GREENHOUSE GAS REDUCTION FEASIBILITY STUDY

CITY OF CAMBRIDGE

EXECUTIVE SUMMARY

WalterFedy Project No: 2024-0016-10

June 5, 2025

WALTERFEDY

Project Number: 2024-0016-10

June 5, 2025

Ryan Hoeksma
Energy and Sustainability
Specialist City of Cambridge
50 Dickson Street
Cambridge, ON N1R
5W8

Dear Ryan Hoeksma,

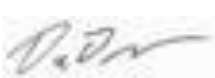
RE: Greenhouse Gas Reduction Feasibility Study

WalterFedy is pleased to submit the attached Executive Summary report to the City of Cambridge. This report provides aggregated results of the scenario analyses of the 10 City facilities examined in the GHG Reduction Feasibility Study.

Based on the information provided by the City of Cambridge, WalterFedy completed the report with the data supplied and collected, engineering judgment and various analysis tools to arrive at the final recommendations.

All of which is respectfully submitted,

WALTERFEDY



David Brodrecht, P.Eng.
Senior Geothermal
Engineer Energy and
Carbon Solutions

dbrodrecht@walterfedy.
com 519 465 0791

Project overview

WalterFedy was engaged by the City of Cambridge to complete a Greenhouse Gas (GHG) Emissions Reduction Feasibility Study focusing on the City's 10 highest emitting facilities. These facilities included:

- Allan Reuter Centre and Fire Station 3
- Bishop Operations Centre
- Cambridge City Hall
- David Durward Centre and Cambridge Centre for the Arts
- Dickson Centre Arena
- Duncan McIntosh Arena
- Galt Arena Gardens
- Hespeler Memorial Arena
- Queens Square Library
- WG Johnson Centre

This project aimed to identify a recommended GHG Reduction Pathway that results in a 50% reduction within 10 years and an 80% reduction within 20 years for each facility. To achieve this objective, WalterFedy and the City's staff collaborated on the following steps:

1. **Facility Description**. The existing conditions of each facility were reviewed through available documentation, and site surveys were completed in the summer of 2024 to gain an understanding of the facilities and their operations.
2. **Baseline data**. Metered utility data provided by the City was reviewed to understand historical utility use trends and to establish the utility use baseline for each facility.
3. **Air tightness testing**. Air tightness testing was completed at 7 of the facilities. The air tightness results informed the baseline envelope performance in the energy model.
4. **Energy Model Calibration**. A calibrated energy model was developed for each facility from a bottom-up hourly analysis considering historical weather patterns and the insight gained from reviewing each facility's existing conditions and historical utility use data.
5. **Design Workshop**. WalterFedy presented a series of workshops to the City's stakeholders to provide a progress review of the preceding steps and to discuss overall measures to be considered at each site. This forum was invaluable in prioritizing what measures to consider at each building.
6. **Measure Analysis**. Measures intended to achieve the City's goals were identified and analyzed. The analysis includes conceptual design development and utility analysis and quantifying utility use impacts, GHG emissions, and utility costs for each measure.
7. **Scenario Analysis**. A scenario analysis was completed to estimate the costs and benefits expected from implementing various combinations (i.e. scenarios) of the measures individually analyzed, accounting for the interactive effects between measures within each scenario. At a minimum, the following scenarios were considered for each facility examined:

- **Business as Usual:** To follow the existing capital renewal plan and replace equipment with like-for-like equipment at the end of its life, meeting minimum energy-efficiency requirements of ASHRAE 90.1.
- **Comprehensive**: To understand the limit of GHG reductions possible by implementing all measures with the greatest reduction on GHG emissions that are mutually exclusive.
- **Federation of Canadian Municipalities (FCM) Minimum Performance**: To achieve a 50% reduction in operational GHG emissions within 10 years and 80% within 20 years. This scenario addresses the minimum performance scenario of the FCM Community Buildings Retrofit (CBR) funding program. The project timeline for this scenario intends to align with the existing capital renewal plan as applicable, without impairing the ability to achieve the specified GHG reduction targets.
- **Short-Term Deep Retrofit**: To implement the same measures as in the FCM Minimum Performance scenario but within five years.
- **Asset Management**: To follow the existing capital renewal plan and replace equipment with a low GHG alternative.

8. **Decision Making Workshop**. WalterFedy presented a series of workshops to the City's stakeholders to provide the results of each scenario considered. The stakeholders provided feedback on the overall approach of implementation for each scenario and their preferred recommended scenario to proceed with.
9. **Finalize study**. WalterFedy then implemented the feedback collected in the Decision Making Workshop, and each building's analysis was submitted for review by the City's staff. Additional feedback was then provided by the City's staff on the draft reports, and WalterFedy finalized the study.
10. **Executive Summary and Council Presentation**. WalterFedy prepared this executive summary report to highlight the overall results when considering all facilities together and present it to the Cambridge City Council.

Project themes

The following section is intended to reveal findings and general themes identified throughout the project. These include the following:

- Project intent and how the information will be used moving forward
- Energy conservation measure identification
- Financial implications
- Net metering for solar photovoltaics (PV)

These items are summarized in the following subsections.

Project Intent

The information provided in this executive summary and the full study is intended to guide City staff in implementing GHG reduction measures to meet the City's overall GHG emissions reduction goals. Though a scenario of measures to be implemented is recommended for each individual facility, it is recommended that City staff diligently review these measures and prioritize those that offer the most benefit, align with each facility's asset management needs, and consider budgetary constraints.

Energy Conservation Measures

Numerous energy conservation measures were identified for the facilities based on the known conditions of the building. Some examples include:

- **Fuel-switching measures**: Converting HVAC systems such as natural gas boilers and furnaces to air-source heat pumps.
- **Efficiency measures**: Low flow water fixtures, lighting replacements to LED.
- **Envelope measures**: Upgrades to the roof, walls, windows and doors.
- **Renewables**: Solar PV systems and geothermal systems.

Each measure was analyzed to determine the impact on utility use, utility cost and GHG emission reductions in the building.

Financial

WalterFedy, along with the City's staff, has identified a variety of measures for reducing GHG emissions across its project portfolio. Among these measures, energy efficiency measures tend to be more financially viable as they come with lower capital costs and good utility cost savings. However, fuel switching, which typically involves converting equipment from natural gas to electricity, can result in significant reductions in GHG emissions, but it can require significant capital investment with only moderate operational savings. To ensure cost-effectiveness, each recommended scenario is structured to prioritize measures with better financial outcomes early on in the GHG reduction pathway and consider more financially intensive measures towards the end of the equipment's life to reduce overall costs.

Net Metering

Numerous facilities consider solar photovoltaic (PV) measures to offset GHG emissions. A net metering arrangement is the preferred approach to utilize on-site renewable energy, such as solar PV, while maintaining the benefits of being connected to the electricity grid. The infographic below provides an overview of how a net metering arrangement works.

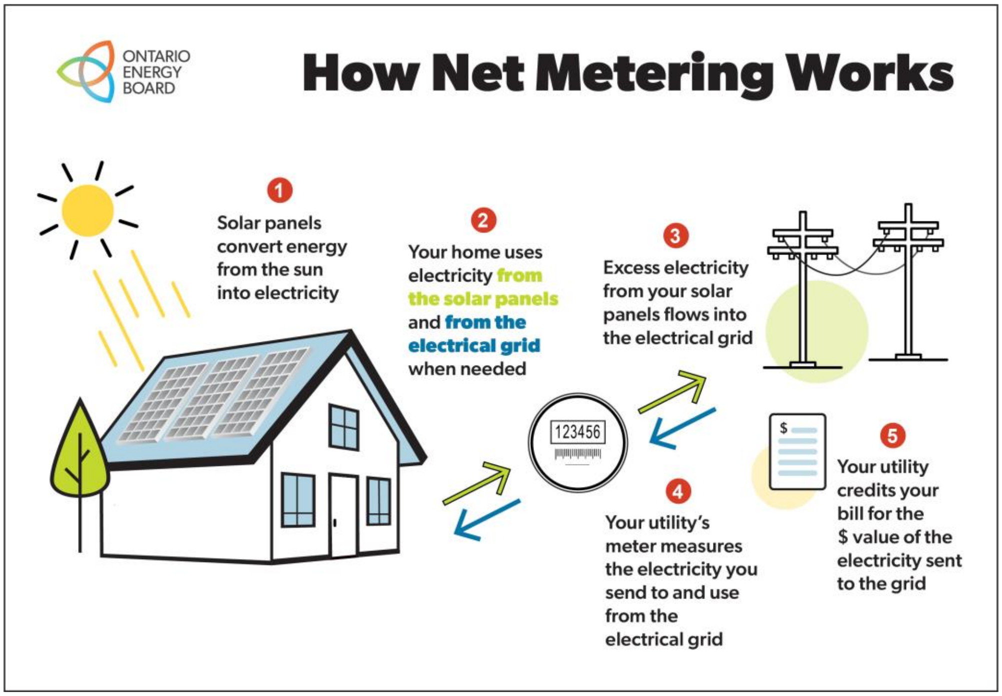


Figure 1: Infographic explaining a net metering arrangement. (source: Ontario Energy Board)

A net metering arrangement has two main states:

- **Generation is greater than facility load**. When the solar PV system generates more electricity than the facility needs, this electricity is exported to the grid for a utility credit. This credit is based on the facility's rate structure and can vary depending on the time of day or season. Furthermore, this credit must be used within a 12-month period; otherwise, it will be reduced to $0.
- **Generation is less than facility load**. When the solar PV system cannot meet the facility's electricity needs, the electricity grid is used to import electricity. If there is a utility credit outstanding, this amount is applied first; if no credit remains, the facility will pay for electricity per its rate structure.

Based on this arrangement, here are some important factors that must be considered:

- It's important to size solar PV systems to output no more than the facility's annual electricity consumption when in a net metering arrangement. Otherwise, the facility will be providing electricity to the grid with no compensation.
- Electricity generated at the facility is currently non-transferable in Ontario to other facilities. However, some jurisdictions in North America allow transferring of electricity to other facilities. This approach is called virtual net metering. There is another form of net metering in Ontario called community net metering (O. Reg. 679/21), similar to virtual net metering. However, this arrangement is only available to one entity at the moment. Furthermore, there is another proposal under consideration to amend O. Reg. 429/04 to allow Class A customers to offset a facility's demand through power purchase agreements (PPA). However, none of the City's facilities within the scope of this project are eligible for the Class A rate structure.
- **If virtual net metering became an option for the City, the constraint on sizing a**

facility's solar PV system would change from the building's annual electricity consumption to the physical area available for placing solar PV arrays.

