



ENERGY STRATEGY STUDY OFFICIAL PLAN AND ZONING BY-LAW AMENDMENT

VANLEGEND REGINA LP

REGINA/ERB

6 Regina St N and 24, 28, 34 Erb St E, Waterloo, ON

WalterFedy project number: 2021-0601-10

VanLegend Regina LP project number: TBD

December 17, 2021



WALTERFEDY

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Project Number: 2021-0601-10

December 17, 2021

Jennifer Voss
MCIP, RPP
JV Planning and Development Consulting
VanLegend Regina LP
22 King Street South, Suite 300
Waterloo, ON N2J 1N8

Dear Jennifer Voss,

RE: Energy Strategy Study

WalterFedy is pleased to submit the attached Energy Strategy Study Investigation report and master list of findings (MLF) to VanLegend Regina LP. This encompasses the originally agreed to scope, providing a Energy Strategy Study Investigation for Regina/Erb, located at 6 Regina St N and 24, 28, 34 Erb St E in Waterloo, ON.

Based on the information provided by VanLegend Regina LP, the report was completed with the data supplied and collected, as well as engineering judgement and various analysis tools to arrive at the final recommendations.

All of which is respectfully submitted,

WALTERFEDY

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P.Eng., PMP
Energy Engineer
Energy Management Solutions

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1 INTRODUCTION

1.1 Background

WalterFedy was engaged by VanLegend Regina LP to complete the Energy Strategy Study enclosed in this report. The intent of this Energy Strategy Study is to develop an Energy Strategy as required as part of an Official Plan Amendment and Zoning By-law Amendment application for the proposed site. The Energy Strategy will evaluate various energy conservation measures (ECMs) and recommend which measures to implement to achieve a minimum energy-efficiency improvement of at least 15% relative to Ontario Building Code (OBC) SB-10 baseline. The path followed for this analysis is ASHRAE Standard 90.1-2013 as modified by OBC SB-10.

OBC SB-10 stipulates that the energy-efficiency of the building consists of the following three metrics. The minimum energy-efficiency improvement of 15% is therefore assumed to apply to all three of the metrics.

- Electricity peak demand.
- Greenhouse gas (GHG) emissions.
- Utility cost.

1.2 Scope of work

The scope of work is detailed in WalterFedy's proposal number 2021-0685-01. A brief summary is as follows.

- Obtain site development information.
- Perform start-up meeting.
- Develop SB-10 baseline energy model.
- Analyze various ECMs to quantify approximate project cost, energy use, greenhouse gas (GHG) emissions, utility cost, cost-benefit.
- Recommend a set of ECMs to be included in the proposed facility (recall, the Energy Strategy must improve energy-efficiency by at least 15% relative to the OBC SB-10 baseline).
- Compare proposed scenario with baseline scenario.
- Review with WR Community Energy.
- Develop draft report compliant with City of Waterloo Energy Strategy requirements.
- Review draft report with VanLegend Regina LP and other stakeholders.
- Revise report based on feedback and provide final version.

1.3 Contact information

Contact information for WalterFedy (the Consultant) and VanLegend Regina LP (the Client) is provided in Table 1.

Table 1: Contact information

Description	Consultant	Client
Organization	WalterFedy	VanLegend Regina LP
Address	Suite 111, 675 Queen St South	22 King Street South, Suite 300
Location	Kitchener, ON	Waterloo, ON
Postal code	N2M 1A1	N2J 1N8
Contact name	Cory Rosa	Jennifer Voss
Credentials	P.Eng., PMP	MCIP, RPP
Title	Energy Engineer	JV Planning and Development Consulting
Phone	519 635 9805	519 279 0170
Email	crosa@walterfedy.com	jvoss@urbanlegendgroup.com

2 FACILITY DESCRIPTION

2.1 Facility description methodology

The facility is reviewed and described according to the following methodology. The intent of reviewing and describing the facility is to understand the pertinent operations and systems in the facility that use utilities so that baseline (i.e. existing) utility use can be accurately quantified.

1. **Facility document review.** Available facility documents are reviewed, including the following.
 - Preliminary site plan.
 - Preliminary floor plans.
2. **Documentation of findings.** The findings associated with executing the above steps are documented, including the following.
 - The facility, its operations and energy systems are described in Section 2.3.

2.2 Facility overview

An overview of Regina/Erb is provided in Table 2.

Table 2: Facility overview

Description	Unit	Value
Name	[-]	Regina/Erb
Address	[-]	6 Regina St N and 24, 28, 34 Erb St E
Location	[-]	Waterloo, ON
Type	[-]	Mixed Use Residential Building
Construction year	[-]	Not yet built
Gross floor area	[ft ²]	246,000

A rendering of Regina/Erb is presented in Figure 1 for illustration.



Figure 1: Regina/Erb aerial view

2.3 Facility description

Regina/Erb is in its preliminary planning stages. Preliminary space use and floor plans are as follows.

- 18 storeys in total.
- Level 1: Parking, retail. See Figure 2.

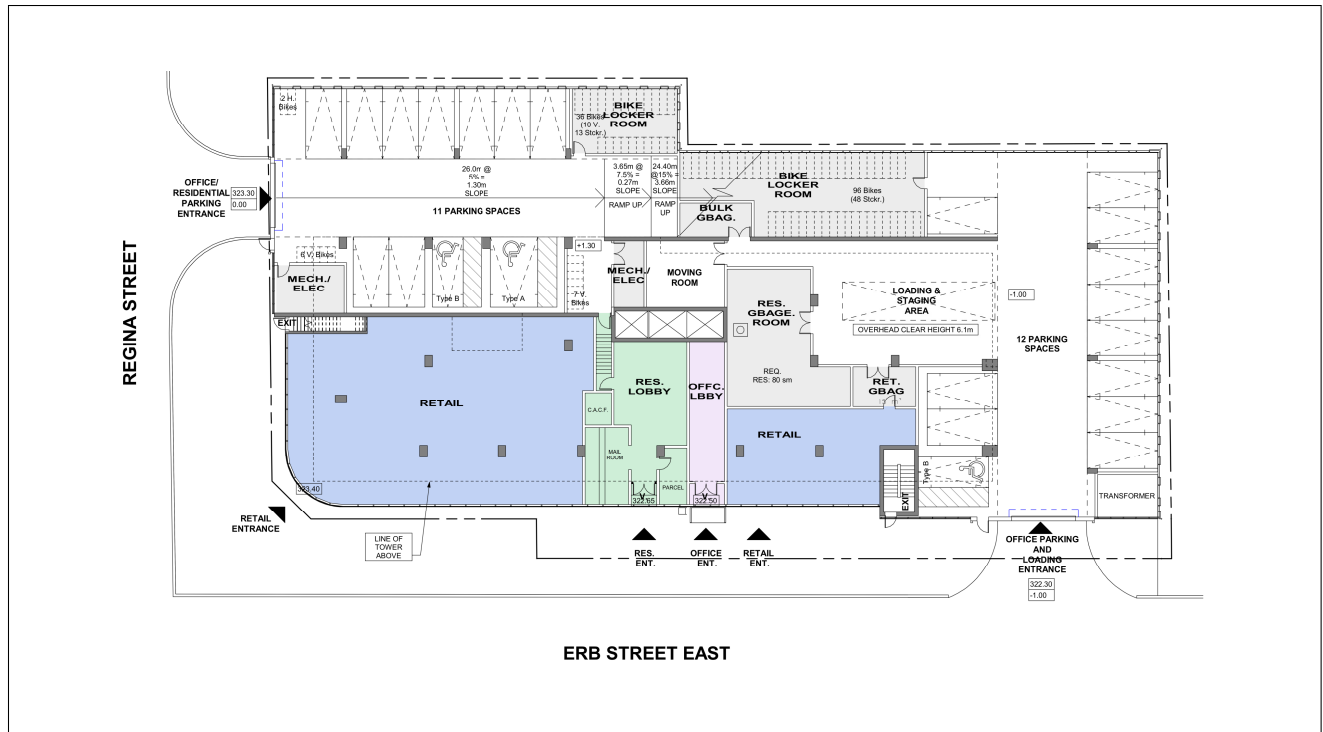


Figure 2: Floor plan, level 1

- Level 2-3: Parking, service. See Figure 3.

