CORPORATE NET ZERO EMISSIONS PLAN

TOWN OF AJAX

WalterFedy Project No: 2023-0870-10

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Acknowledgements

The Town of Ajax acknowledges that the land on which we gather is situated within the traditional and treaty territory of the Mississaugas. More specifically, the Mississaugas of Scugog Island First Nation, signatories of the Gunshot Treaty of 1788 and the Williams Treaties of 1923. Indigenous communities have long been the stewards of the land, and it is the goal of the Town to honour that history through open dialogue, engagement, and the shared knowledge of Indigenous Peoples.

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Executive Summary

In April 2021, Ajax Council unanimously passed a motion to establish new corporate green-house gas (GHG) emission reduction targets (below 2019 levels), including: 20% GHG emission reduction by 2025; 40% GHG emission reductions by 2030; 100% GHG emission reductions by 2050.

The Town of Ajax currently emits 3,493 tonnes of GHG emissions from its Town buildings, streetlighting and outdoor sports and parks lighting. (using 2019 and 2024 GHG inventory data). The majority of these emissions (approximately 93%) are generated from Town buildings and facilities highlighting the need to implement the GHG reduction roadmap to decarbonize the buildings.

The Corporate Net-Zero Emissions Plan outlines a plan for the Town of Ajax to achieve corporate GHG emissions reduction targets including 50% by 2035 and 80% by 2045 using a baseline year of 2019. The plan also aligns with the Federation of Canadian Municipalities (FCM) guidelines of a 50% reduction by 2035 and an 80% reduction by 2045, using a baseline year of 2019.

Individual energy audits were completed at thirteen (13) Town of Ajax facilities and two (2) archetypes, considering the existing conditions of the site and potential energy conservation measure implementation timelines in order to meet the reduction goals at each facility. The cumulative results of the individual energy audits are presented in the Corporate Net-Zero Emissions Plan which includes a GHG Net-Zero Roadmap for the Town of Ajax to meet the desired targets in all buildings and archetypes.

The GHG Net-Zero Roadmap is compared to a Business as Usual (BAU) scenario to determine the impacts of the recommended GHG reducing measures to GHG emissions, utility costs, and utility use. By implementing the GHG Net-Zero Roadmap outlined in this plan, GHG emissions are expected to decrease from 3,260 tCO_2e in 2019 to 0 tCO_2e in 2050. Cumulative utility costs from now until 2050 are expected to decrease by just over $9.6 million by implementing the GHG Net-Zero Roadmap over the BAU scenario.

It is recommended that the Town of Ajax pursue the GHG Net-Zero Roadmap as it allows the Town to achieve it's GHG emission reduction targets. Decarbonizing municipal buildings reduces GHG emissions by cutting fossil fuel use for heating, cooling, and electricity, while improving indoor air quality and comfort. This is crucial especially in facilities like the Ajax Community Centre which serve as warming center in the winter, cooling center and air quality center in the summer for the local Ajax Community. It also showcases municipal leadership in sustainability, encouraging community-wide green initiatives and creating jobs in clean industries. Energy-efficient upgrades lower operating costs over time, and financial incentives from government programs help offset modernization expenses. Additionally, modern electrified systems enhance building resilience with backup or off-grid capabilities, boosting emergency preparedness.

Project Overview

WalterFedy was engaged by the Town of Ajax to complete a Corporate Net-Zero Emissions Plan focusing on the following facilities and archetypes:

- Ajax Community Centre
- Ajax Fire Station 1 (formerly Ajax Fire Headquarters)
- Ajax Fire Station 2
- Ajax Fire Station 3 (formerly Ajax Fire Station 1)
- Ajax Main Branch Library
- Ajax Memorial Pool
- Ajax Municipal Building
- Ajax Operations Centre
- Audley Recreation Centre
- McLean Community Centre
- Rotary Park Pavillion
- St. Andrews Community Centre
- St. Francis Centre
- Storage Archetypes
- Washroom Archetypes

