multiple installations. This typically effects lighting upgrades and the proposed case model.

11.4 Appendix D: REM-1 Photovoltaic Panel Installation

Design 1 Taber and District Housing Foundation - Clearview Lodge, 4730 50 Ave, Taber, AB



Annual Production			
	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,423.4	
	POA Irradiance	1,698.1	19.3%
	Shaded Irradiance	1,696.9	-0.1%
	Irradiance after Reflection	1,636.6	-3.6%
	Irradiance after Soiling	1,437.4	-12.2%
	Total Collector Irradiance	1,437.4	0.0%
Energy (kWh)	Nameplate	142,368.4	
	Output at Irradiance Levels	141,238.6	-0.8%
	Output at Cell Temperature Derate	131,347.6	-7.0%
	Output After Mismatch	131,347.4	0.0%
	Optimizer Output	129,770.9	-1.2%
	Optimal DC Output	129,659.0	-0.1%
	Constrained DC Output	129,457.9	-0.2%
	Inverter Output	127,516.0	-1.5%
	Energy to Grid	126,878.0	-0.5%
Temperature Metrics			
	Avg. Operating Ambient Temp		9.9 °C
	Avg. Operating Cell Temp		25.1 °C
Simulation Metrics			
	Operating Hours	4637	
	Solved Hours	4637	

Condition Set												
Description	Condition Set 2											
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)											
Solar Angle Location	Meteo Lat/Lng											
Transposition Model	Perez Model											
Temperature Model	Sandia Model											
Temperature Model Parameters	Rack Type	a		b		Temperature Delta						
	Fixed Tilt	-3.56		-0.075		3°C						
	Flush Mount	-2.81		-0.0455		0°C						
	East-West	-3.56		-0.075		3°C						
	Carport	-3.56		-0.075		3°C						
Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D
	50	40	20	2	2	2	2	2	2	20	40	50
Irradiation Variance	5%											
Cell Temperature Spread	4° C											
Module Binning Range	-2.5% to 2.5%											
AC System Derate	0.50%											
Module Characterizations	Module							Characterization				
	TSM-DE14A(I) PERC MONO 365 (Trina Solar)							Spec Sheet Characterization, PAN				
Component Characterizations	Device							Characterization				
	P400 NA (SolarEdge)							Mfg Spec Sheet				
	SE100KUS (SolarEdge)							Spec Sheet				

Components		
Component	Name	Count
Inverters	SE100KUS (SolarEdge)	1 (100.0 kW)
Strings	10 AWG (Copper)	8 (1,303.0 ft)
Optimizers	P400 NA (SolarEdge)	271 (108.4 kW)
Module	Trina Solar, TSM-DE14A(I) PERC MONO 365 (365W)	271 (98.9 kW)

Wiring Zones			
Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	17-34	Along Racking

Field Segments									
Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 2	Flush Mount	Portrait (Vertical)	18.4°	203.54°	0.0 ft	1x1	58	58	21.2 kW
Field Segment 3	Flush Mount	Portrait (Vertical)	18.4°	180°	0.0 ft	1x1	114	114	41.6 kW
Field Segment 1	Flush Mount	Portrait (Vertical)	22.5°	202.094°	0.0 ft	1x1	99	99	36.1 kW

11.5 Appendix E: Proposed Case Model

Show: All	Heating	Cooling	Electricity	Incremental initial costs	Fuel cost savings	Incremental O&M savings	Simple payback	Include measure?
Energy - proposed case	GJ	GJ	GJ	\$	\$	\$	yr	☐
Heating								
Boilers				0	0	0		☐
RTU 1, 2				0	0	0		☐
RTU 3				0	0	0		☐
MUA-1				0	0	0		☐
MUA-2				0	0	0		☐
MUA-4				0	0	0		☐
DHW-1				0	1,252	0	0.0	☒
DHW-2				0	886	0	0.0	☒
Cooking Appliances (Gas)				0	0	0		☐
Cooling								
RTU 1, 2				0	0	0		☐
RTU 3				0	0	0		☐
MUA-1				0	0	0		☐
MUA-2				0	0	0		☐
MUA-4				0	0	0		☐
Walk-in Cooler/Freezer				0	0	0		☐
Building envelope								
Zone 1,2	138			0	-51.7	0	0.0	☒
Zone 4b, 7, 8	180			0	-67.4	0	0.0	☒
Zone 3,4a,6	293			0	-110	0	0.0	☒
Zone 5 (Atrium)	35.2	36.1		0	56.9	0	0.0	☒
Zone 5 (Atrium Clerestory)	295	177		0	372	0	0.0	☒
Zone 9 (Staff Room+Ancillary)	18.4	13.8		0	-0.87	0	0.0	☒
Zone 10 (Kitchen+Ancillary)	19.4			0	26.6	0	0.0	☒
Zone 11 Basement	18.6			0	61.7	0	0.0	☒
Ventilation								
RTU 1, 2	54.5	12.4		0	44.4	0	0.0	☒
RTU 3	39.1	9.4		0	-9.7	0	0.0	☐
MUA-1	928	224		0	-226	0	0.0	☐
MUA-2	492	119		0	-126	0	0.0	☐
MUA-3	471	114		0	-136	0	0.0	☐
MUA-4	521	113		0	650	0	0.0	☒
Lights								
Suites			129	0	1,602	0	0.0	☒
Suites WC			8.6	0	242	0	0.0	☒
Hair Salon			0.64	0	9.9	0	0.0	☒
Staff Areas			8.8	0	121	0	0.0	☒
Resident Service Areas			7	0	117	0	0.0	☒
Hallways, Foyer			205	0	2,864	0	0.0	☒
Kitchen			11.1	0	130	0	0.0	☒
Common WC, tub room			2	0	22.6	0	0.0	☒
Basement			0.95	0	2.8	0	0.0	☒
Atrium, Dining Area			16.3	0	197	0	0.0	☒
Exit Lights			1.3	0	140	0	0.0	☒
Exterior Lights			10.7	0	627	0	0.0	☒