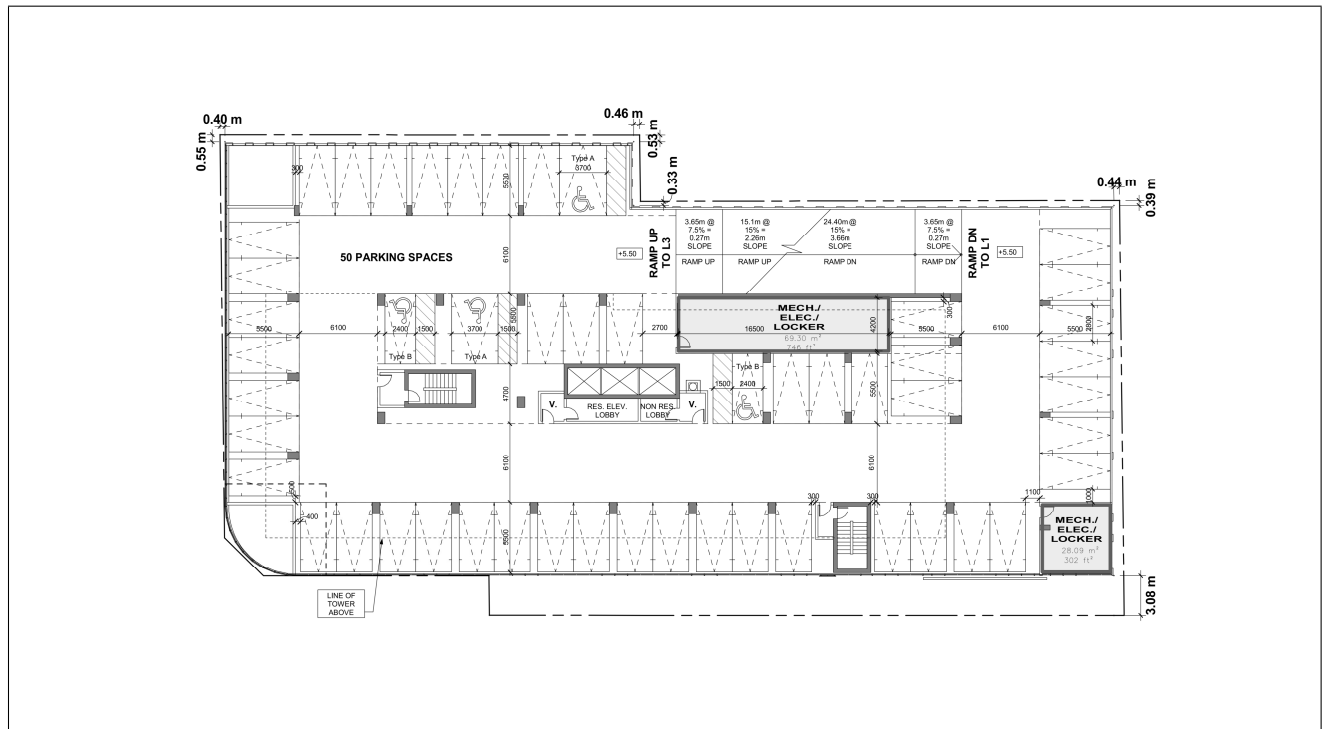


Figure 3: Floor plan, level 2

- Level 4: Office. See Figure 4.

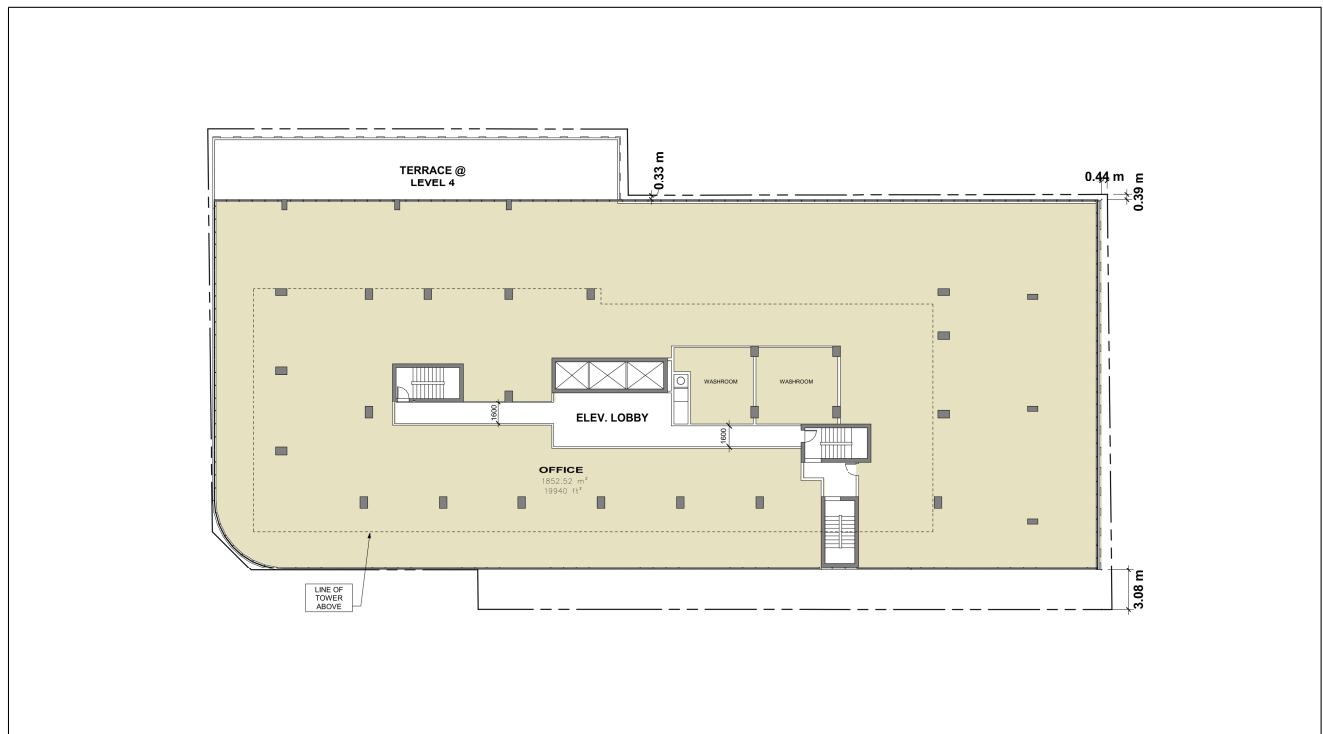


Figure 4: Floor plan, level 4

- Level 5: Residential, amenity, terrace. See Figure 5.

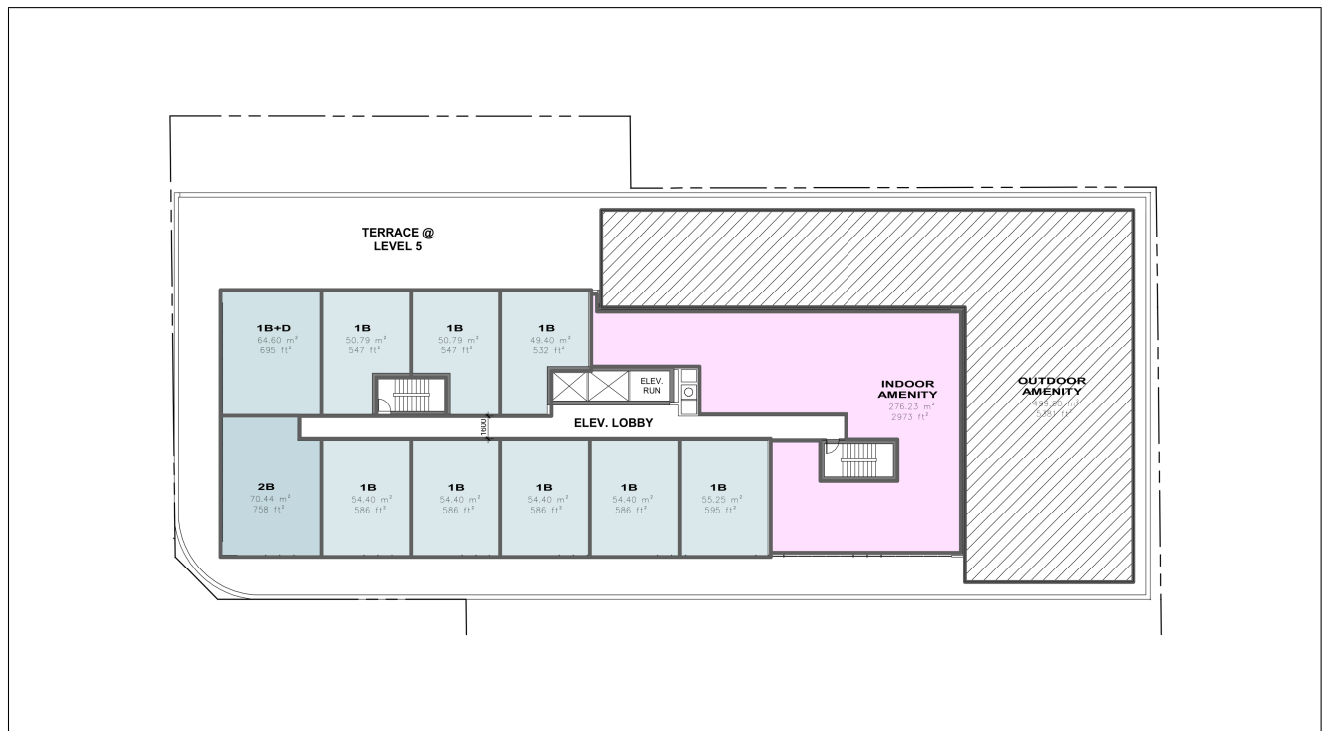


Figure 5: Floor plan, level 5

- Level 6-18: Residential. See Figure 6.