This project identifies the recommended greenhouse gas (GHG) reduction roadmap that results in a 50% reduction within 10 years, 80% reduction within 20 years, and 100% reduction by 2050 for each facility in order to achieve the Town's reduction targets of 20% by 2025, 40% by 2030, and net-zero by 2050, as compared to 2019 levels. This was done by completing ASHRAE Level 3 energy audits at Ajax Community Centre, Audley Recreation Centre and McLean Community Centre, and ASHRAE Level 2 energy audits for all other facilities and archetypes. To achieve this objective, WalterFedy and the Town'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 to gain an understanding of the facilities and their operations.
2. **Baseline data**. Metered utility data provided by the Town was reviewed to understand historical utility use trends and to establish the utility use baseline for each facility.
3. **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.
4. **Design Workshop**. WalterFedy presented a workshop to the Town's stakeholders to provide a progress review of the preceding steps and to discuss overall low carbon measures

to be considered at each site. This forum was invaluable in prioritizing energy saving and GHG reducing measures to consider at each building.

5. **Measure Analysis**. Low carbon intensive measures intended to achieve the Town's goals were identified and analyzed. The analysis included conceptual design development, utility analysis, quantifying utility use impacts, GHG emissions, and utility costs for each measure.
6. **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 (BAU)**: To follow the existing capital renewal plan and replace equipment with like-for-like equipment at the end of its life based on the Town's Asset Management Plan, meeting minimum energy-efficiency requirements of ASHRAE 90.1.
    - **Comprehensive**: To implement all measures with the greatest reduction on GHG emissions without redundancies, excluding carbon offsets.
    - **Greenhouse Gas (GHG) Net-Zero Roadmap**: To achieve a 50% reduction in operational GHG emissions within 10 years, 80% within 20 years, and 100% by 2050. This scenario addresses the minimum performance scenario of the Federation of Canadian Municipalities (FCM) Community Buildings Retrofit (CBR) funding program. It also aligns with the Town's GHG reduction targets of 20% by 2025, 40% by 2030, and net-zero by 2050, in comparison with 2019 levels. The project timeline for this scenario is intended 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 GHG Net-Zero Roadmap scenario within five years, excluding the use of carbon offsets.
    - **Asset Management**: To follow the existing capital renewal plan and replace equipment with a low GHG alternative. This differs from the BAU scenario as the BAU scenario replaces equipment with like-for-like equipment, while the Asset Management scenario replaces equipment with a low GHG alternative.
7. **Decision Making Workshop**. WalterFedy presented a workshop to the Town'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.
8. **Corporate Net-Zero Emissions Plan (CNZEP)**. The CNZEP was developed to achieve Ajax's net-zero goals by integrating ongoing feedback from Town staff and the findings from individual building energy audit reports. WalterFedy incorporated the feedback gathered from Town staff during the Design and Decision-Making Workshops to generate the draft energy audit reports for each building. Additional feedback was then provided by the Town on these drafts, which WalterFedy used to finalize the study.

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
- Carbon offsets for GHG emissions
- Net metering for solar photovoltaics (PV)

These items are summarized in the following subsections.

Project Intent

The information provided in this Corporate Net-Zero Emissions Plan and all individual energy audits is intended to guide Town staff in implementing energy and GHG reduction measures to meet the Town's overall GHG emissions reduction goals. It is recommended that Town staff diligently review the scenarios and measures and prioritize those that offer the most benefit, align with each facility's asset management needs, while also considering 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 (ASHPs) or geothermal systems.
- **Efficiency measures**: Recommissioning, energy recovery ventilation (ERVs).
- **Envelope measures**: Upgrades to the roof, walls, windows and doors.
- **Renewables**: Solar PV systems, carbon offsets.

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 Town's staff, have identified a variety of measures for reducing GHG emissions across this project portfolio. Among these measures, energy efficiency measures tend to be more financially viable as they come with lower capital costs and higher 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 Roadmap and consider more financially intensive measures towards the end of the equipment's life to reduce overall costs.