- Unlike the former Feed-In Tariff (FIT) program, the facility owner retains the solar PV system's environmental attributes. This condition means you can offset your GHG emissions with the facility's power generation

Scenario analysis

The GHG Reduction Feasibility Study focused on the 10 individual facilities, each of which were analyzed individually examining the following five scenarios:

- **Business as Usual**: To follow the existing capital renewal plan and replace equipment with like-for-like equipment at the end of its life, meeting minimum energy-efficiency requirements of ASHRAE 90.1.
- **Comprehensive**: To understand the limit of GHG reductions possible by implementing all measures with the greatest reduction on GHG emissions that are mutually exclusive.
- **Federation of Canadian Municipalities (FCM) Minimum Performance**: To achieve a 50% reduction in operational GHG emissions within 10 years and 80% within 20 years. This scenario addresses the minimum performance scenario of the FCM Community Buildings Retrofit (CBR) funding program. The project timeline for this scenario intends to align with the existing capital renewal plan as applicable, without impairing the ability to achieve the specified GHG reduction targets.
- **Short-Term Deep Retrofit**: To implement the same measures as in the FCM Minimum Performance scenario but within five years.
- **Asset Management**: To follow the existing capital renewal plan and replace equipment with a low GHG alternative.

The following section groups this information from the analyses of the 10 facilities to understand how these facilities would perform together.

Assumptions

An analysis of this calibre requires many assumptions on projecting values of numerous parameters over the period selected (i.e., 2023 to 2050). Particular parameters include, but are not limited to, the following:

- Utility rates
- Utility escalation rates
- Federal carbon charge
- Capital cost
- Replacement cost
- Annual inflation rate
- Technology limitations

These parameters are subject to change and potentially deviate from those used in the scenario analysis. Therefore, it is important to review how these parameters compare going forward periodically.

Scenario analysis discussion

Figures 2 through 21 illustrate how the City's portfolio of buildings will change over time for each scenario per its electricity use, natural use, GHG emissions, and utility costs. A few items to note on how to read these graphs:

- Each figure represents a stacked bar graph depicting the impacts of each scenario over time, in terms of utility consumption, costs and GHG emissions.
- Overlay dotted black lines indicate the 20% reduction, 50% reduction, and 80% from the baseline year of 2023.
- Whenever there is a negative value present (e.g., solar PV generation in the electricity use figure or carbon offsets in GHG emissions), it is shown below the zero mark on the graph. A black box outline represents the net value for that particular year.
- Each graph has a legend at the bottom to identify sub-groups.
- The scenario is noted in the caption of each graph.

Electricity end-use

Figures 2 to 6 present how electricity will change for each scenario. As seen, electricity will either remain the same (Business as Usual scenario) or increase in all other scenarios.

In the Business as Usual (BAU) scenario, electricity is set to remain consistent as it assumes a status quo approach. Though an argument could suggest electricity will increase over time, the intent here is to show how consumption would be if the City maintained the buildings as they are now.

The remaining scenarios will all see a net annual increase in electricity over time. This result is due to electrification via fuel switching from natural gas-fired equipment. However, the increase is not one-to-one, as electrically powered equipment is generally more efficient.

The Comprehensive scenario has the highest solar PV output, while others have slightly less. This result stems from the fact that not all solar PV measures are viable at each location.

There is one acronym used in the legend for electricity, DHW ("Domestic Hot Water").