Figure 6: Floor plan, level 6-18 (typical)

2.4 Energy systems

The goal of this Energy Strategy is to recommend a plan to improve the facility's energy-efficiency by at least 15% relative to the OBC SB-10 baseline. The energy systems assumed in the baseline scenario are summarized in the following tables. And whereas most energy-consuming systems have not yet been designed, the baseline scenario assumptions reflect typical electrical and mechanical systems, given the building type, and are aligned with OBC SB-10.

Table 3: Building envelope systems summary

System	Type	U-Value	Ratio	Infiltration
-	-	[btu/hr/ft2/F]	[dcml]	[cfm/ft2]
Roof	Insulation above deck	0.029	-	0.069
Walls	Mass	0.048	-	0.069
Windows	Operable	0.45	0.4	0.069

Table 4: Lighting systems summary

System	Type	Serves	LPD	Controls
-	-	-	[W/ft2]	-
Lighting	-	Parking	0.15	Continuous
Lighting	-	Retail	1.06	Scheduled
Lighting	-	Office	0.79	Scheduled
Lighting	-	Residential (corridor)	0.68	Manual
Lighting	-	Residential	0.68	Continuous

Table 5: DHW heating systems summary

System	Type	Serves	Fuel	Efficiency
-	-	-	-	[dcml]
DHW1	Non-condensing	Retail, Office	Natural gas	0.8
DHW2	Non-condensing	Residential	Natural gas	0.8

Table 6: Air distribution systems summary

System	Type	Serves	Operation	Supply air	Outside air	ERV effectiveness	Economizer	Heating	Cooling
-	-	-	-	[cfm]	[dcml]	[dcml]	-	-	-
MAU1	Makeup air	Residential	Continuous	21498	1	-	-	Hydronic	-
ERV1	Energy recovery ventilator	Retail	Scheduled	1815.9	1	0.5	Yes	-	-
ERV2	Energy recovery ventilator	Office	Scheduled	1994.1	1	0.5	Yes	-	-
FCUs	Four-pipe fan-coils	Res, retl, offc	Intermittent	-	-	-	-	Hydronic	Hydronic
UHs	Unit heaters	Parking	Intermittent	-	-	-	-	Hydronic	-
EF (Residential)	Exhaust fans	Residential	Intermittent	-	-	-	-	-	-
EF (Parking)	Exhaust fans	Parking	Intermittent	30028.8	1	-	-	-	-

Table 7: Heating systems summary

System	Type	Serves	Fuel	Efficiency
-	-	-	-	[dcml]
Boiler	Non-condensing	Hydronic heating loop	Natural gas	0.8

Table 8: Cooling systems summary

System	Type	Serves	Fuel	COP
-	-	-	-	[dcml]
Chiller	Water-cooled	Hydronic cooling loop	Electricity	6.4

3 UTILITY USE BASELINE

3.1 Utility baseline analysis methodology

The utility baseline analysis is completed according to the following methodology. The intent of the utility baseline analysis is to quantify the baseline utility performance of Regina/Erb, using the understanding gained through the facility description summarized in Section 2.3.

1. **Utility data sources.** Utility data is obtained from the following sources for each respective utility.
 - **Electricity.** Energy model; see energy model development methodology below.
 - **Natural gas.** Energy model; see energy model development methodology below.
2. **Energy model development.** An energy model of the facility is developed using eQUEST Version 3.65, reflecting the facility description of Regina/Erb documented in Section 2.3. eQUEST is a building energy modeling tool that simulates hourly energy consumption of the facility based on user-defined characteristics (e.g. weather data, building size / geometry / envelope, operating schedules, lighting, HVAC systems, etc.). A rendering of the eQUEST model can be seen in Figure 7. Note that eQUEST does not render duplicated building levels to reduce computing resource requirements.

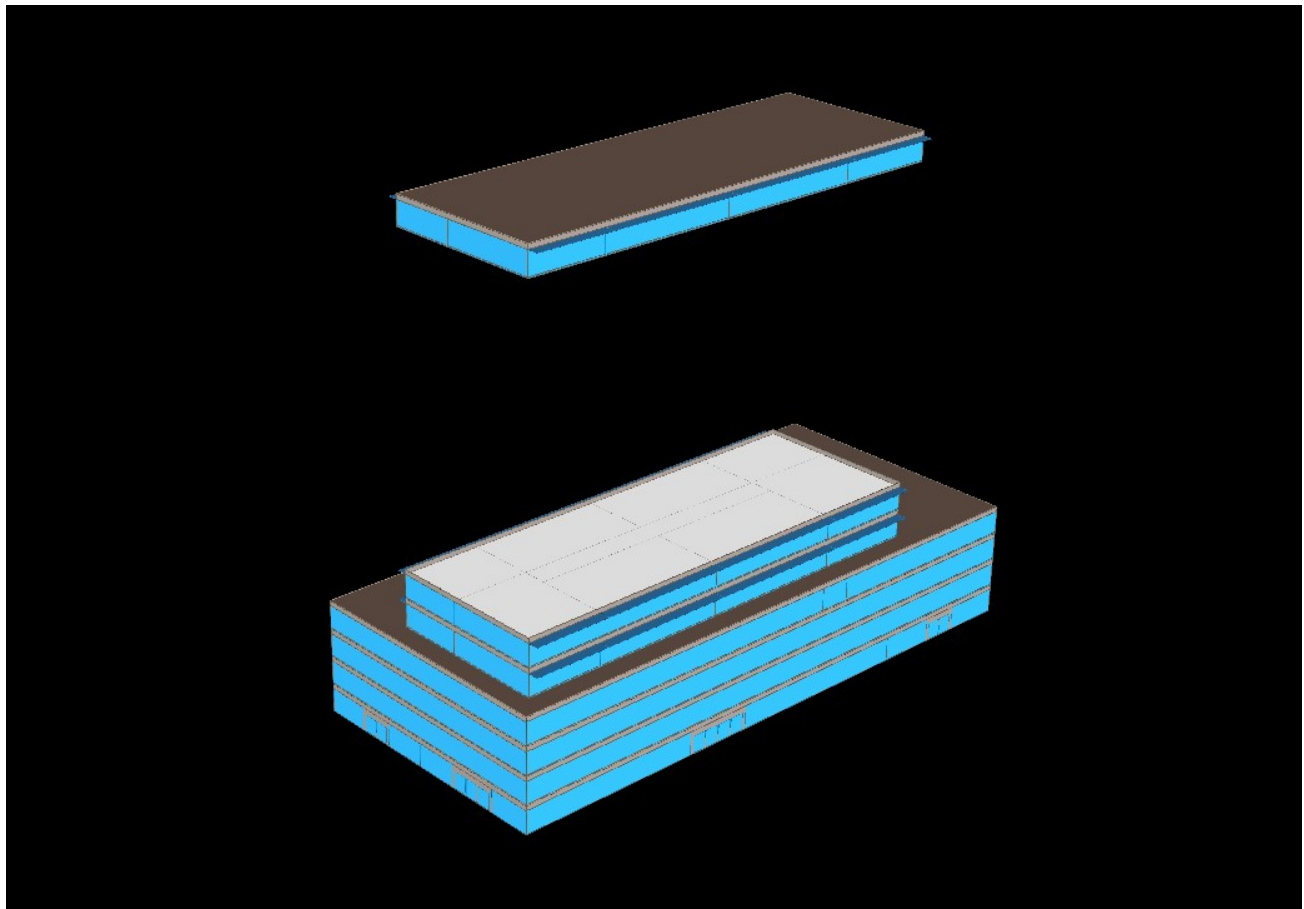


Figure 7: eQUEST energy model rendering

Since metered utility data is not available, the annual electricity and natural gas use estimated through the energy model are taken to represent the energy use baseline for Regina/Erb. Figure 8 plots the monthly electricity and natural gas use estimated by the eQUEST model.