Carbon Offsets

Several facilities within the project's scope of work could not meet the GHG reduction roadmap of reducing GHG emissions by 50% within 10 years, 80% within 20 years, and 100% by 2050 when considering only GHG reduction measures. This result can be typical, especially for facilities that only use electricity and are process-driven, and can result from GHG emissions factor assumptions. When this issue arises, a last resort option to reach the GHG emissions reduction goal is to export green power or purchase carbon offsets.

Green power exports include the exporting of on-site renewable energy, as well as the injection of renewable energy into local grids through offsite renewable energy generation facilities. The latter approach can be accomplished by purchasing Renewable Energy Certificates (RECs). RECs are utility-specific and are purchased by energy unit of the utility (e.g. kWh for electricity, or m^3 for natural gas) and can only be used to offset GHG emissions associated with the specific utility and typically valid for the calendar year. For example, electricity RECs can be purchased to offset up to 100% of the electricity the building uses, but cannot be used to offset natural gas (and vice versa). RECs are typically considered best practices because they facilitate an immediate injection of renewable energy into grids.

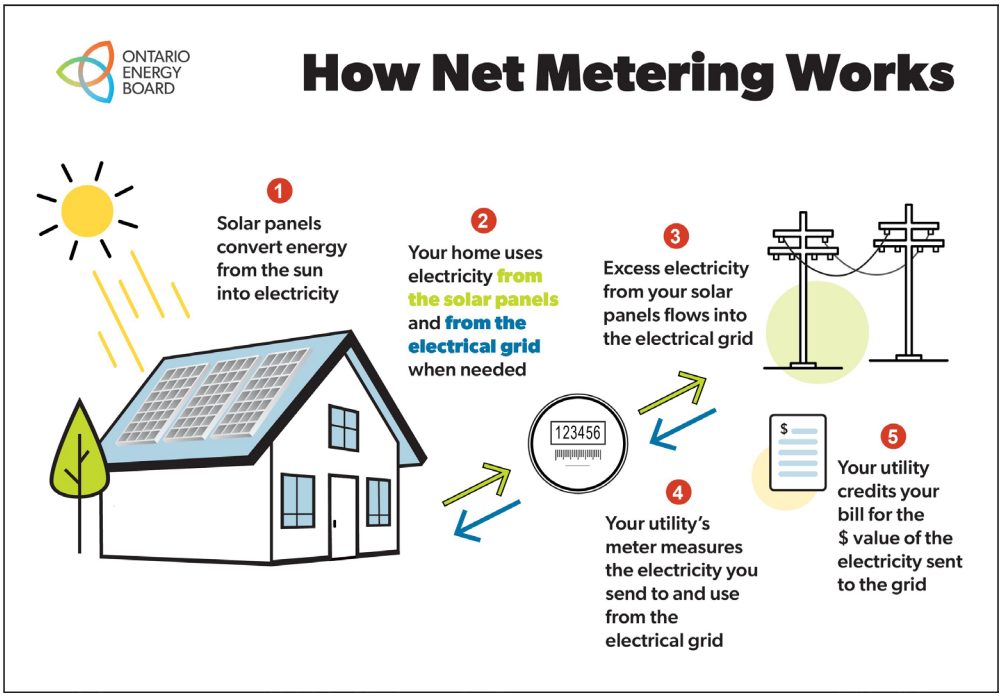
Purchasing carbon offsets is the second approach for avoiding emissions recognized by the Canadian Green Building Council (CaGBC). Carbon offsets are purchased per tonne of GHG emissions. They can offset direct (e.g. natural gas combustion on-site) or indirect (e.g. electricity use on-site, generated offsite) GHG emissions. The best approach when considering carbon offsets is to ensure they are certified as stipulated within the CaGBC Zero Carbon Building Standard, which is required to uphold the quality standards of the carbon offsets. Carbon offsets do not expire and can be bought ahead of time to be used to offset remaining emissions over multiple years.