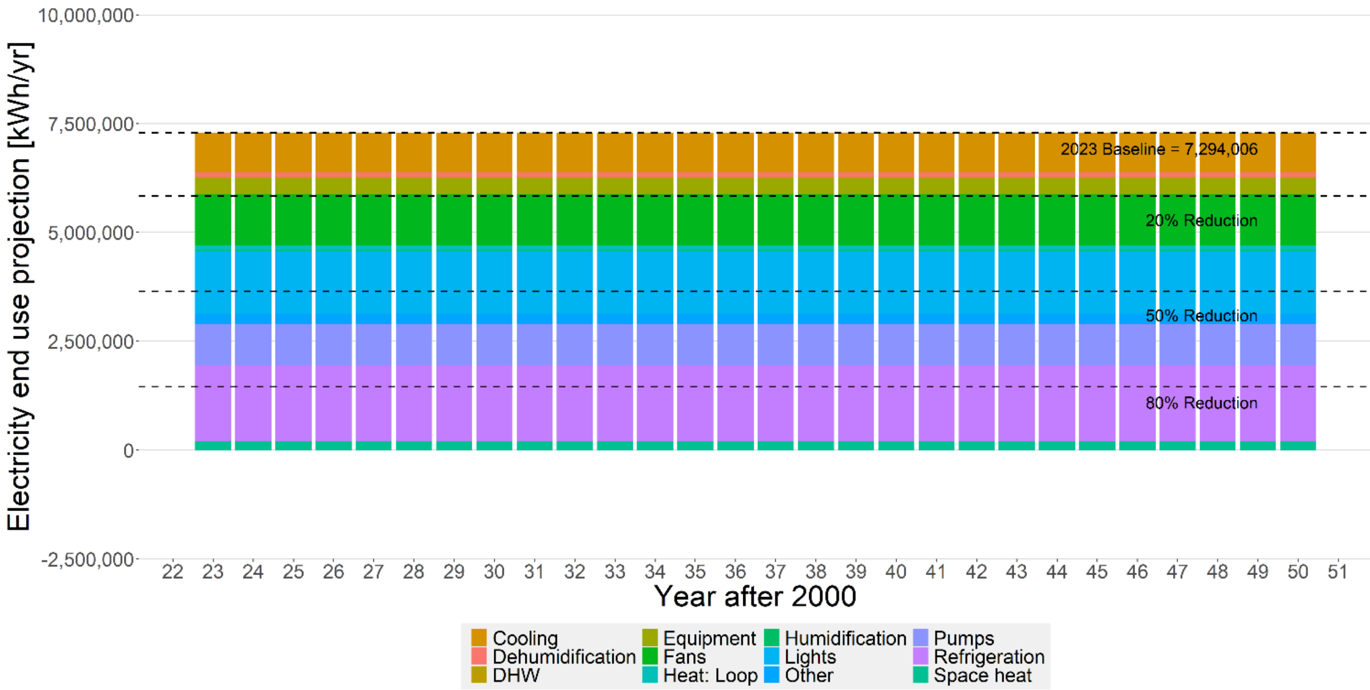


Figure 2: Business as Usual Electricity End Use Projection

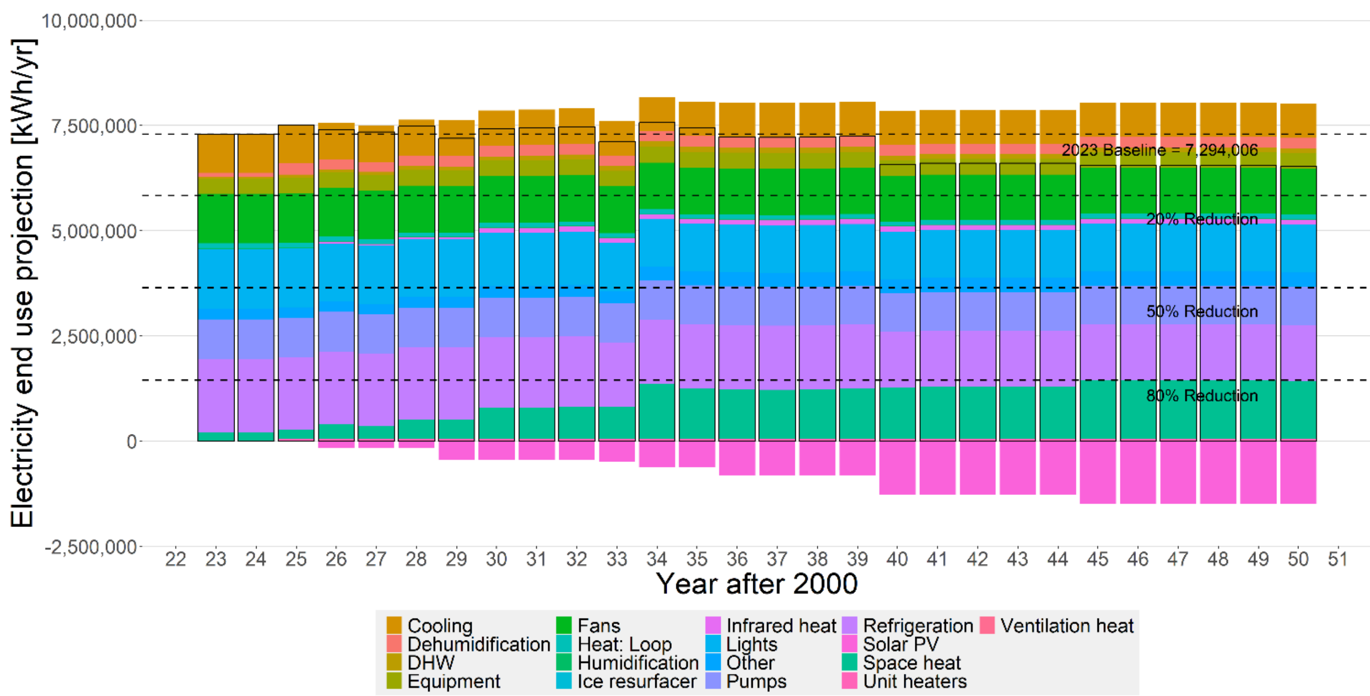


Figure 3: Comprehensive Electricity End Use Projection

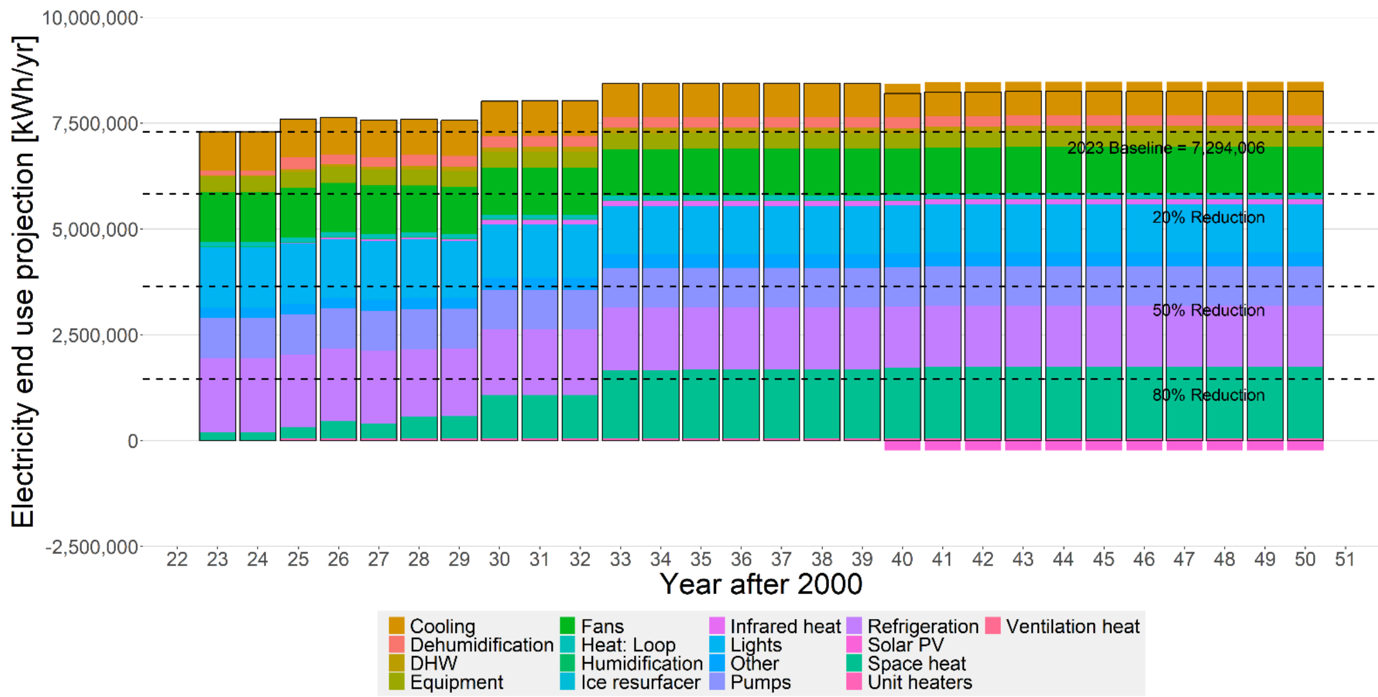


Figure 4: FCM Minimum Performance Electricity End Use Projection

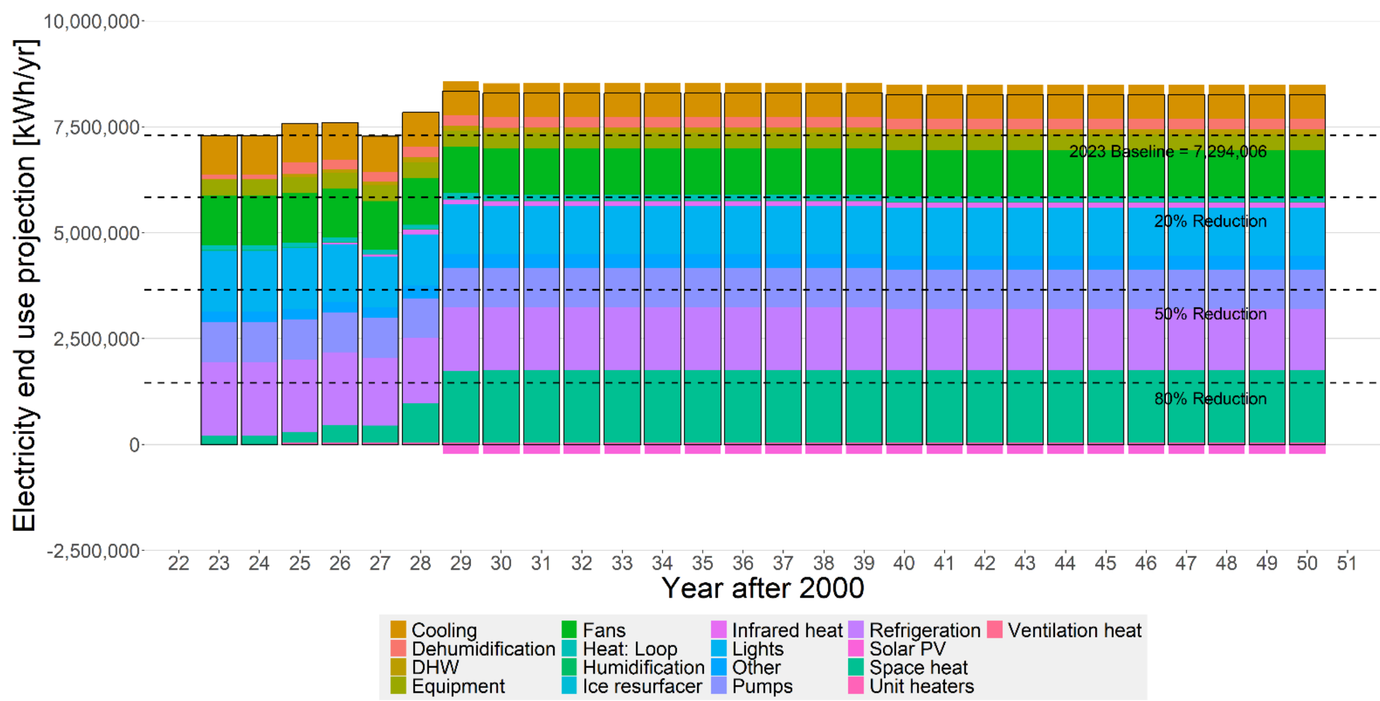


Figure 5: Short Term Deep Retrofit Electricity End Use Projection

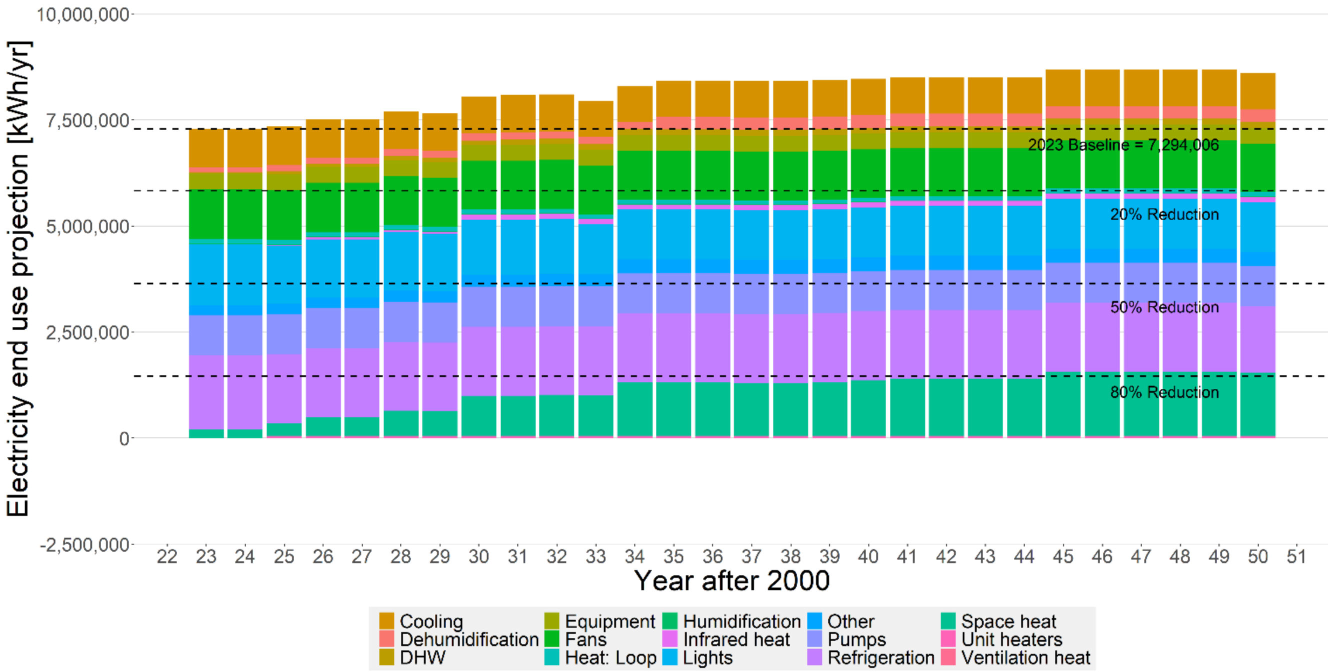


Figure 6: Asset Management Electricity End Use Projection

Natural gas end-use

Figures 7 to 11 present how natural gas will change for each scenario. As seen, natural gas will either remain the same (Business as Usual scenario) or decrease in all other scenarios.

In the BAU scenario, natural gas is set to remain consistent as it assumes a status quo approach. Though an argument could suggest natural gas will increase over time, the intent here is to show how consumption would be if the City maintained the buildings as they are now.

The Comprehensive scenario's natural gas consumption will decrease the most to 5792 m^3 annually. This scenario differs from the remaining scenarios because it uses all theoretically available measures and does not consider overall costs.

The FCM Minimum Performance and the Short Term Deep Retrofit scenarios have the same end result in annual consumption as they consider the same measures, which is approximately 10,863 m^3 annually. However, the Short Term Deep Retrofit scenario has a higher cumulative natural gas savings as all the measures are implemented by 2029.

The term "going the last mile" refers to fully eliminating the use of natural gas at a facility. In certain building types, there typically comes a point where replacing natural gas-fired equipment becomes an overwhelming financial burden (e.g., upgrading electrical services to the building) or compromises building performance (e.g., inability to condition a space properly). This point is unique for all building types and requires an extensive review of applicable measures to ensure the best outcome. This issue is also the reason why natural gas consumption remains within the building portfolio once all measures are implemented.