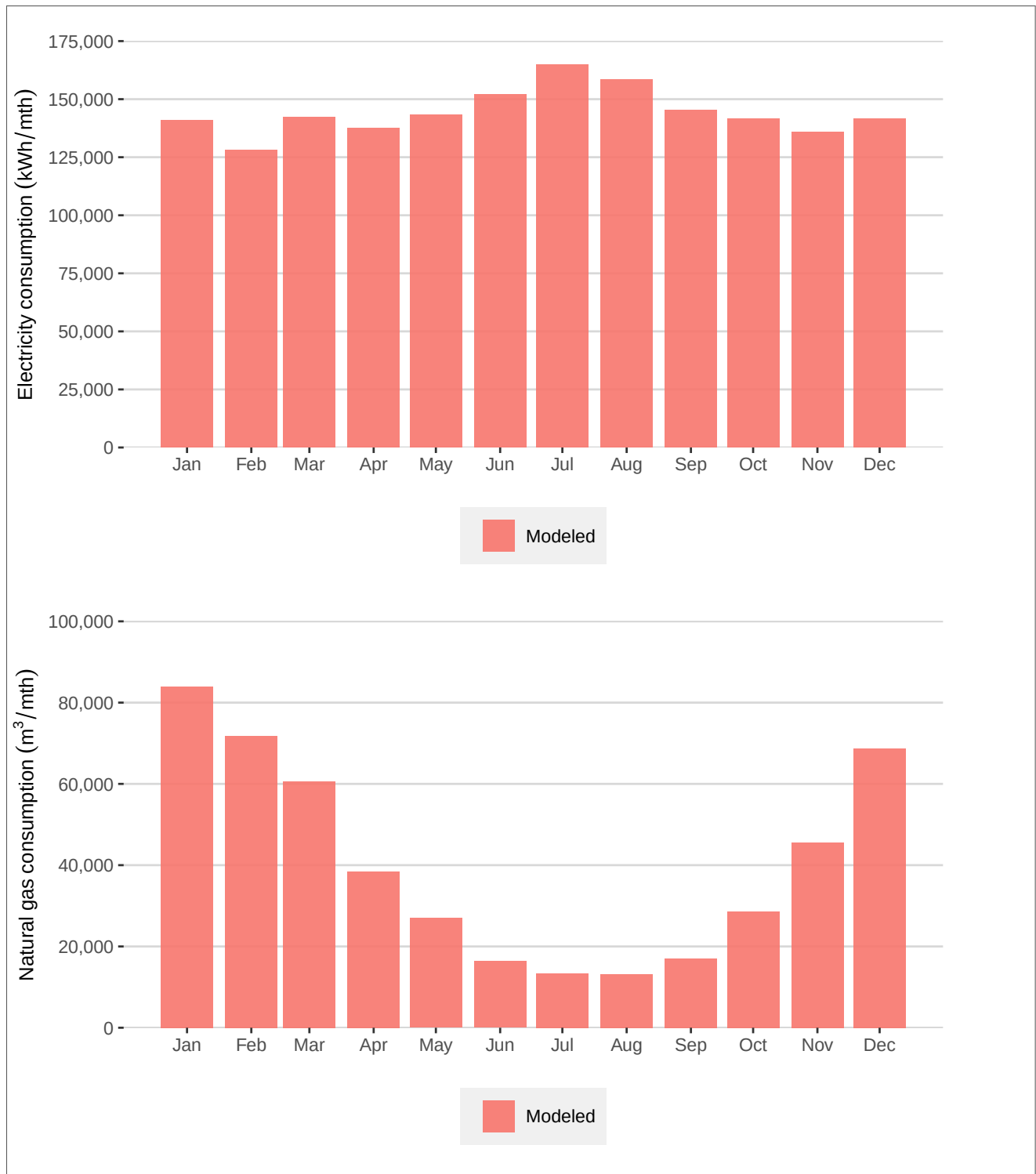


Figure 8: Energy model monthly results

3. **Yearly utility baseline.** The yearly utility use baseline, determined by executing the above steps 1 and 2, is summarized in Section 3.3.
4. **End use analysis.** The eQUEST energy model is used to analyze energy end uses to gain an understanding of how much energy is used by the various energy-consuming systems (i.e. end uses) at the facility. Typical

end uses include lighting, fans, heating, cooling, etc. Results are summarized in Section 3.4.

5. **Benchmark analysis.** A benchmark analysis involves comparing the normalized utility use (i.e. energy utility use per unit gross floor area) of a facility with facilities of similar type / size / location. Since metered utility data for Regina/Erb is not available, a benchmark analysis is not completed..

3.2 Utility baseline analysis assumptions

Assumptions applied throughout the methodology are summarized as follows.

- GHG emissions factor and utility cost rate assumptions are as per Table 9.

Table 9: GHG emissions factor and utility cost rate assumptions

Category	Utility	Description	Unit	Value
GHG emissions factors	Electricity	GHG emissions factor	[mtCO ₂ e/kWh]	0.000040
	Natural gas	GHG emissions factor	[mtCO ₂ e/m ³]	0.001910
Utility cost rates	Electricity	Consumption (blended)	[\$ /kWh]	0.14
	Natural gas	Consumption (blended)	[\$ /m ³]	0.26
	Federal carbon charge	Direct GHG emissions	[\$ /mtCO ₂ e]	40

3.3 Yearly utility baseline

The yearly utility baseline is summarized in Table 10.

Table 10: Yearly utility baseline

Category	Description	Unit	Value
Consumption	Electricity	[kWh/yr]	1,731,506
	Natural gas	[m ³ /yr]	484,662
GHG emissions	Electricity	[mtCO ₂ e/yr]	69
	Natural gas	[mtCO ₂ e/yr]	926
	Total	[mtCO ₂ e/yr]	995
Utility cost	Electricity	[\$ /yr]	242,411
	Natural gas	[\$ /yr]	126,012
	Federal carbon charge	[\$ /yr]	37,028
	Total	[\$ /yr]	405,451

3.4 End use analysis

Utility end uses are estimated from the calibrated energy model. Figures 9 through 12 indicate the contribution of each end use to the annual results for the electricity and natural gas use, GHG emissions, and utility cost.