All reports within this project consider carbon offsets to address the residual emission gaps and to ensure that all applicable buildings meet the GHG reduction roadmap.

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:

- In a net metering arrangement, it is essential to design solar PV systems such that their annual energy production does not exceed the facility's total annual electricity consumption. Overproduction may result in uncompensated energy being exported to the grid.
- 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 agree-

ments (PPA). The Town can benefit from this in the event that certain facilities transition sufficiently from fossil fuel to electricity.

- **If virtual net metering became an option for the Town, 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 CNZEP is a study which analyzes 13 individual facilities and two archetypes, examining the following five scenarios:

- **BAU**: To follow the existing capital renewal plan and replace equipment with like-for-like equipment at the end of its life based on the Town's Asset Management Plan, meeting minimum energy-efficiency requirements of ASHRAE 90.1.
- **Comprehensive**: To implement all measures with the greatest reduction on GHG emissions without redundancies, excluding carbon offsets.
- **Greenhouse Gas (GHG) Net-Zero Roadmap**: To achieve a 50% reduction in operational GHG emissions within 10 years, 80% within 20 years, and 100% by 2050. This scenario addresses the minimum performance scenario of the Federation of Canadian Municipalities (FCM) Community Buildings Retrofit (CBR) funding program. It also aligns with the Town's GHG reduction targets of 20% by 2025, 40% by 2030, and net-zero by 2050, in comparison with 2019 levels. The project timeline for this scenario is intended 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 GHG Net-Zero Roadmap scenario within five years, excluding the use of carbon offsets.
- **Asset Management**: To follow the existing capital renewal plan and replace equipment with a low GHG alternative. This differs from the BAU scenario as the BAU scenario replaces equipment with like-for-like equipment, while the Asset Management scenario replaces equipment with a low GHG alternative.

The Scenario Analysis groups information from 13 facilities to understand how these facilities would perform together. The Washroom and Storage Archetypes were excluded because the individual energy audits represent only a single building within each archetype, as such data is not sufficient to accurately reflect the result of implementation over the entire archetype.

Assumptions

An analysis of this calibre requires many assumptions on projecting values of numerous parameters over the period selected (i.e., 2025 to 2050). Particular parameters include, but are not limited to, the following:

- Carbon offset purchase cost
- Utility rates
- Utility escalation rates
- Federal carbon charge
- Capital cost
- Replacement cost

- Annual inflation rate
- Technology limitations
- GHG emissions factor projections

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.

Performance Summary

Tables 1 and 2 summarize 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 9.

Table 1 represents the estimated performance in the final year (2050) of the evaluation period. Table 2 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 2 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 (BAU) scenario acts as the point of reference for comparison purposes. Therefore, comparing the BAU scenario to the GHG Net-Zero Roadmap will result in a life cycle cost increase of $35.9 million if the GHG Net-Zero Roadmap is fully implemented. However, the Town will decrease annual emissions by 100% in 2050 from present levels and meet the target of net-zero by 2050.

Table 1: Scenario performance summary in final year (2050)

Section	Description	Unit	Business as usual	Comprehensive	GHG net zero roadmap	Short term deep retrofit	Asset management roadmap
Utility use final	Electricity use	[kWh/yr]	10,829,205	12,445,709	**12,489,738**	12,423,968	13,755,334
	Natural gas use	[m3/yr]	1,503,180	201,316	**237,824**	220,621	299,330
GHG emissions final	Electricity GHGs	[tCO2e/yr]	95.6	110	**110**	111	122
	Natural gas GHGs	[tCO2e/yr]	2,888	387	**457**	424	575
	Carbon offsets GHGs	[tCO2e/yr]	0.00	0.00	**-568**	0.00	0.00
	Total GHGs	[tCO2e/yr]	3,075	497	**0.00**	535	698
Utility cost final	Electricity utility cost	[$/yr]	2,481,628	2,884,335	**2,897,110**	2,877,945	3,126,931
	Natural gas utility cost	[$/yr]	680,339	91,116	**107,638**	99,853	135,477
	Federal carbon charge	[$/yr]	506,391	65,744	**77,665**	72,049	97,752
	Carbon offsets utility cost	[$/yr]	0.00	0.00	**38,457**	0.00	0.00
	Total utility cost	[$/yr]	3,731,272	3,041,195	**3,120,872**	3,049,847	3,360,160
	Utility cost savings vs BAU	[$/yr]	0.00	690,077	**610,400**	681,426	371,112
Utility use final	Electricity monthly peak (av)	[kW]	2,483	3,064	**3,088**	3,057	3,098
	Electricity yearly peak (max)	[kW]	3,148	3,775	**3,767**	3,702	3,688