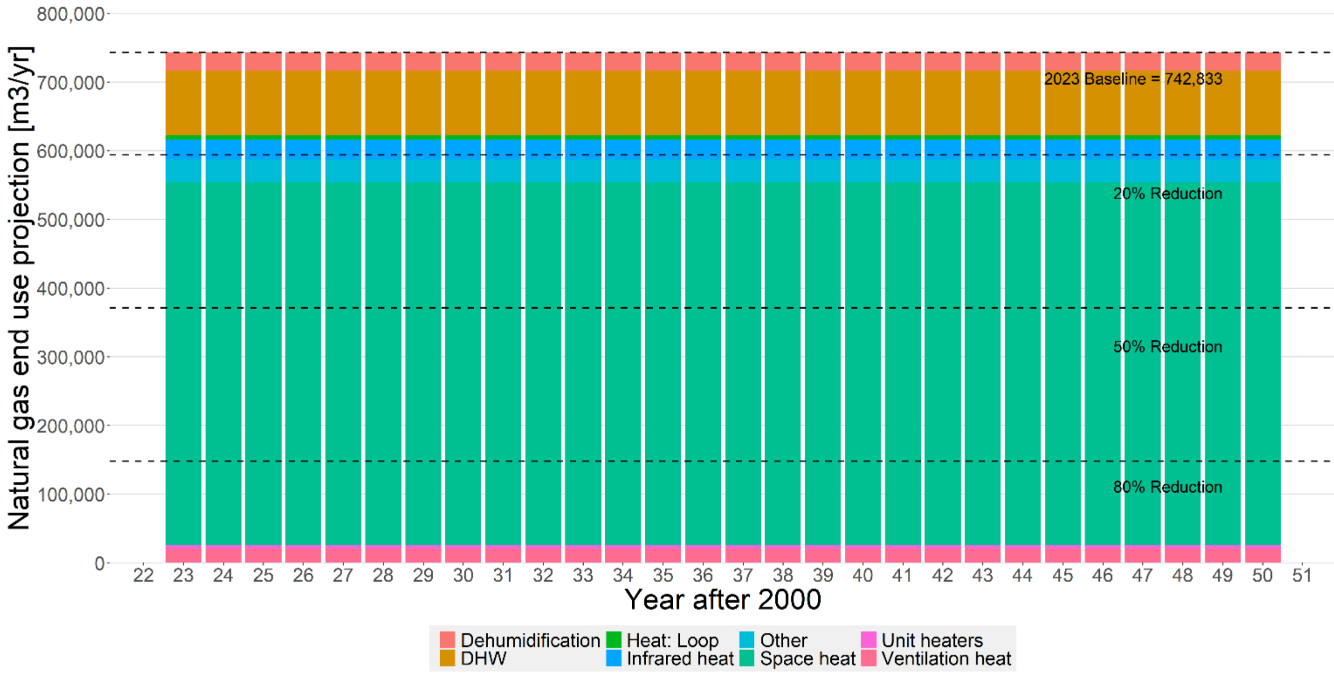


Figure 7: Business as Usual Natural Gas End Use Projection

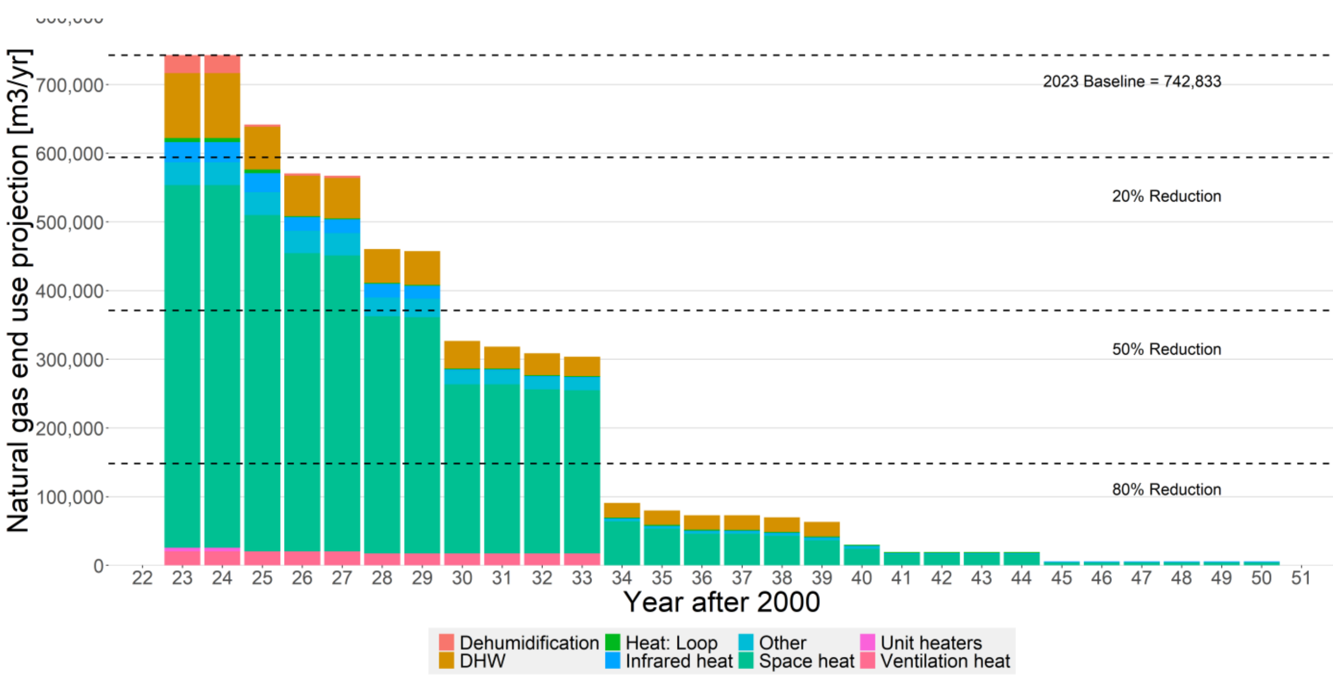


Figure 8: Comprehensive Natural Gas End Use Projection

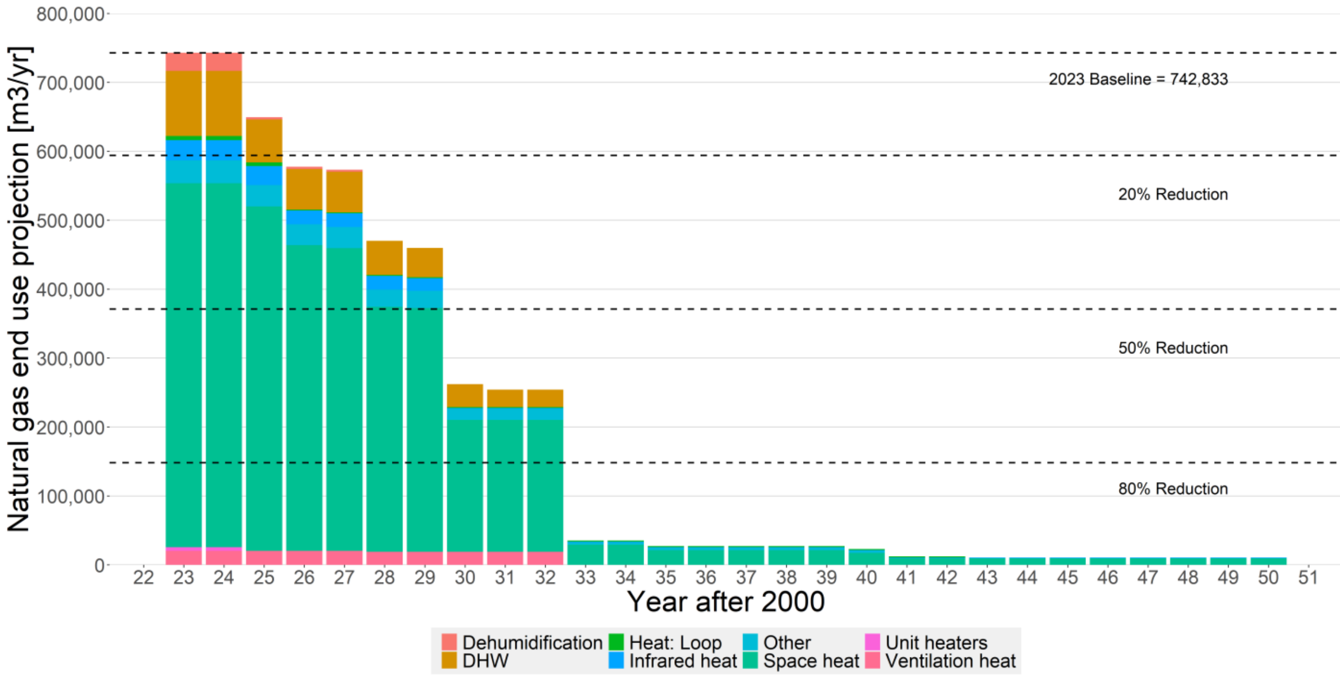


Figure 9: FCM Minimum Performance Natural Gas End Use Projection

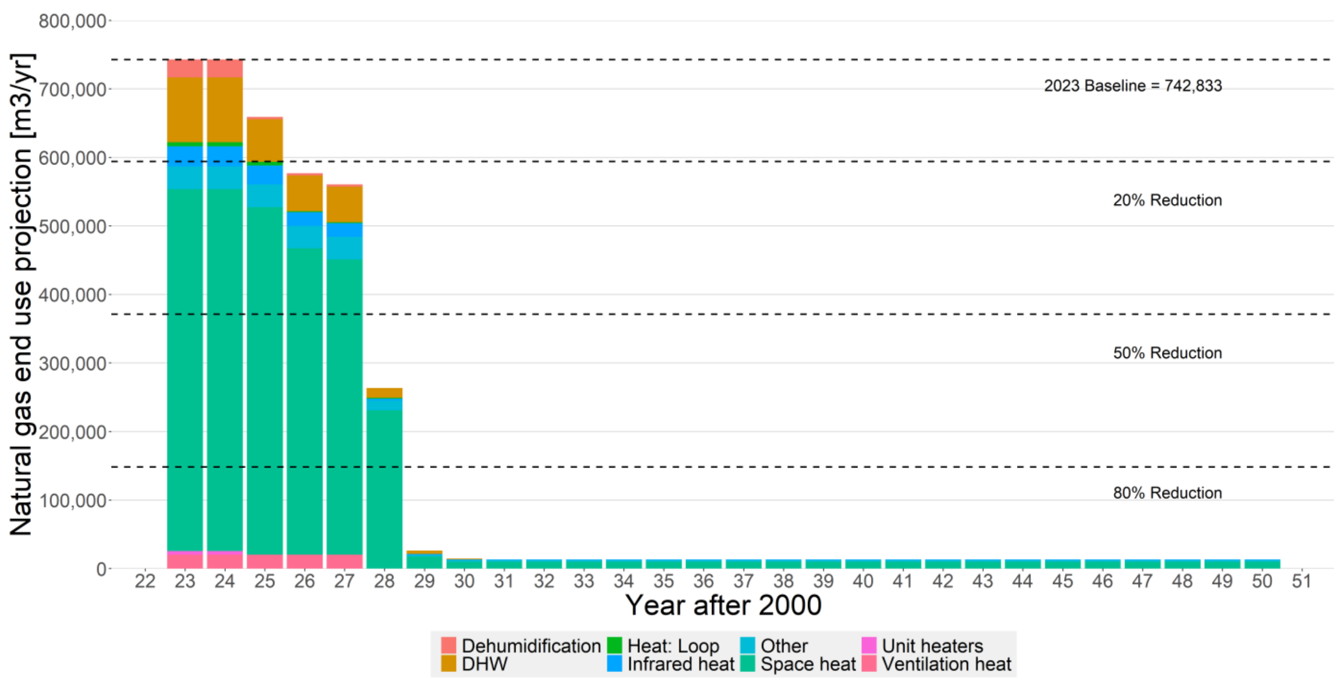


Figure 10: Short Term Deep Retrofit Natural Gas End Use Projection

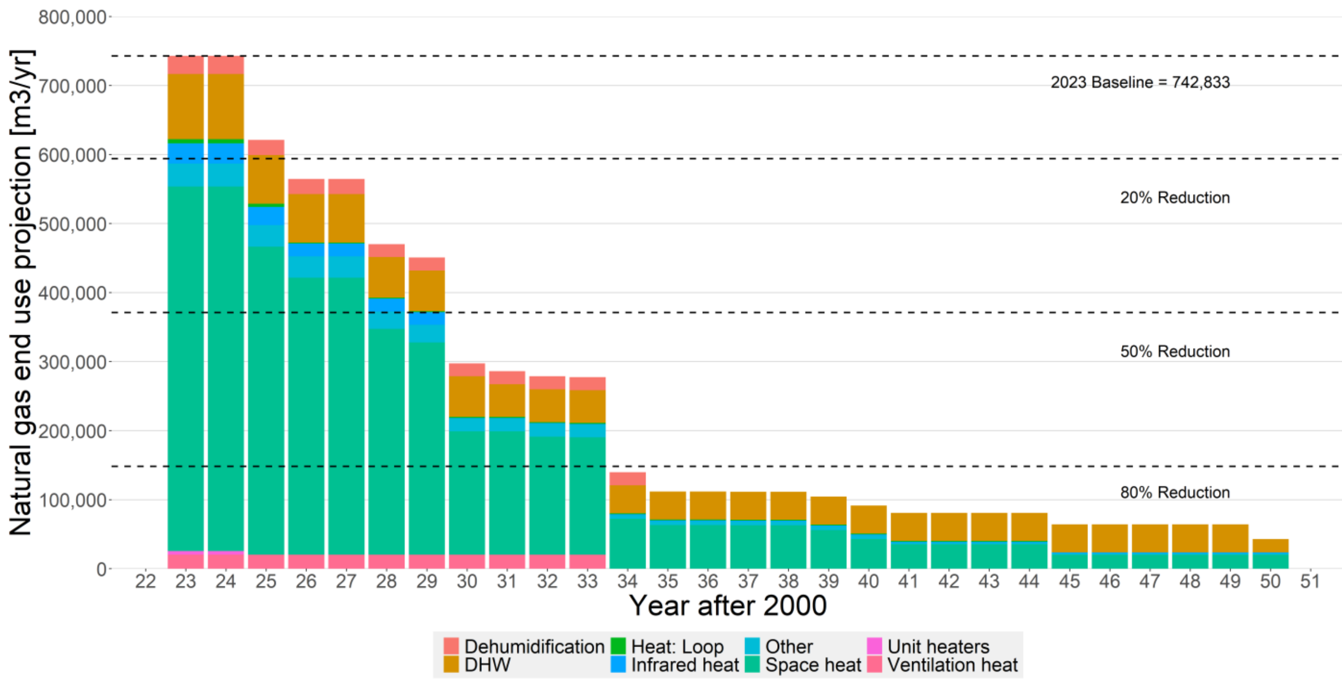


Figure 11: Asset Management Natural Gas End Use Projection

GHG emissions

Figures 12 to 16 present how GHG emissions will change for each scenario. As seen, GHG emissions will either increase for the Business as Usual scenario or decrease in all other scenarios.

A big uncertainty in this scenario analysis lies in how Ontario's electricity grid's annual emission factor will change. According to most recent IESO guidelines, the electricity grid emissions are expected to be zero by 2050. In the BAU scenario, the GHG emissions increase because the electricity grid is assumed to produce more GHG emissions for every unit of electricity produced. If the electricity grid were to be net-zero emitting, it would result in a 20% reduction in GHG emissions.

Note that propane is included in the legend for figures 12 to 16 as it is used to fuel the ice resurfacers at Dickson Arena and Duncan McIntosh arena. Because this propane use is very small compared to electricity and natural gas, the propane GHG emissions are not visible in the individual bars in the figure.