Electrical equipment								
Electrical equipment	425			0	0	0		☐
Washer, Dryer	208			0	0	0		☐
Hot water								
Hot water - Suites, tubs	624			0	1,501	0	0.0	☒
Hot water - Laundry	146			0	0	0		☐
Hot water - Kitchen	234			0	11.6	0	0.0	☒
Pumps								
P-1, 2	7.4			0	0	0		☐
P-3	0.39			0	0	0		☐
RP-1, 2	9.4			0	0	0		☐
Fans								
RTU 1, 2 Supply Fan	17.3			0	11	0	0.0	☒
RTU 1, 2 Condenser Fan	1.1			0	0	0		☐
RTU 3 Supply Fan	1.4			0	0.86	0	0.0	☒
RTU 3 Condenser Fan	0.06			0	0	0		☐
MUA-1 Supply Fan	118			0	74.9	0	0.0	☒
MUA-1 Condenser Fan	0.93			0	0	0		☐
MUA-2 Supply Fan	79.7			0	50.4	0	0.0	☒
MUA-2 Condenser Fan	0.56			0	0	0		☐
MUA-3 Supply Fan	48.5			0	30.7	0	0.0	☒
MUA-4 Supply Fan	79.7			0	50.4	0	0.0	☒
MUA-4 Condenser Fan	1			0	0.74	0	0.0	☒
FFH-1, 2	0.11			0	0	0		☐
UH-1 to 5	1.2			0	0	0		☐
DHW Fans	0.32			0	-6.6	0	0.0	☒
Process heat								
Cooking - Gas fuel	635			0	0	0		☐
Refrigeration								
Walk-in Cooler/Freezer	3.3			0	0	0		☐
Heating								
Solar water heater	0	0		0	0	0		☐
Power								
Photovoltaic	0			0	0	0		☐
Total	5,144	822	1,401	0	10,422	0	0.0	

Process heat								
Cooking - Gas fuel	0			0	0	0		☐
Refrigeration								
Walk-in Cooler/Freezer	0			0	0	0		☐
Heating								
Solar water heater	0	0		0	0	0		☐
Power								
Photovoltaic	0			0	0	0		☐
Total	1,058	28.3	350	0	15,766	0	0.0	

Summary - Electricity and fuels

Fuel type	Fuel type		Base case		Proposed case		Savings	
	Fuel rate	Fuel consumption - unit	Fuel consumption	Fuel cost	Fuel consumption	Fuel cost	Fuel saved	Savings
Natural gas	\$ 7.55	GJ	7,002	\$ 52,838	6,545	\$ 49,384	458	\$ 3,454
Electricity	\$ 0.074	kWh	553,767	\$ 40,979	459,600	\$ 34,010	94,167	\$ 6,968
Total				\$ 93,816		\$ 83,394		\$ 10,422

Project verification

Fuel type	Fuel consumption - unit	Fuel consumption - historical	Fuel consumption - Proposed case	Fuel consumption - variance
Natural gas	GJ	6,614	6,545	-1.1%
Electricity	kWh	546,053	459,600	-15.8%

Savings

	Heating	Cooling	Electricity	Total	Plan	Variance
Fuel consumption	kWh	kWh	kWh	kWh	kWh	%
Base case	1,945,071	79,575	474,192	2,498,837	730,208	242%
Proposed case	1,817,917	70,357	389,243	2,277,517	620,677	267%
Fuel saved	127,153	9,218	84,949	221,320	109,531	102%
Fuel saved - %	6.5%	11.6%	17.9%	8.9%	15%	

Benchmark

Energy unit	kWh					
Reference unit	m ²	3,843 				
Benchmark	Heating	Cooling	Electricity	Total	Benchmark	Variance
Fuel consumption	kWh/m²	kWh/m²	kWh/m²	kWh/m²	kWh/m²	%
Base case	506	20.7	123	650	190	242%
Proposed case	473	18.3	101	593	190	212%
Fuel saved	33.1	2.4	22.1	57.6		

11.6 Appendix F: References

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