Table 2: Scenario performance summary cumulative over all years (present-2050)

Section	Description	Unit	Business as usual	Comprehensive GHG net zero roadmap		Short term deep retrofit	Asset manage-ment roadmap
Utility use cumulative	Electricity use	[kWh]	346,534,529	363,149,72	**363,740,983**	379,654,502	402,842,365
	Natural gas use	[m3]	48,101,786	21,536,455	**22,930,470**	18,345,533	24,519,274
GHG emissions cumulative	Electricity GHGs	[tCO2e]	10,418	10,454	**10,544**	11,199	11,718
	Natural gas GHGs	[tCO2e]	92,403	41,371	**44,049**	35,241	47,101
	Carbon offsets GHGs	[tCO2e]	0.00	0.00	**-8,640**	0.00	0.00
	Total GHGs	[tCO2e]	105,739	52,829	**45,953**	47,078	59,640
Utility cost cumulative	Electricity utility cost	[$]	59,867,721	64,167,916	**64,305,681**	66,809,191	70,329,150
	Natural gas utility cost	[$]	16,331,309	6,437,298	**6,972,484**	5,436,182	7,525,770
	Federal carbon charge	[$]	13,344,880	4,502,738	**5,250,839**	3,433,796	5,433,725
	Carbon offsets utility cost	[$]	0.00	0.00	**427,560**	0.00	0.00
Capital cost	Total utility cost	[$]	91,054,239	75,526,613	**81,437,143**	75,936,588	83,625,095
	Project cost	[$]	89,104,553	151,574,72	**96,770,846**	123,106,913	126,888,511
	Incremental project cost	[$]	0.00	62,470,175	**7,666,293**	34,002,360	37,783,958
	Life cycle cost	[$]	96,674,073	164,632,50	**132,542,616**	167,546,629	117,988,093
Project cost per GHG reduction	Project cost per GHG reduction	[$/tCO2e]		2,865	**2,106**	2,615	2,753

Cost of Implementing the GHG Net-Zero Roadmap

The costs of doing nothing on climate mitigation are far greater than the costs of taking action, and the Town of Ajax has a crucial role to play in reducing emissions and transitioning to a sustainable future. By embracing climate action, Ajax will be able to mitigate risks, reduce costs, and create opportunities for innovation and growth. Overall, implementing GHG roadmap to decarbonize these buildings (see Measure Analysis Summary) requires a net incremental capital investment of $7.7 million between 2025 and 2050. During the same period, the utility costs will decrease by $9.6 million. From this investment, 3,260 tCO2e emissions will be mitigated annually (Refer to the Measure Analysis Summary in the Appendix).