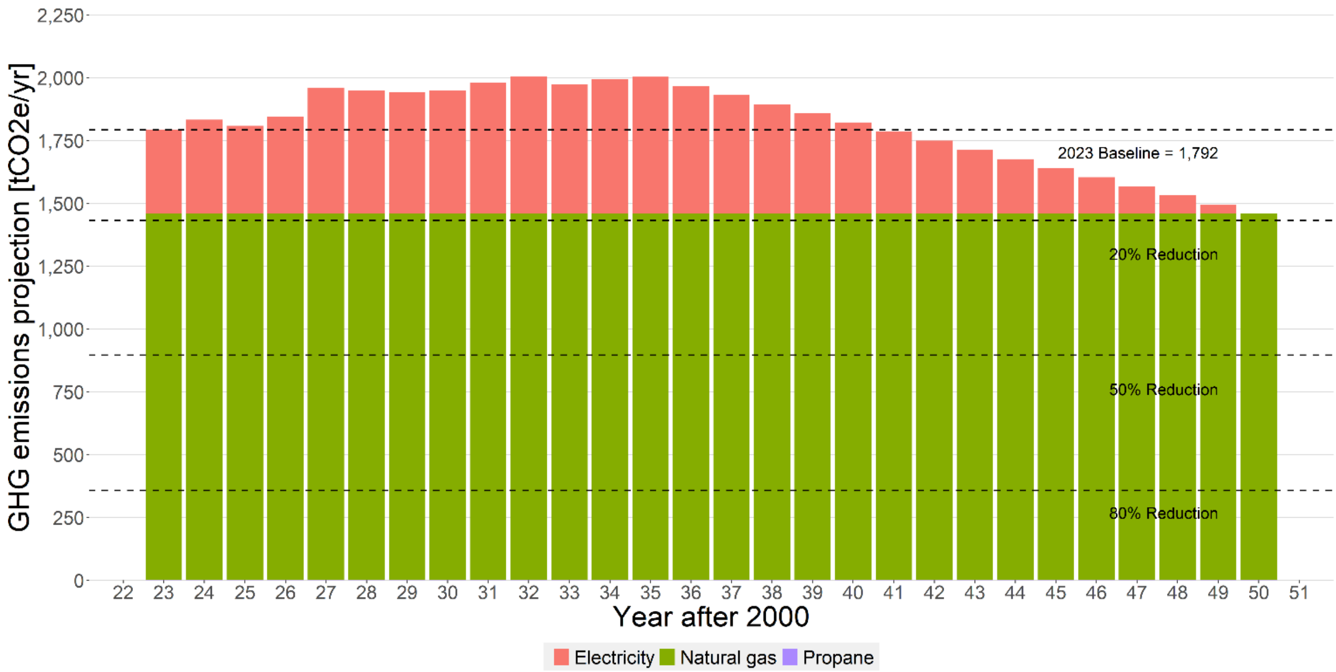


Figure 12: Business as Usual GHG Emissions Projection

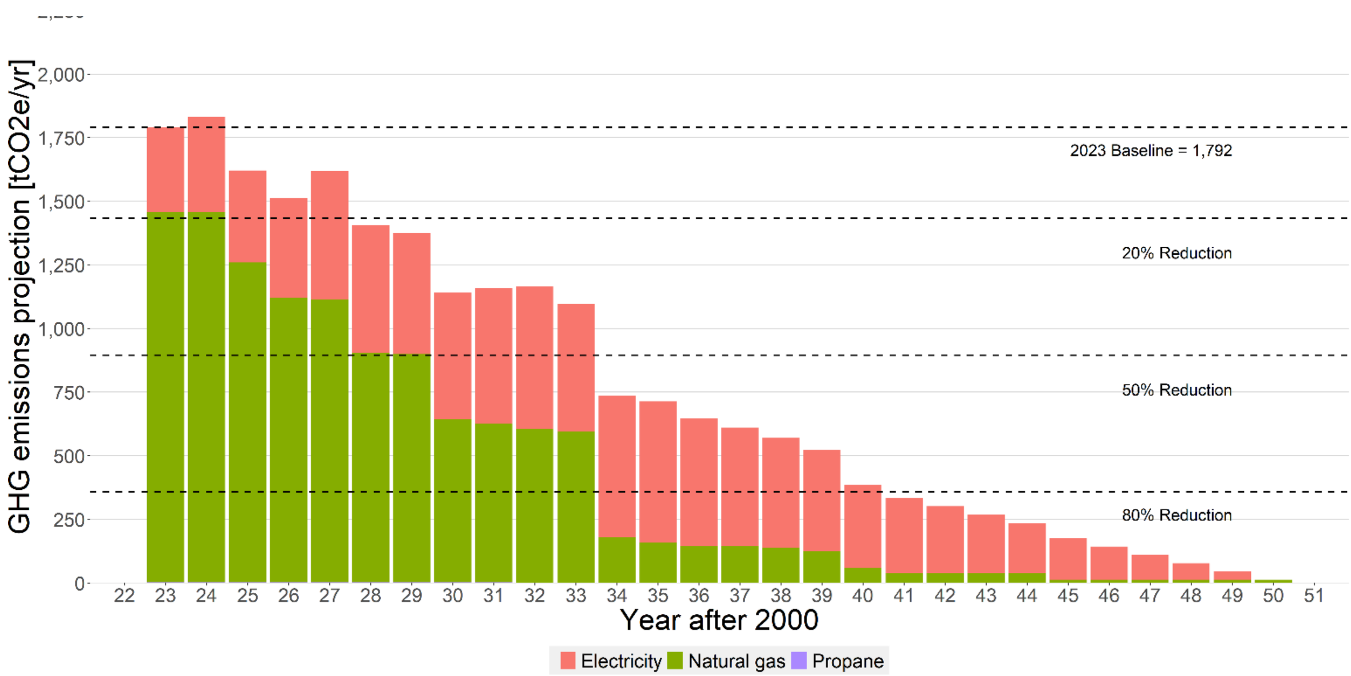


Figure 13: Comprehensive GHG Emissions Projection

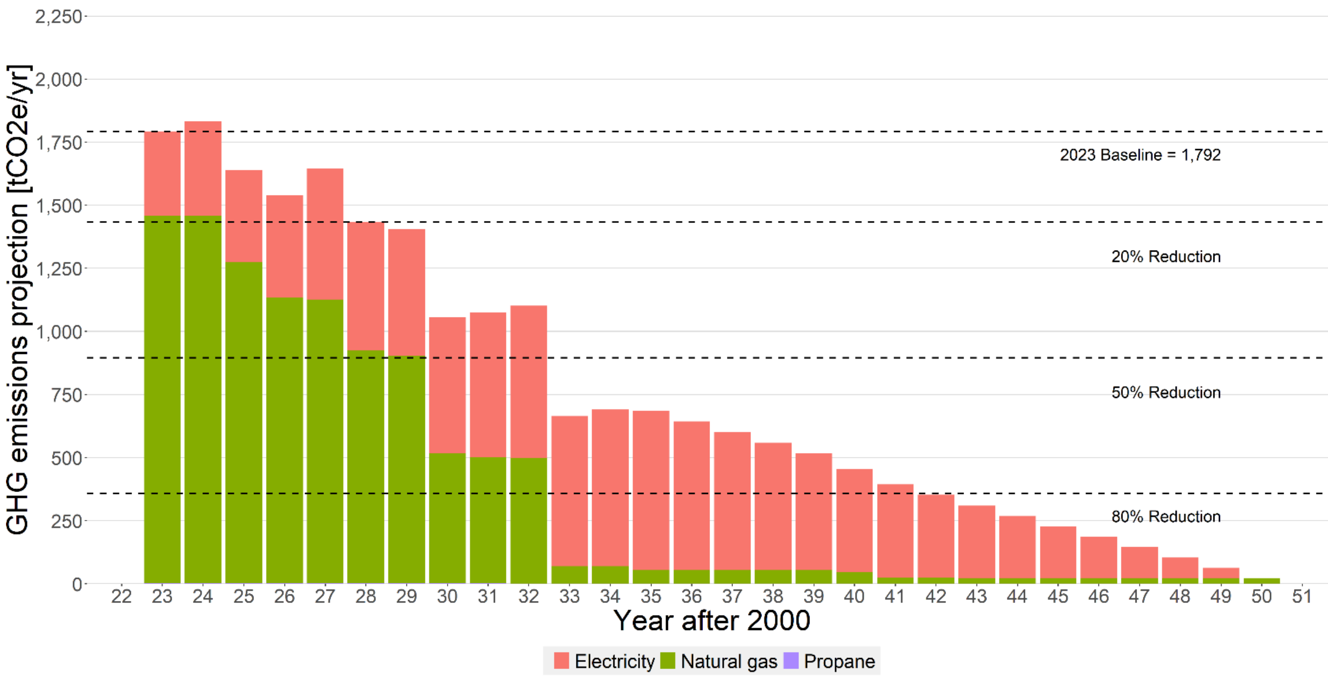


Figure 14: FCM Minimum Performance GHG Emissions Projection

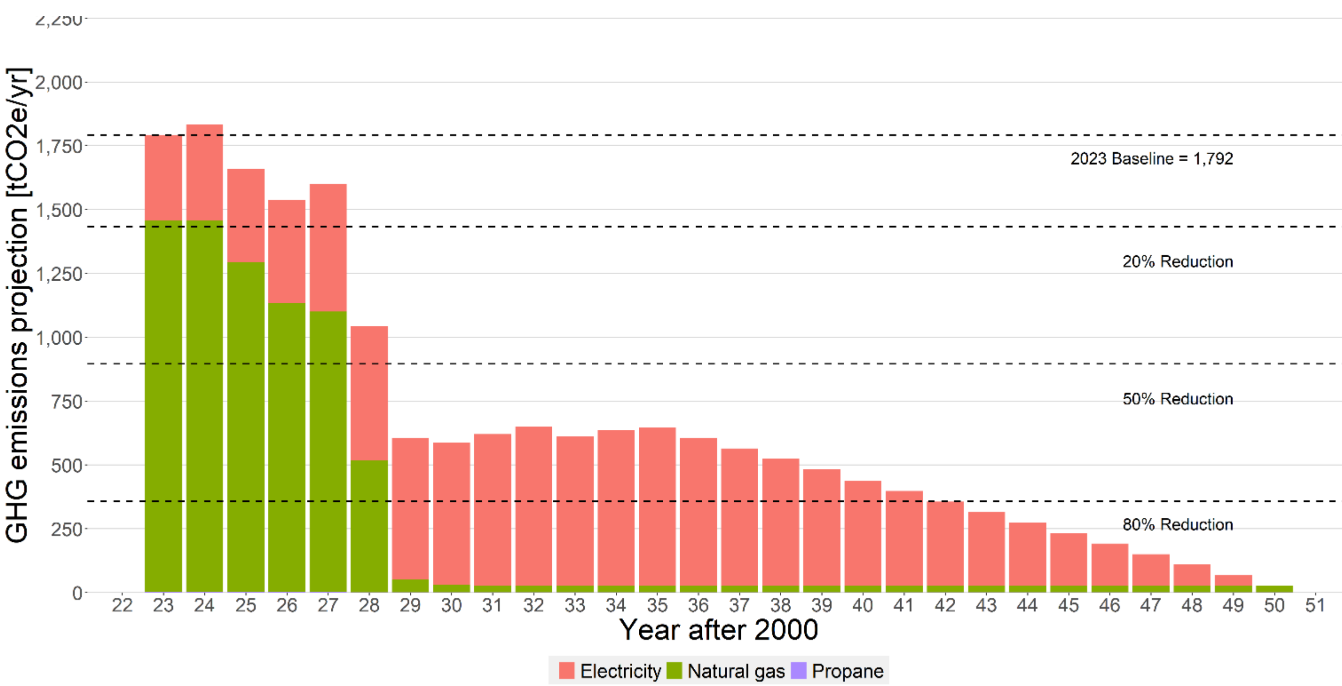


Figure 15: Short Term Deep Retrofit GHG Emissions Projection

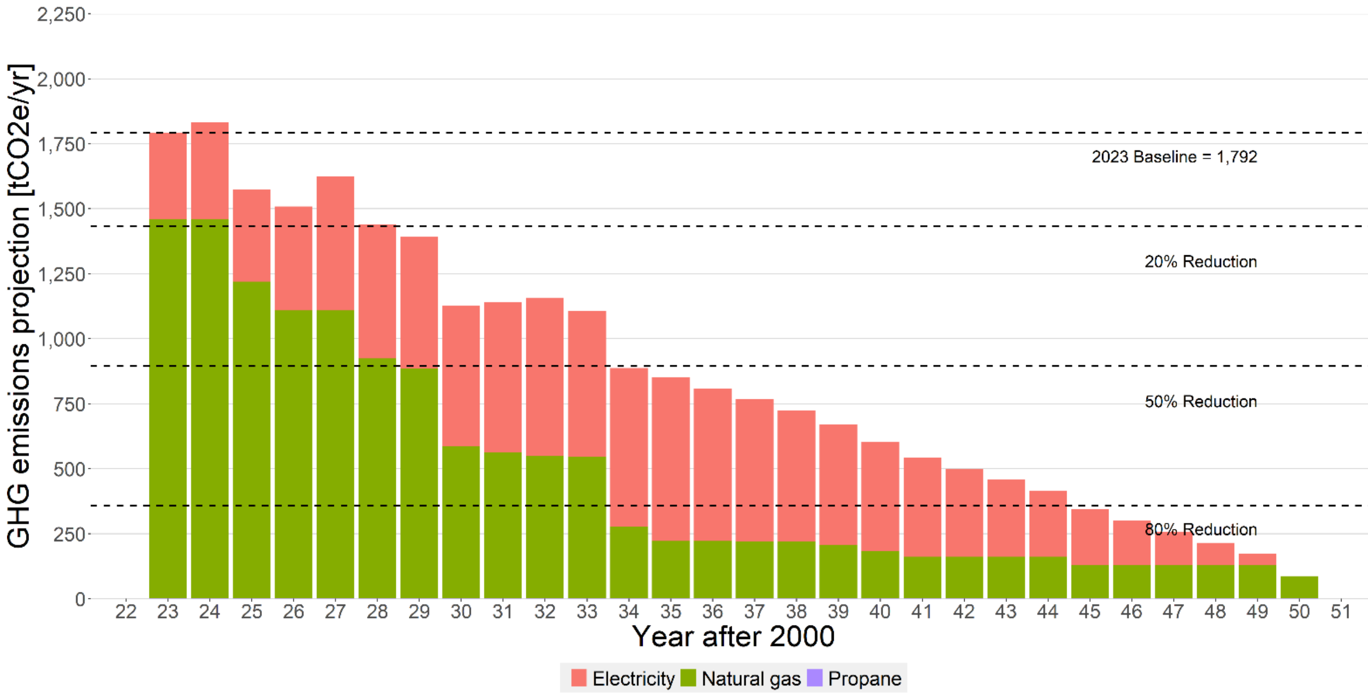


Figure 16: Asset Management GHG Emissions Projection

Utility costs

Figures 17 to 21 present how utility costs will change for each scenario. As seen, utility costs will decrease for all other scenarios when compared to the Business as Usual scenario.

In the scenario analysis, an escalation rate is applied to all utilities at a rate of 2% annually. This outcome results in utility costs increasing to over $1 million annually in the Business as Usual scenario. However, comparing to other scenarios, there are significant annual savings expected. In 2050, the annual savings exceed $350,000 for the FCM Minimum Performance and the Short Term Deep Retrofit scenarios over the BAU.