Electricity end uses

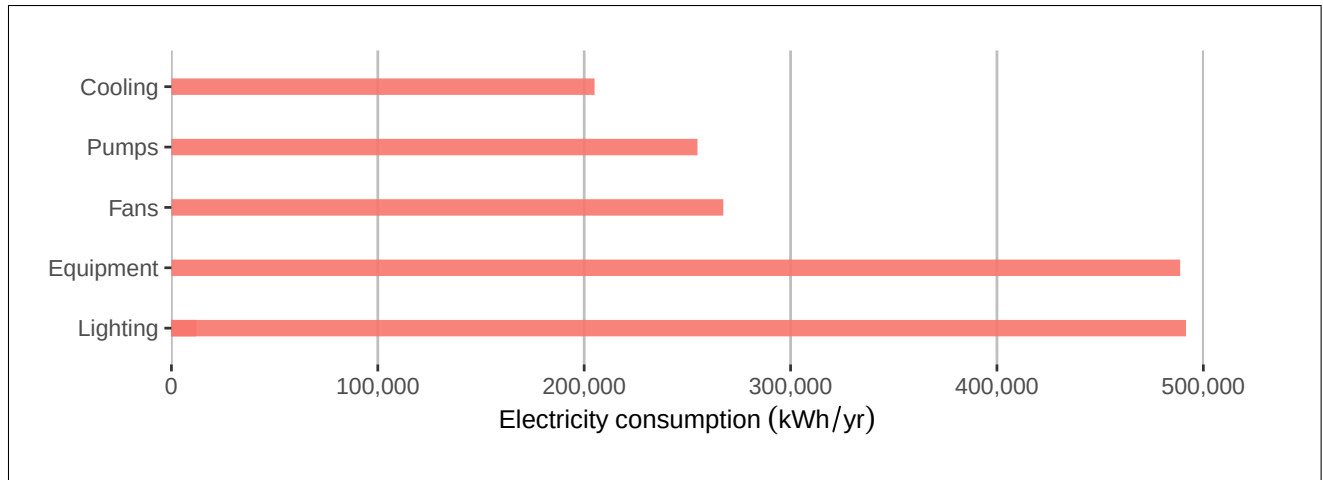


Figure 9: Electricity end use breakdown

Natural gas end uses

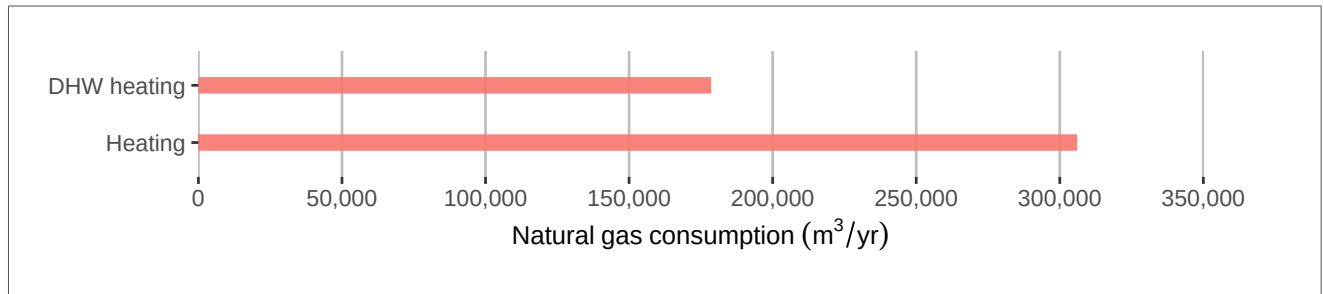


Figure 10: Natural gas end use break down

GHG emissions end uses

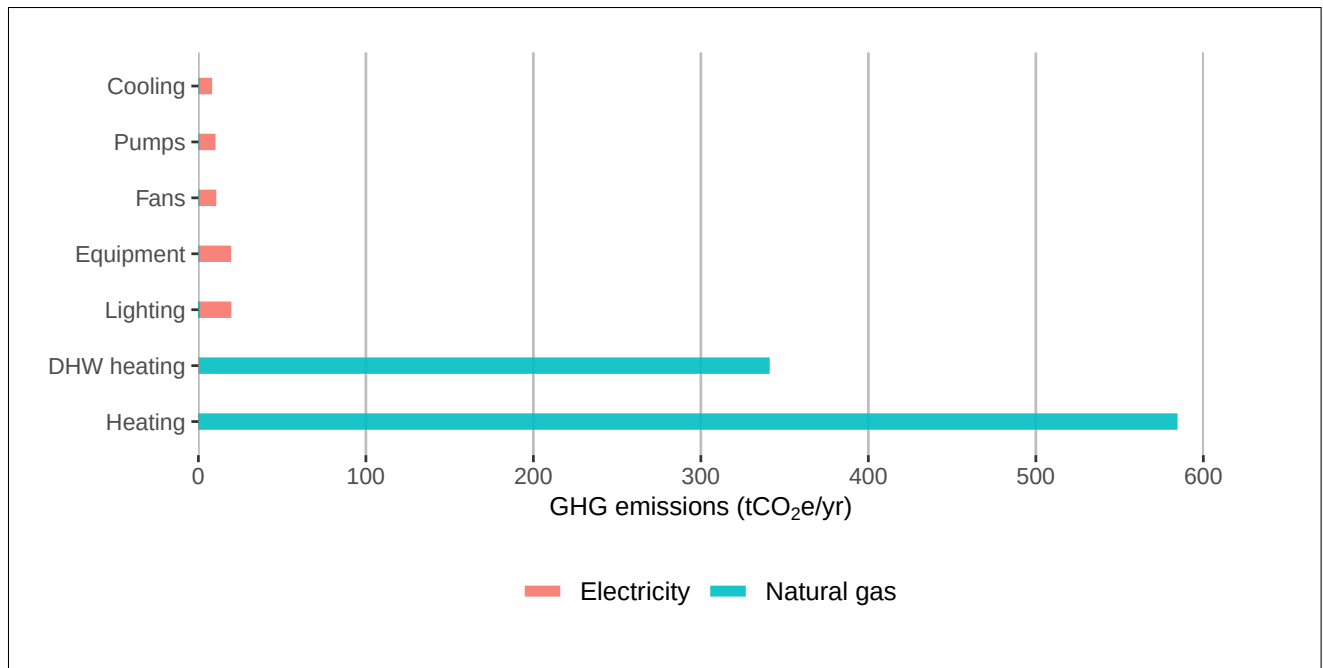


Figure 11: GHG emissions end use breakdown

Utility cost end uses

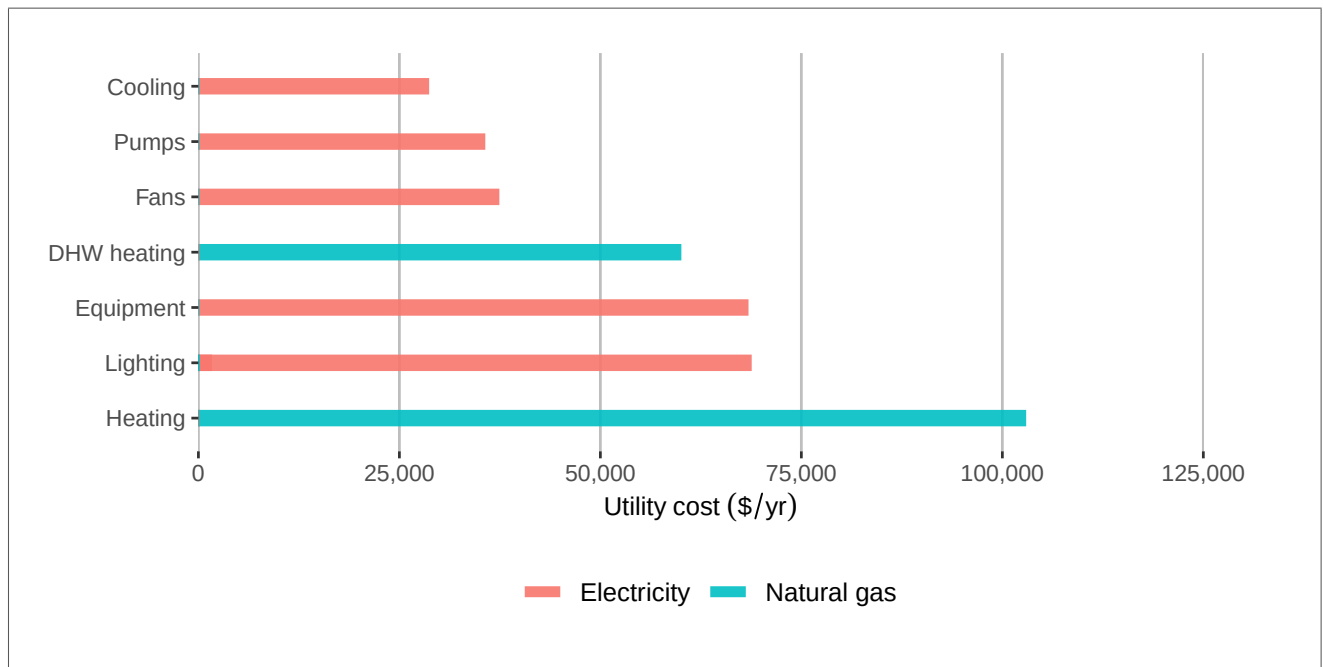


Figure 12: Utility cost end use breakdown

4 MEASURE ANALYSIS

4.1 Measure analysis methodology

The measure analysis is completed according to the following methodology. The intent of the measure analysis is to estimate the implementation project cost and expected impact on utility use, GHG emissions and utility cost for each measure analyzed.

1. **Measure analysis.** All measures are analyzed and the analysis is summarized in a dedicated report Subsection, within Section 4, for that measure. Each measure analysis addresses the following.
 - **Measure description:** The existing condition, recommended action, and utility-savings mechanism of the measure are described.
 - **Measure details:** Details of the measure are provided, including a design overview and project cost estimate.
 - **Utility analysis:** The impacts on electricity and natural gas utility use are estimated via energy modeling; measure-specific methodologies and assumptions are noted in the dedicated report Subsection for that measure. Associated impacts on GHG emissions and utility cost are estimated based on assumptions listed in Table 9.
 - **Final recommendation:** The final recommendation (either Preferred, Nonpreferred, or Moderate) for each measure is determined based on the results of the measure analysis, and the overall intent of the project.