Table 3a: GHG Net-Zero Roadmap Cost Savings Summary

Description	Unit	Business as usual	GHG net zero roadmap	Utility cost savings	Incremental cost to decarbonize the buildings
Total utility cost	[$]	91,054,239	81,437,143	9,616,186	-
Project cost	[$]	89,104,553	96,770,846	-	7,666,293

Table 3b: GHG Net-Zero Roadmap Cost Savings Summary per Building

Building	Units	GHG Net Zero Roadmap	Business as Usual	Increased Cost	Utility Savings* (over 25 years)	Total Impact** (over 25 years)
Ajax Community Centre	[$]	14,817,353	10,995,196	3,822,157	2,946,647	878,036
Ajax Memorial Pool	[$]	495,366	194,530	300,836	-16,176	419,241
Ajax Municipal Building	[$]	7,035,530	16,298,156	-9,262,626	394,489	-8,883,004
Ajax Operations Centre	[$]	6,598,328	6,416,419	181,909	1,722,430	-581,790
Audley Recreation Centre	[$]	32,792,000	20,806,084	11,985,916	644,068	11,341,848
Fire Station 1 (HQ)	[$]	2,276,277	1,609,542	666,735	663,617	-170,058
Fire Station 2	[$]	2,351,986	2,937,760	-585,774	-58,307	-549,205
Fire Station 3 (1)	[$]	1,218,872	269,909	948,963	1,015,720	79,667
Main Branch Library	[$]	1,832,150	5,467,565	-3,635,415	28,421	-3,093,423
McLean Community Centre	[$]	23,535,340	19,517,337	4,018,003	1,577,595	8,401,459
Rotary Pavillion	[$]	627,143	266,705	360,438	-45,032	453,453
St Andrews Community Centre	[$]	2,545,290	2,891,179	-345,889	236,056	-134,958
St Francis Centre	[$]	645,211	1,434,171	-788,960	506,658	-447,015
Total	**[$]**	**96,770,846**	**89,104,553**	**7,666,293**	**9,616,186**	**7,714,251**

Note: *The negative sign in this column indicates an increase in electricity costs as a result of fuel switching from natural gas to electricity in order to decarbonize the building.

** The negative sign in this column indicates a stronger business case for implementing the GHG Net Zero Roadmap, as it reflects savings in capital expenditure. These savings arise since the projects under the GHG Net Zero Roadmap are more cost-effective than the Business-as-Usual (BAU) approach. They result from a combination of measures, including more accurate system sizing, improved operational efficiency, and strategic investments in low-carbon technologies such as installation of solar PV panels.

Scenario Analysis Discussion

Figures 2 through 9 illustrate how the Town's portfolio of buildings will change over time for the BAU and GHG Net-Zero Roadmap scenarios per its electricity use, natural use, GHG emissions, and utility costs. Plan scenario plots for all other plans are available in the appendix.

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 2019.
- 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.

GHG Emissions

Figures 2 and 3 present how GHG emissions will change for the BAU and GHG Net-Zero Roadmap scenarios, respectively. As seen, GHG emissions will increase for the BAU scenario and decrease in all other scenarios.

The GHG figures are displayed as a stacked bar graph sorted into the following facility types:

Administrative and Operational Services

- Ajax Municipal Building
- Ajax Operations Centre

Emergency Services

- Ajax Fire Station 1 (formerly Ajax Fire Headquarters)
- Ajax Fire Station 2
- Ajax Fire Station 3 (formerly Ajax Fire Station 1)

Library and Culture

- Ajax Main Branch Library
- St. Francis Centre

Recreation and Community Centres

- Ajax Community Centre
- Audley Recreation Centre
- McLean Community Centre

- St. Andrews Community Centre

Auxiliary Facilities

- Ajax Memorial Pool
- Rotary Park Pavilion

A significant source of uncertainty in this scenario analysis stems from the potential changes in the annual emissions factor of Ontario's electricity grid. The annual emissions factor projections for this analysis were taken from both the most recent National Inventory Report (NIR) and the most recent Independent Electricity System Operator (IESO) Planning Outlook. The GHG emissions associated with the washroom and storage archetypes were minor and have not been included in this graph.

It is recommended to pursue the GHG Net-Zero Roadmap scenario outlined in Figure 3 as it meets the desired GHG reduction goals of the Town and promotes energy as well as cost savings.