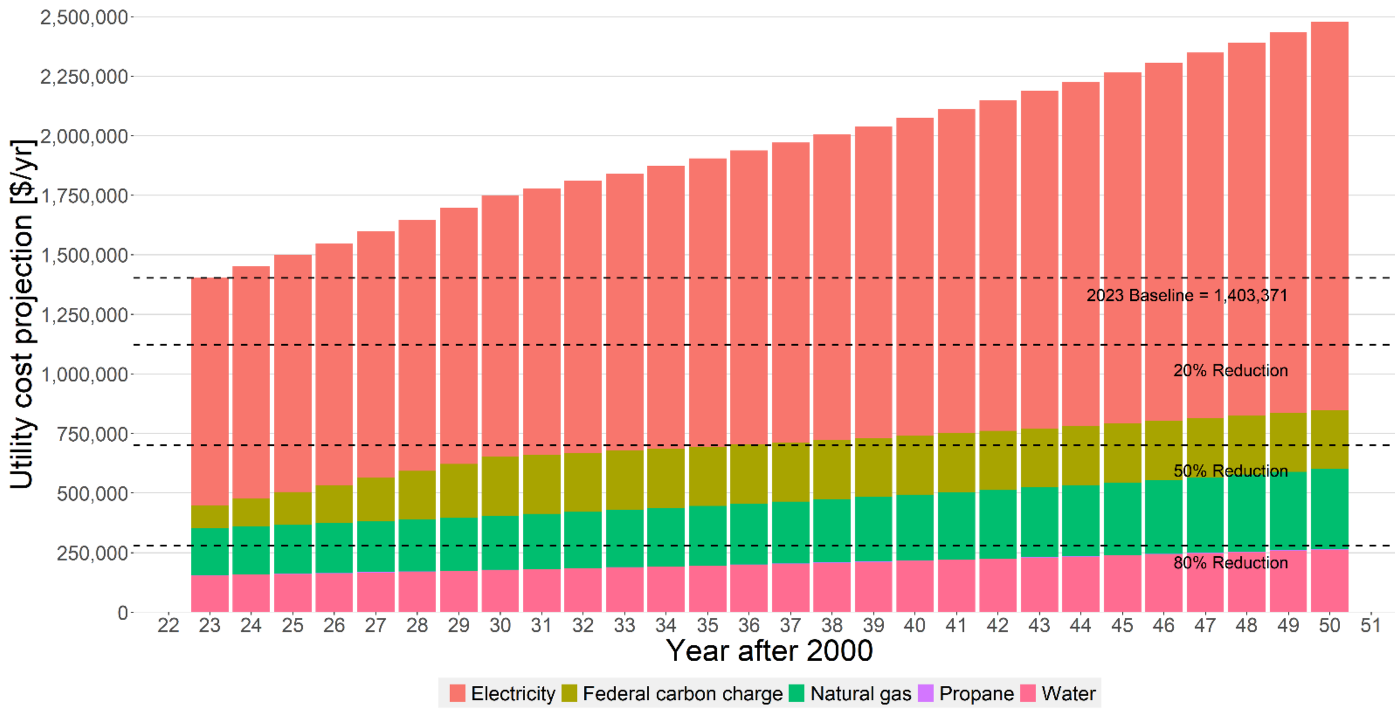


Figure 17: Business as Usual Utility Cost Projection

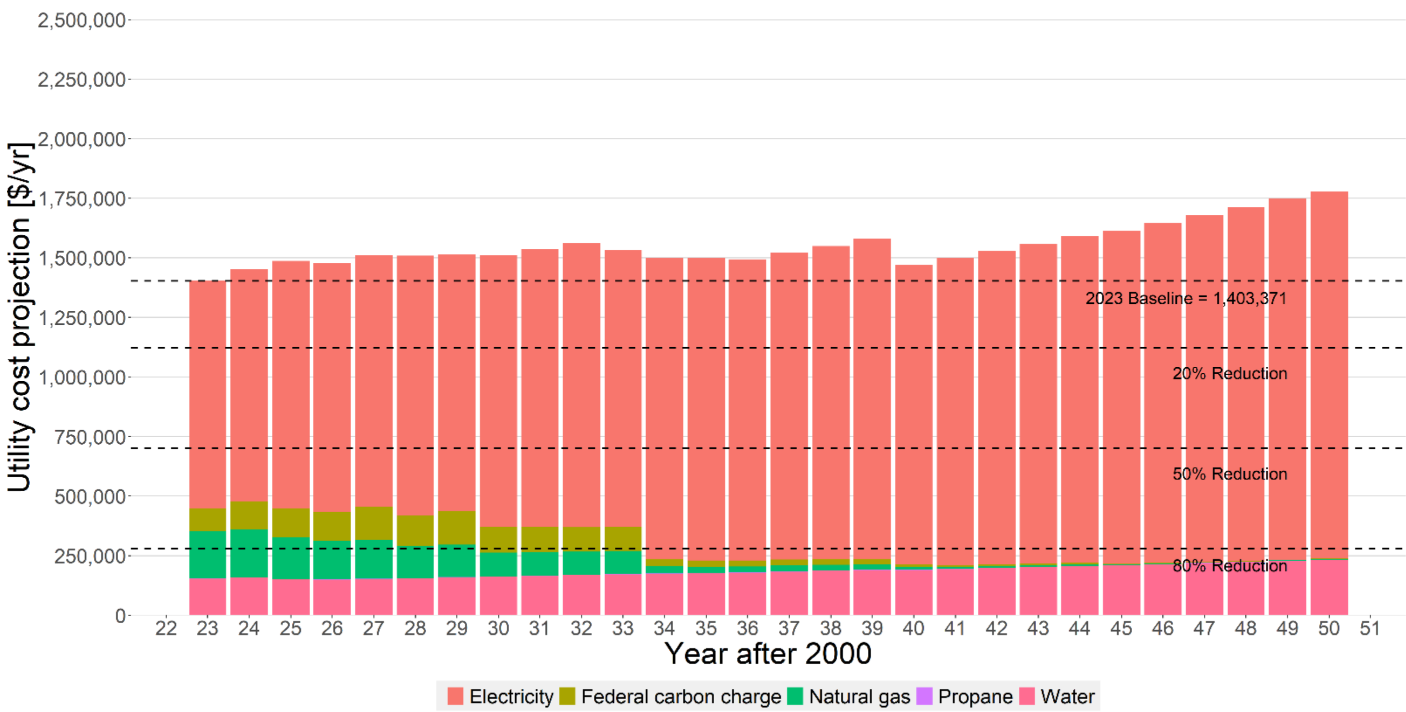


Figure 18: Comprehensive Utility Cost Projection

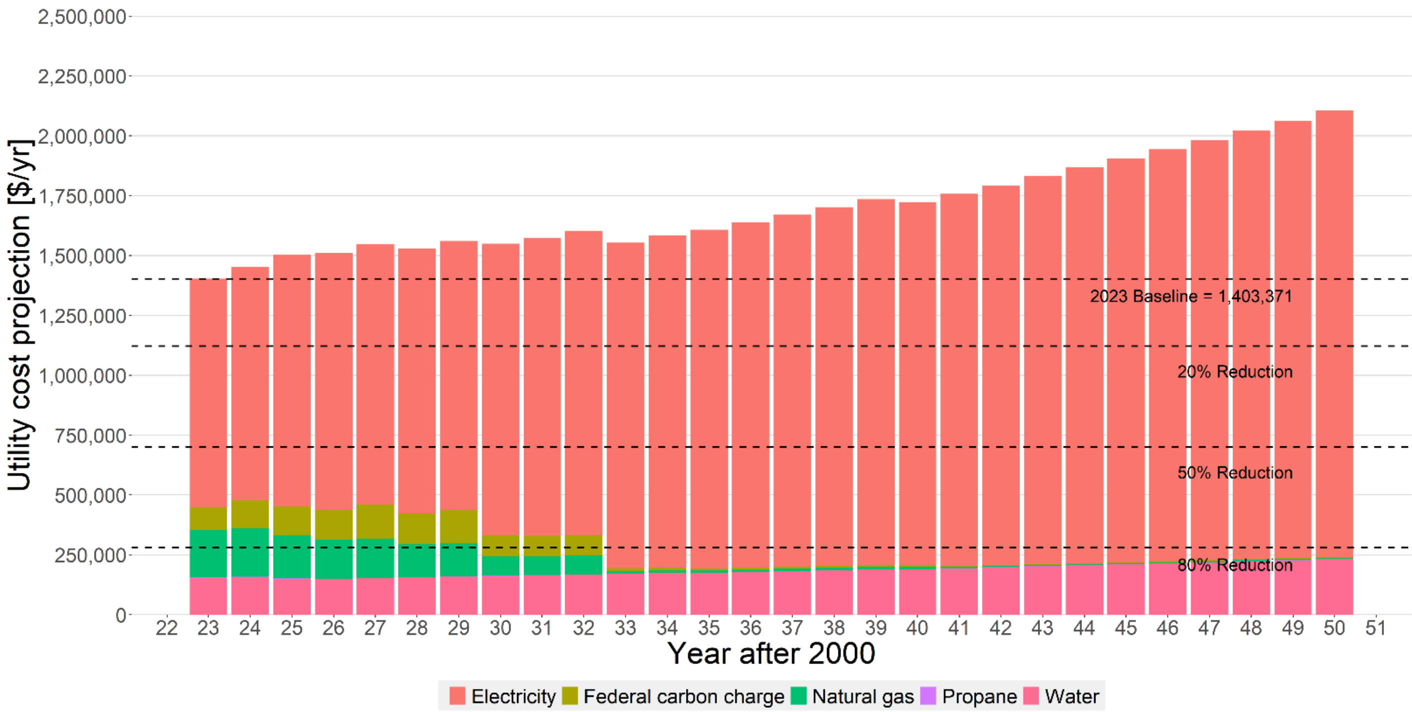


Figure 19: FCM Minimum Performance Utility Cost Projection

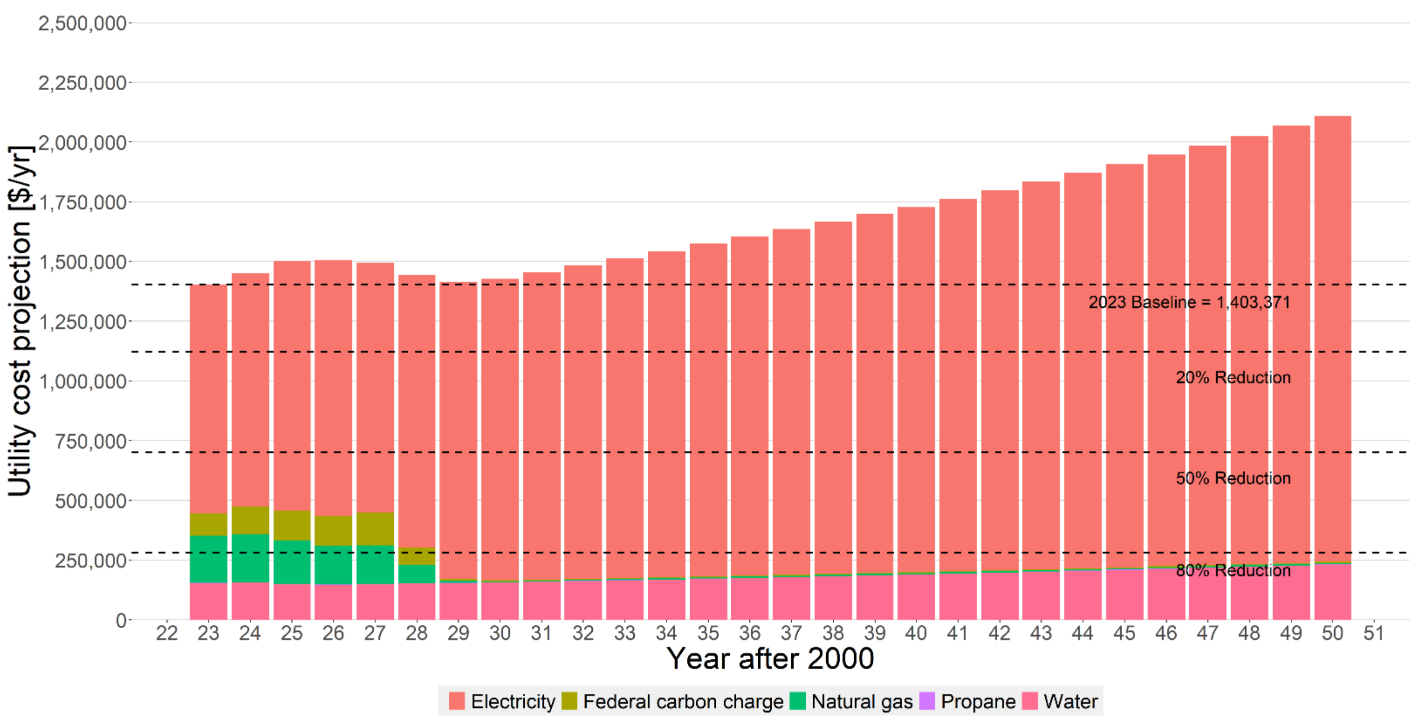


Figure 20: Short Term Deep Retrofit Utility Cost Projection

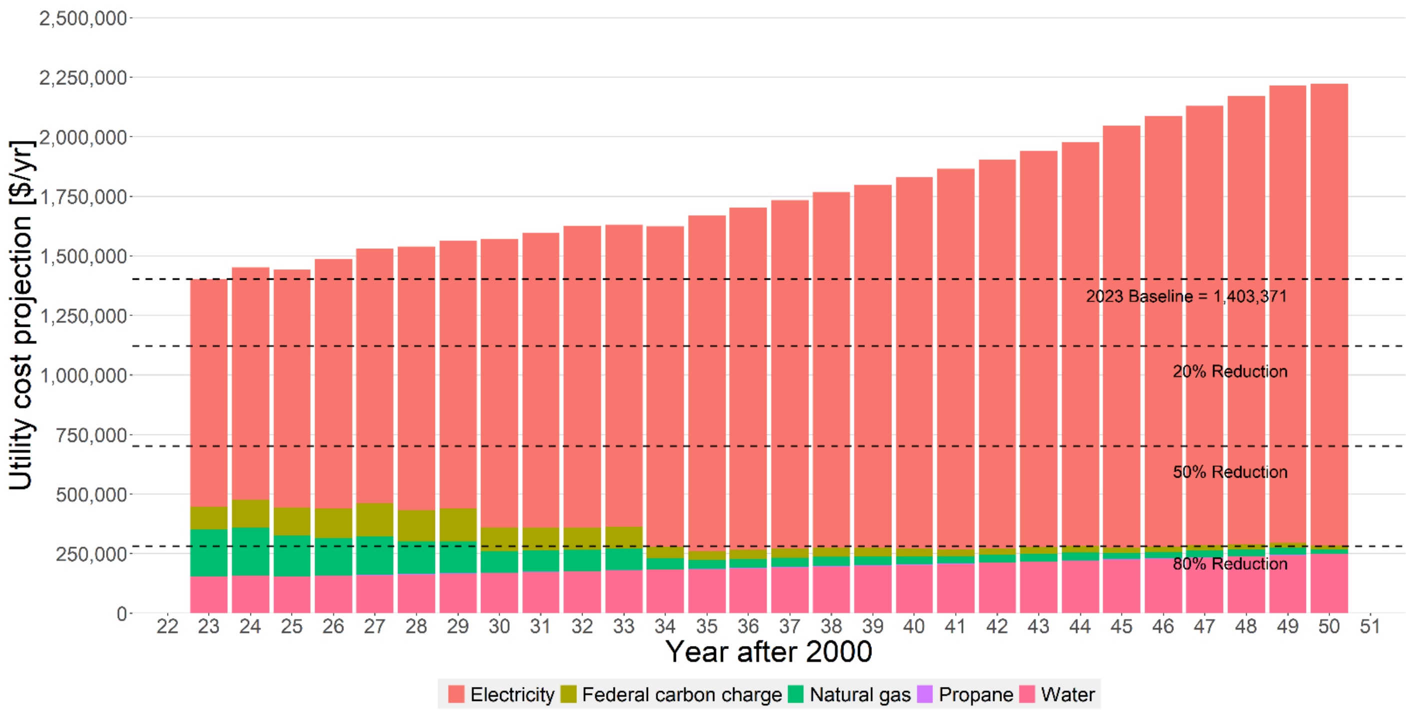


Figure 21: Asset Management Utility Cost Projection

Performance Summary

Table 1 summarizes the performance of all the plan aggregate scenarios with respect to utility use, GHG emissions, utility cost, and financial metrics as illustrated in Figures 2 through 21.

The top half of Table 1 represents the estimated performance in the final year (2050) of the evaluation period.

The bottom half of Table 1 represents the estimated cumulative performance across the entire evaluation period (present to 2050). All final year dollar values are in the value of today's currency. All cumulative dollar values presented in Table 1 are calculated as the simple sum of expenditures over the evaluation period, except for the life cycle cost, which is discounted to present value.

All values are presented as absolute values. The Business as Usual scenario acts as the point of reference for comparison purposes. Therefore, comparing the BAU scenario to the FCM Minimum Performance will result in a life cycle cost increase of $14.1 million if the FCM Minimum Performance scenario is fully implemented. However, the City will reduce annual emissions by 99% in 2050 from present levels and meet the target of 80% within 20 years.

Table 1: Scenario performance summary

Section	Description	Unit	Business as usual	Comprehensive	FCM minimum performance	Short term deep retrofit	Asset management roadmap
Utility use final	Electricity use	[kWh/yr]	7,294,007	6,522,778	**8,250,273**	8,257,361	8,598,727
	Natural gas use	[m3/yr]	742,833	5,792	**10,863**	13,473	43,059
GHG emissions final	Electricity GHGs	[tCO2e/yr]	0.00	0.00	**0.00**	0.00	0.00
	Natural gas GHGs	[tCO2e/yr]	1,456	11.4	**21.3**	26.4	84.3
	Carbon offsets GHGs	[tCO2e/yr]	0.00	0.00	**0.00**	0.00	0.00
	Total GHGs	[tCO2e/yr]	1,459	12.5	**22.4**	27.6	86.9
Utility cost final	Electricity utility cost	[$/yr]	1,629,357	1,540,854	**1,863,813**	1,865,322	1,938,195
	Natural gas utility cost	[$/yr]	336,207	2,622	**4,916**	6,097	19,488
	Federal carbon charge	[$/yr]	247,941	2,128	**3,818**	4,688	14,777
	Carbon offsets utility cost	[$/yr]	0.00	0.00	**0.00**	0.00	0.00
	Total utility cost	[$/yr]	2,478,282	1,778,218	**2,105,160**	2,108,719	2,222,377
Utility use cumulative	Electricity use	[kWh]	204,671,401	197,537,879	**226,850,672**	227,450,756	229,880,908
	Natural gas use	[m3]	20,846,852	6,080,214	**5,375,869**	3,903,635	6,816,508
GHG emissions cumulative	Electricity GHGs	[tCO2e]	9,906	9,770	**10,949**	10,987	10,985
	Natural gas GHGs	[tCO2e]	40,860	11,918	**10,536**	7,653	13,360