4.2 Air-source VRF

Measure description

Existing condition

Heating and cooling are assumed to be performed via a four-pipe fan-coil system served by a natural gas-fired boiler plant and a chilled water plant.

Recommended action

Provide heating and cooling through an air-source VRF system. Note, this measure is presented as an option to reduce the absolute GHG emissions of the facility. As such, it is compared with the baseline four-pipe fan-coil system (SB-10 procedures would require the baseline building to be redefined and remodeled as packaged terminal heat pump (for residence) and packaged rooftop heat pump (for office); however, in this analysis, baseline systems are maintained as four-pipe fan-coil). Nevertheless, it is recommended as an optional measure due to its energy-efficiency and reduction in GHG emissions.

Utility-savings mechanism

Reduced natural gas use through fuel-switching to an electrically-energized system that takes advantage of co-efficients of performance to improve energy-efficiency. Electricity use is expected to increase due to the electrification of the heating system.

Measure details

Project cost estimate

Incremental project costs are estimated assuming approximately 3,000 \$/suite in the residential space and 2,000 \$/ton in the office space. These cost rates are derived to reflect the incremental project cost relative to the baseline four-pipe fan-coil system. Project cost estimates are derived from detailed cost estimates for similar projects.

Table 11: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	752,000
Total	[\$]	752,000

Utility analysis

Baseline heating and cooling to the residential building and the retail and office spaces were assumed to be provided by a four-pipe fan-coil unit served by natural gas fired boilers and a chilled water plant. Proposed heating and cooling systems were modeled as air-source VRF in eQUEST.

Analysis results are summarized in the following table.

Table 12: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,972,275	-240,769	-14
	Electricity peak (avg)	[kW]	303	368	-65	-21
	Natural gas use	[m3/yr]	484,662	334,196	150,466	31
GHG emissions	Electricity GHG emissions	[tCO2e/yr]	69	79	-10.0	-14
	Natural gas GHG emissions	[tCO2e/yr]	926	638	288	31
	Total GHG emissions	[tCO2e/yr]	995	717	278	28
Utility cost	Electricity utility cost	[\$/yr]	242,411	276,118	-33,707	-14
	Natural gas utility cost	[\$/yr]	126,012	86,891	39,121	31
	Federal carbon charge	[\$/yr]	37,028	25,533	11,495	31
	Total utility cost	[\$/yr]	405,451	388,542	16,909	4.2
Financial	Total project cost	[\$]	-	752,000	-	-
	Simple payback period	[yr]	-	44	-	-

Final recommendation

Moderate

4.3 Decentralized ventilation

Measure description

Existing condition

Ventilation to the residence is assumed to be provided through a centralized makeup air unit. Distribution is assumed to be via pressurized corridors.

Recommended action

Rather than providing centralized ventilation to the residential dwelling units, install a dedicated ERV in each individual dwelling unit. ERV can be ducted into the return of the fan coil units. Provide various speed controls to allow tenants to adjust ventilation rates.

Utility-savings mechanism

Not applicable.

Measure details

Project cost estimate

Incremental project costs are estimated assuming approximately 2,000 \$/suite; this measure applies only to the residential suites. Project cost estimates are derived from detailed cost estimates for similar projects.

Table 13: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	436,000
Total	[\$]	436,000

Utility analysis

Baseline ventilation was assumed to be provided through a centralized, constant volume makeup air unit with no heat recovery. Proposed ventilation was assumed to be provided to residential spaces through energy recovery ventilators with an effectiveness of 50%.

Analysis results are summarized in the following table.

Table 14: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,688,236	43,270	2.5
	Electricity peak (avg)	[kW]	303	296	7.0	2.3
	Natural gas use	[m3/yr]	484,662	394,097	90,565	19
GHG emissions	Electricity GHG emissions	[tCO2e/yr]	69	68	1.00	1.4
	Natural gas GHG emissions	[tCO2e/yr]	926	753	173	19
	Total GHG emissions	[tCO2e/yr]	995	820	175	18
Utility cost	Electricity utility cost	[\$/yr]	242,411	236,353	6,058	2.5
	Natural gas utility cost	[\$/yr]	126,012	102,465	23,547	19
	Federal carbon charge	[\$/yr]	37,028	30,109	6,919	19
	Total utility cost	[\$/yr]	405,451	368,927	36,524	9.0
Financial	Total project cost	[\$]	-	436,000	-	-
	Simple payback period	[yr]	-	12	-	-

Final recommendation

Preferred

4.4 DHW heat recovery heat pump

Measure description

Existing condition

The baseline DHW heating is assumed to be provided solely by natural gas fired DHW heaters.

Recommended action

Provide a DHW heat recovery heat pump to recovery waste heat from DHW drained from the residential dwelling units. Note, this measure is presented as an option to reduce the absolute GHG emissions of the facility, and is not expected to reduce the annual utility cost, nor peak electricity demand, due to the partial electrification of the DHW heating system. Nevertheless, it is recommended as an optional measure due to its energy-efficiency and reduction in GHG emissions.

Utility-savings mechanism

Reduced DHW heating natural gas consumption; increased DHW heating electricity consumption.

Measure details

Project cost estimate

Incremental project costs are estimated based on equipment budget cost estimates from suppliers for the required equipment multiplied by 2, to account for installation, contingencies, etc.

Table 15: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	1,750,000
Total	[\$]	1,750,000

Utility analysis

Baseline DHW heating is assumed to be provided solely by natural gas fired DHW heaters. Proposed DHW heating is assumed to be provided partly by natural gas, and partly by electrically-powered heat-recovery heat pumps.

Analysis results are summarized in the following table.

Table 16: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	2,183,192	-451,686	-26
	Electricity peak (avg)	[kW]	303	360	-57	-19
	Natural gas use	[m3/yr]	484,662	352,159	132,503	27
GHG emissions	Electricity GHG emissions	[tCO2e/yr]	69	87	-18	-26
	Natural gas GHG emissions	[tCO2e/yr]	926	673	253	27
	Total GHG emissions	[tCO2e/yr]	995	760	235	24
Utility cost	Electricity utility cost	[\$/yr]	242,411	305,647	-63,236	-26
	Natural gas utility cost	[\$/yr]	126,012	91,561	34,451	27
	Federal carbon charge	[\$/yr]	37,028	26,905	10,123	27
	Total utility cost	[\$/yr]	405,451	424,113	-18,662	-4.6
Financial	Total project cost	[\$]	-	1,750,000	-	-
	Simple payback period	[yr]	-	-94	-	-

Final recommendation

Moderate

4.5 Exterior wall insulation enhancement

Measure description

Existing condition

The exterior wall assembly U-value is assumed to be 0.048 (or R21; SB-10 minimum).

Recommended action

Provide enhanced insulation with respect to SB-10 minimum values.

Utility-savings mechanism

Reduced heating energy use due to reduced thermal conduction through the envelope.

Measure details

Project cost estimate

Incremental project costs are estimated assuming that the primary additional cost is associated to the additional quantity and installation of insulation. Installed costs are estimated assuming 0.5 \$/ft² per R-value.

Table 17: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	282,870
Total	[\$]	282,870

Utility analysis

Baseline insulation value was assumed to be R21; proposed insulation value was assumed to be R30.

Analysis results are summarized in the following table.

Table 18: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,728,956	2,550	0.15
	Electricity peak (avg)	[kW]	303	303	0	0
	Natural gas use	[m ³ /yr]	484,662	481,085	3,577	0.74
GHG emissions	Electricity GHG emissions	[tCO ₂ e/yr]	69	69	0	0
	Natural gas GHG emissions	[tCO ₂ e/yr]	926	919	7.0	0.76
	Total GHG emissions	[tCO ₂ e/yr]	995	988	7.0	0.70
Utility cost	Electricity utility cost	[\$/yr]	242,411	242,054	357	0.15
	Natural gas utility cost	[\$/yr]	126,012	125,082	930	0.74
	Federal carbon charge	[\$/yr]	37,028	36,755	273	0.74
	Total utility cost	[\$/yr]	405,451	403,891	1,560	0.38
Financial	Total project cost	[\$]	-	282,870	-	-
	Simple payback period	[yr]	-	181	-	-

Final recommendation

Nonpreferred

4.6 Infiltration mitigation

Measure description

Existing condition

The rate of infiltration through the envelope was assumed to be 0.069 cfm/ft² of exterior envelope surface area. This number is considered reasonable for a new construction, based on research performed by RWDI.

Recommended action

Mitigate infiltration through the envelope through the use of spray-foam insulation and provision of sealing adhesive materials at construction transitions; as an alternative to adhesive, spray air-barriers (e.g. AeroBarrier) may be used. Perform building leakage testing in accordance with ASTM E779 (this testing is necessary to account for the energy-savings associated with this measure under SB-10).

Utility-savings mechanism

Reduced heating energy use due to reduced infiltration through the envelope.

Measure details

Project cost estimate

Incremental project costs are estimated assuming 1,200 \$/suite, which is estimated based on the application of AeroBarrier technology.

Table 19: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	261,600
Total	[\$]	261,600

Utility analysis

Baseline infiltration rate was assumed to be 0.069 cfm/ft² of exterior envelope surface area. Proposed infiltration rate is assumed to be reduced by 50% relative to the baseline infiltration rate.

Analysis results are summarized in the following table.

Table 20: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,721,201	10,305	0.60
	Electricity peak (avg)	[kW]	303	302	1.00	0.33
	Natural gas use	[m ³ /yr]	484,662	456,289	28,373	5.9
GHG emissions	Electricity GHG emissions	[tCO ₂ e/yr]	69	69	0	0
	Natural gas GHG emissions	[tCO ₂ e/yr]	926	872	54	5.8
	Total GHG emissions	[tCO ₂ e/yr]	995	940	55	5.5
Utility cost	Electricity utility cost	[\$/yr]	242,411	240,968	1,443	0.60
	Natural gas utility cost	[\$/yr]	126,012	118,635	7,377	5.9
	Federal carbon charge	[\$/yr]	37,028	34,860	2,168	5.9
	Total utility cost	[\$/yr]	405,451	394,464	10,987	2.7
Financial	Total project cost	[\$]	-	261,600	-	-
	Simple payback period	[yr]	-	24	-	-

Final recommendation

Preferred

4.7 Lighting optimization (res corridors)

Measure description

Existing condition

The baseline corridor lighting is assumed to have a lighting power density (LPD) of 0.68 W/ft² (SB-10 maximum prescriptive value) and to operate at full level 24/7.

Recommended action

Provide LED lights and occupancy controls to enable lighting levels to be reduced when occupancy is not detected.

Utility-savings mechanism

Reduced lighting energy use through improved efficiency of LEDs and the reduced average lighting level due to occupancy controls.

Measure details

Project cost estimate

Incremental project costs are estimated assuming the incremental cost of the lighting system is 5 \$/ft² of corridor floor area; this measure applies only to the residential corridor spaces. Project cost estimates are derived from detailed cost estimates for similar projects.

Table 21: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	70,000
Total	[\$]	70,000

Utility analysis

Baseline corridor lighting is assumed to have a lighting power density (LPD) of 0.68 W/ft² (SB-10 maximum prescriptive value) and to operate at full level 24/7. Proposed lighting power density (LPD) is assumed to be 0.48 W/ft² (30% reduction) due to LEDs and lighting fraction schedule is assumed to be reduced by 30% on average due to occupancy controls.

Analysis results are summarized in the following table.

Table 22: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,689,761	41,745	2.4
	Electricity peak (avg)	[kW]	303	298	5.0	1.7
	Natural gas use	[m3/yr]	484,662	487,489	-2,827	-0.58
GHG emissions	Electricity GHG emissions	[tCO ₂ e/yr]	69	68	1.00	1.4
	Natural gas GHG emissions	[tCO ₂ e/yr]	926	931	-5.0	-0.54
	Total GHG emissions	[tCO ₂ e/yr]	995	999	-4.0	-0.40
Utility cost	Electricity utility cost	[\$/yr]	242,411	236,567	5,844	2.4
	Natural gas utility cost	[\$/yr]	126,012	126,747	-735	-0.58
	Federal carbon charge	[\$/yr]	37,028	37,244	-216	-0.58
	Total utility cost	[\$/yr]	405,451	400,558	4,893	1.2
Financial	Total project cost	[\$]	-	70,000	-	-
	Simple payback period	[yr]	-	14	-	-

Final recommendation

Preferred

4.8 Lighting upgrade (rest of bldg)

Measure description

Existing condition

The baseline lighting is assumed to achieve the maximum allowable lighting power densities (LPDs) prescribed by OBC SB-10.

Recommended action

Provide LED lights throughout the building, including the parking garage, retail, office, and residential dwelling units. This is expected to reduce the lighting power density relative to the prescribed OBC SB-10 values.

Utility-savings mechanism

Reduced lighting energy use through improved efficiency of LEDs.

Measure details

Project cost estimate

Incremental project costs are assumed to be negligible, due to the high likelihood that LED lighting is used in any new construction project.

Table 23: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	0
Total	[\$]	0

Utility analysis

Baseline lighting power densities for the parking, retail, office and residential spaces are as stated in Section 2.4. Proposed lighting power densities are assumed to be reduced by 33% for all spaces.

Analysis results are summarized in the following table.

Table 24: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,575,074	156,432	9.0
	Electricity peak (avg)	[kW]	303	277	26	8.6
	Natural gas use	[m3/yr]	484,662	493,926	-9,264	-1.9
GHG emissions	Electricity GHG emissions	[tCO2e/yr]	69	63	6.0	8.7
	Natural gas GHG emissions	[tCO2e/yr]	926	943	-17	-1.8
	Total GHG emissions	[tCO2e/yr]	995	1,006	-11	-1.1
Utility cost	Electricity utility cost	[\$/yr]	242,411	220,510	21,901	9.0
	Natural gas utility cost	[\$/yr]	126,012	128,421	-2,409	-1.9
	Federal carbon charge	[\$/yr]	37,028	37,736	-708	-1.9
	Total utility cost	[\$/yr]	405,451	386,667	18,784	4.6
Financial	Total project cost	[\$]	-	0	-	-
	Simple payback period	[yr]	-	0	-	-

Final recommendation

Preferred

4.9 Low-flow fixtures

Measure description

Existing condition

The baseline residential handwashing and shower faucets are assumed to be standard flow.

Recommended action

Provide low-flow handwashing faucet aerators and low-flow shower heads to reduce DHW consumption.

Utility-savings mechanism

Reduced DHW heating through reduced consumption of DHW.

Measure details

Project cost estimate

Incremental project costs are assumed to be negligible, as standard- and low-flow fixtures are typically similar in cost.

Table 25: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	0
Total	[\$]	0

Utility analysis

Typical standard handwashing faucets and shower heads have flow rates of roughly 2 gpm; typical low-flow handwashing faucet aerators and shower heads are 1 gpm and 1.5 gpm, respectively. For the energy analysis, the consumption of domestic hot water in the residence was assumed to be reduced by 25% relative to the baseline scenario.

Analysis results are summarized in the following table.

Table 26: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,731,506	0	0
	Electricity peak (avg)	[kW]	303	303	0	0
	Natural gas use	[m3/yr]	484,662	454,523	30,139	6.2
GHG emissions	Electricity GHG emissions	[tCO2e/yr]	69	69	0	0
	Natural gas GHG emissions	[tCO2e/yr]	926	868	58	6.3
	Total GHG emissions	[tCO2e/yr]	995	937	58	5.8
Utility cost	Electricity utility cost	[\$/yr]	242,411	242,411	0	0
	Natural gas utility cost	[\$/yr]	126,012	118,176	7,836	6.2
	Federal carbon charge	[\$/yr]	37,028	34,726	2,302	6.2
	Total utility cost	[\$/yr]	405,451	395,312	10,139	2.5
Financial	Total project cost	[\$]	-	0	-	-
	Simple payback period	[yr]	-	0	-	-

Final recommendation

Preferred

4.10 Roof insulation enhancement

Measure description

Existing condition

The roof assembly U-value was assumed to be 0.029 (or R34; SB-10 minimum).

Recommended action

Provide enhanced insulation with respect to SB-10 minimum values.

Utility-savings mechanism

Reduced heating energy use due to reduced thermal conduction through the envelope.

Measure details

Project cost estimate

Incremental project costs are estimated assuming that the primary additional cost is associated to the additional quantity and installation of insulation. Installed costs are estimated assuming 0.25 \$/ft² per R-value.