	Carbon offsets GHGs	[tCO2e]	0.00	0.00	**0.00**	0.00	0.00
	Total GHGs	[tCO2e]	50,838	27,063	**21,530**	18,678	29,748
Utility cost cumulative	Electricity utility cost	[$]	35,416,803	35,100,644	**39,836,190**	39,944,130	40,307,373
	Natural gas utility cost	[$]	7,310,319	1,788,160	**1,556,435**	1,106,497	2,088,710
	Federal carbon charge	[$]	6,334,466	1,485,427	**1,247,618**	780,897	1,738,717
	Carbon offsets utility cost	[$]	0.00	0.00	**0.00**	0.00	0.00
	Total utility cost	[$]	54,810,700	43,544,906	**47,798,751**	46,941,756	49,604,134
Financial cumulative	Project cost	[$]	12,372,574	87,462,981	**37,950,777**	36,204,350	71,940,892
	Replacement cost	[$]	4,931,479	14,743,117	**12,832,982**	13,154,761	14,800,358
	Life cycle cost	[$]	36,643,910	66,372,999	**50,744,938**	52,852,690	68,563,505
Utility use final	Electricity monthly peak (av)	[kW]	1,472	1,648	**1,746**	1,747	1,802
	Electricity yearly peak (max)	[kW]	1,903	2,444	**2,598**	2,604	2,627

Financial

Figure 22 represents the financial summary of all four scenarios as outlined in Table 1. Three metrics are displayed here that compare the overall project cost (i.e., capital expenditures) and utility cost. Furthermore, the life cycle cost of each scenario is presented.

The life cycle cost provides the best metric for evaluating these scenarios as it considers the capital cost, replacement cost, and utility cost. The result is that any scenario chosen over the Business as Usual scenario will result in an **increase** in life cycle cost. This result indicates that there is **no financial payback** available when considering the other scenarios.

The Comprehensive scenario has the highest capital cost of all scenarios, making it unattractive financially. The FCM Minimum Performance scenario and the Short Term Deep Retrofit scenario are still significantly higher than the Business as Usual scenario, at $5.2 million and $5.4 million, respectively.

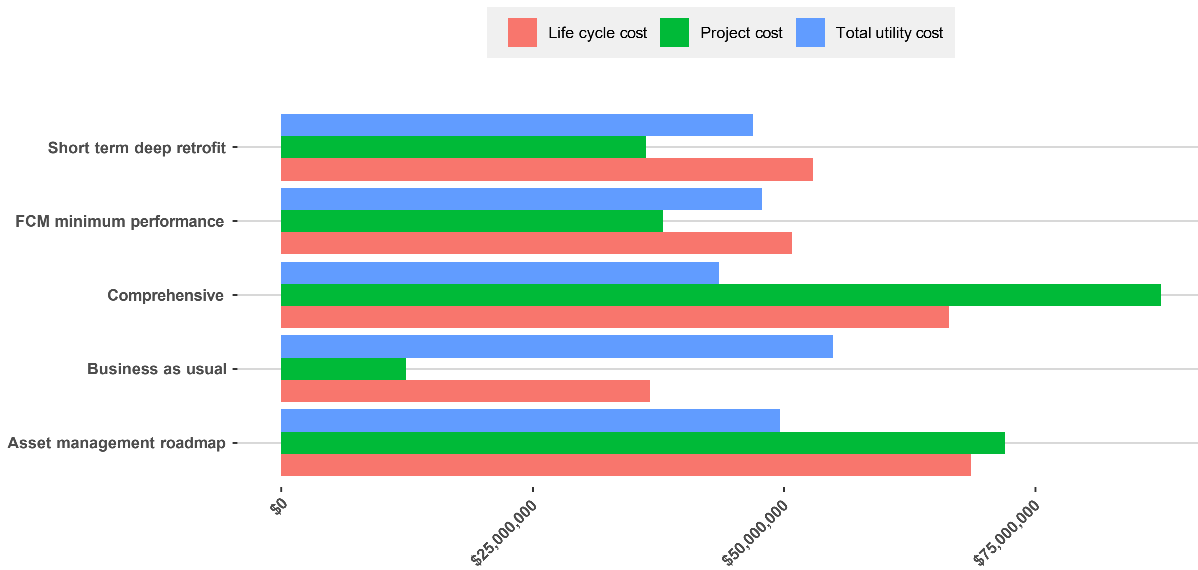


Figure 22: Cumulative financial metrics for each scenario compared

Conclusion and next steps

The collaborative efforts between WalterFedy and the City of Cambridge have resulted in various GHG Reduction Pathways for the City's 10 highest emitting facilities. The recommended scenarios and measures outlined in the study aim to guide the City in achieving significant reductions in GHG emissions while considering financial viability and operational efficiency. The completion of this feasibility study enables the City to apply for further FCM funding for retrofit project implementation through the Community Buildings Retrofit initiative.

It is imperative for City staff to carefully assess and prioritize these measures based on their individual benefits, alignment with asset management needs, and financial considerations. The commitment to reducing GHG emissions is a critical step towards building a sustainable and environmentally conscious community for the future.

END