Table 27: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	35,190
Total	[\$]	35,190

Utility analysis

Baseline insulation value was assumed to be R34; proposed insulation value was assumed to be R40.

Analysis results are summarized in the following table.

Table 28: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,730,655	851	0.05
	Electricity peak (avg)	[kW]	303	303	0	0
	Natural gas use	[m3/yr]	484,662	483,863	799	0.16
GHG emissions	Electricity GHG emissions	[tCO ₂ e/yr]	69	69	0	0
	Natural gas GHG emissions	[tCO ₂ e/yr]	926	924	2.0	0.22
	Total GHG emissions	[tCO ₂ e/yr]	995	993	2.0	0.20
Utility cost	Electricity utility cost	[\$/yr]	242,411	242,292	119	0.05
	Natural gas utility cost	[\$/yr]	126,012	125,804	208	0.17
	Federal carbon charge	[\$/yr]	37,028	36,967	61	0.16
	Total utility cost	[\$/yr]	405,451	405,063	388	0.10
Financial	Total project cost	[\$]	-	35,190	-	-
	Simple payback period	[yr]	-	91	-	-

Final recommendation

Nonpreferred

4.11 Solar PV

Measure description

Existing condition

Under existing conditions, it is assumed that there is no solar PV.

Recommended action

Provide rooftop solar PV.

Utility-savings mechanism

Reduced grid electricity use through on-site electricity generated by the solar PV system.

Measure details

Project cost estimate

Incremental project costs are estimated assuming a cost rate of 3 \$/Watt (installed), which is typical in the industry.

Table 29: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	321,000
Total	[\$]	321,000

Utility analysis

Analysis was performed using an hourly solar PV modeling software called Helioscope. Within the software, a solar PV system was modeled assuming that it is located on the building rooftop.

Analysis results are summarized in the following table.

Table 30: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,644,131	87,375	5.0
	Electricity peak (avg)	[kW]	303	295	8.0	2.6
	Natural gas use	[m3/yr]	484,662	484,662	0	0
GHG emissions	Electricity GHG emissions	[tCO2e/yr]	69	66	3.0	4.3
	Natural gas GHG emissions	[tCO2e/yr]	926	926	0	0
	Total GHG emissions	[tCO2e/yr]	995	991	4.0	0.40
Utility cost	Electricity utility cost	[\$/yr]	242,411	230,178	12,233	5.0
	Natural gas utility cost	[\$/yr]	126,012	126,012	0	0
	Federal carbon charge	[\$/yr]	37,028	37,028	0	0
	Total utility cost	[\$/yr]	405,451	393,219	12,232	3.0
Financial	Total project cost	[\$]	-	321,000	-	-
	Simple payback period	[yr]	-	26	-	-

Final recommendation

Preferred

4.12 Window-to-wall reduction

Measure description

Existing condition

The baseline window-to-wall ratio is assumed to be 40% (SB-10 maximum prescriptive value).

Recommended action

Reduce window-to-wall ratio. Note, this measure is intended to illustrate the potential energy impact associated with a reduced window-to-wall ratio. Note that reducing the window-to-wall ratio below 40% is not a permissible energy-reduction strategy under SB-10, which stipulates that the baseline building shall have the same window-to-wall ratio as the proposed building, up to a maximum of 40%.

Utility-savings mechanism

Reduced heating energy use due to reduced thermal conduction through the envelope.

Measure details

Project cost estimate

Incremental project costs are assumed to be negligible, assuming that glazed to non-glazed wall constructions have approximately equal material costs.

Table 31: Project cost estimate

Line item	Unit	Value
Incremental project cost (installed)	[\$]	0
Total	[\$]	0

Utility analysis

Baseline window-to-wall ratio was assumed to be 40%, per SB-10. Proposed window-to-wall ratio was assumed to be 30%.

Analysis results are summarized in the following table.

Table 32: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use from grid	[kWh/yr]	1,731,506	1,696,584	34,922	2.0
	Electricity peak (avg)	[kW]	303	296	7.0	2.3
	Natural gas use	[m3/yr]	484,662	473,163	11,499	2.4
GHG emissions	Electricity GHG emissions	[tCO2e/yr]	69	68	1.00	1.4
	Natural gas GHG emissions	[tCO2e/yr]	926	904	22	2.4
	Total GHG emissions	[tCO2e/yr]	995	972	23	2.3
Utility cost	Electricity utility cost	[\$/yr]	242,411	237,522	4,889	2.0
	Natural gas utility cost	[\$/yr]	126,012	123,022	2,990	2.4
	Federal carbon charge	[\$/yr]	37,028	36,150	878	2.4
	Total utility cost	[\$/yr]	405,451	396,694	8,757	2.2
Financial	Total project cost	[\$]	-	0	-	-
	Simple payback period	[yr]	-	0	-	-

Final recommendation

Nonpreferred

4.13 Additional measures

Additional measures that were considered are as follows. These measures were not analyzed in detail, however, because they are not expected to affect the targeted energy-efficiency improvement of 15% relative to OBC SB-10.

- **Electric vehicle charging stations.** This presents an opportunity to reduce GHG emissions associated with tenant commuting, by enabling availability of electric-vehicle charging on-site
- **Backup electricity generation systems.** Backup electricity generation systems are typically provided by fossil-fuels. Opportunities exist to utilize less GHG-intensive, or more energy-efficient energy sources (e.g. hydrogen (technology still considered in development), combined heat and power (CHP), etc).
- **District energy distribution.** District energy distribution provides an opportunity to optimize energy-system maintenance and efficiency by creating a centralized energy distribution system that serves a district of buildings including Regina/Erb and surrounding facilities.
- **Geo-exchange heating / cooling.** Geo-exchange is believed to be unfeasible at Regina/Erb based on a preliminary review of regulatory and ground conditions.

5 SUMMARY

The utility use baseline and measure analysis results for Regina/ErB are summarized in Table 33. All measures labeled 'Go' are recommended for implementation to achieve the targeted improvement in energy-efficiency of 15% relative to the OBC SB-10 (recall that electricity peak demand, GHG emissions and utility cost must all be improved by 15% relative to the baseline).

Table 33: Summary of recommended measures

Measure name	Final recommendation	Electricity use from grid	Grid electricity use reduction	Electricity peak reduction	Natural gas use	Natural gas use reduction	Total GHG emissions	GHG emissions reduction	Total utility cost	Utility cost reduction	Total project cost	Simple payback period
-	-	[kWh/yr]	[%]	[%]	[m3/yr]	[%]	[tCO2e/yr]	[%]	[\$/yr]	[%]	[\$]	[yr]
Baseline		1,731,506	0.0	0.0	484,662	0.0	995.0	0.0	405,451	0.0	-	-
Solar PV	Preferred	1,644,131	5.0	2.6	484,662	0.0	991.5	0.4	393,219	3.0	321,000	26.2
Decentralized ventilation	Preferred	1,688,236	2.5	2.4	394,097	18.7	820.3	17.6	368,927	9.0	436,000	11.9
Infiltration mitigation	Preferred	1,721,201	0.6	0.5	456,289	5.9	940.4	5.5	394,464	2.7	261,600	23.8
Lighting optimization (res corridors)	Preferred	1,689,761	2.4	1.7	487,489	-0.6	998.7	-0.4	400,558	1.2	70,000	14.3
Lighting upgrade (rest of bldg)	Preferred	1,575,074	9.0	8.7	493,926	-1.9	1,006.4	-1.1	386,667	4.6	0	0.0
Low-flow fixtures	Preferred	1,731,506	-0.0	0.0	454,523	6.2	937.4	5.8	395,312	2.5	0	0.0
Exterior wall insulation enhancement	Nonpreferred	1,728,956	0.1	0.1	481,085	0.7	988.0	0.7	403,891	0.4	282,870	181.0
Roof insulation enhancement	Nonpreferred	1,730,655	0.0	0.1	483,863	0.2	993.4	0.2	405,063	0.1	35,190	90.7
Window-to-wall reduction	Nonpreferred	1,696,584	2.0	2.3	473,163	2.4	971.6	2.3	396,694	2.2	0	0.0
Air-source VRF	Moderate	1,972,275	-13.9	-21.3	334,196	31.0	717.2	27.9	388,542	4.2	752,000	44.5
DHW heat recovery heat pump	Moderate	2,183,192	-26.1	-18.9	352,159	27.3	760.0	23.6	424,113	-4.6	1,750,000	-93.8