Figure 2: BAU GHG emissions projection

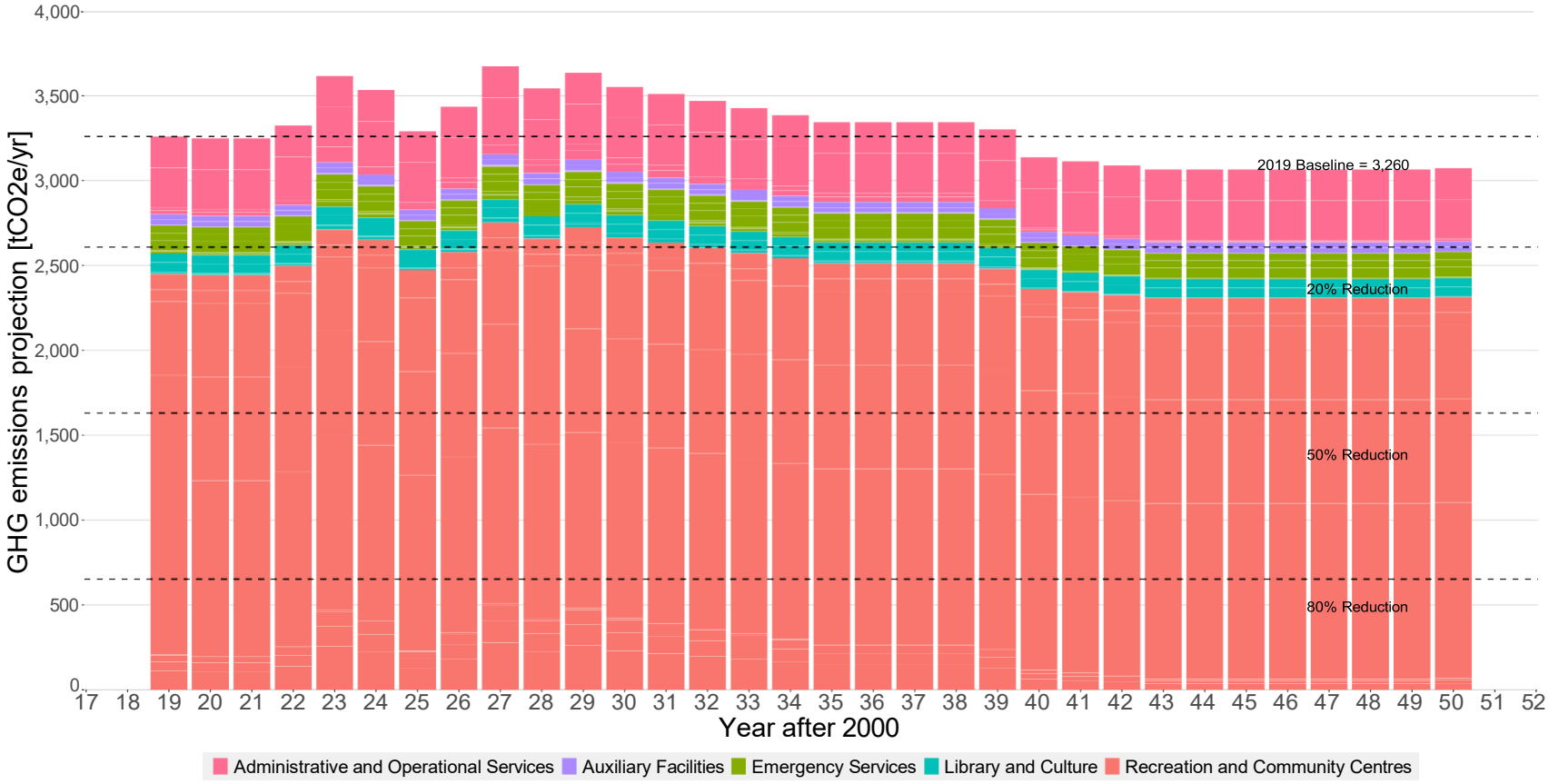
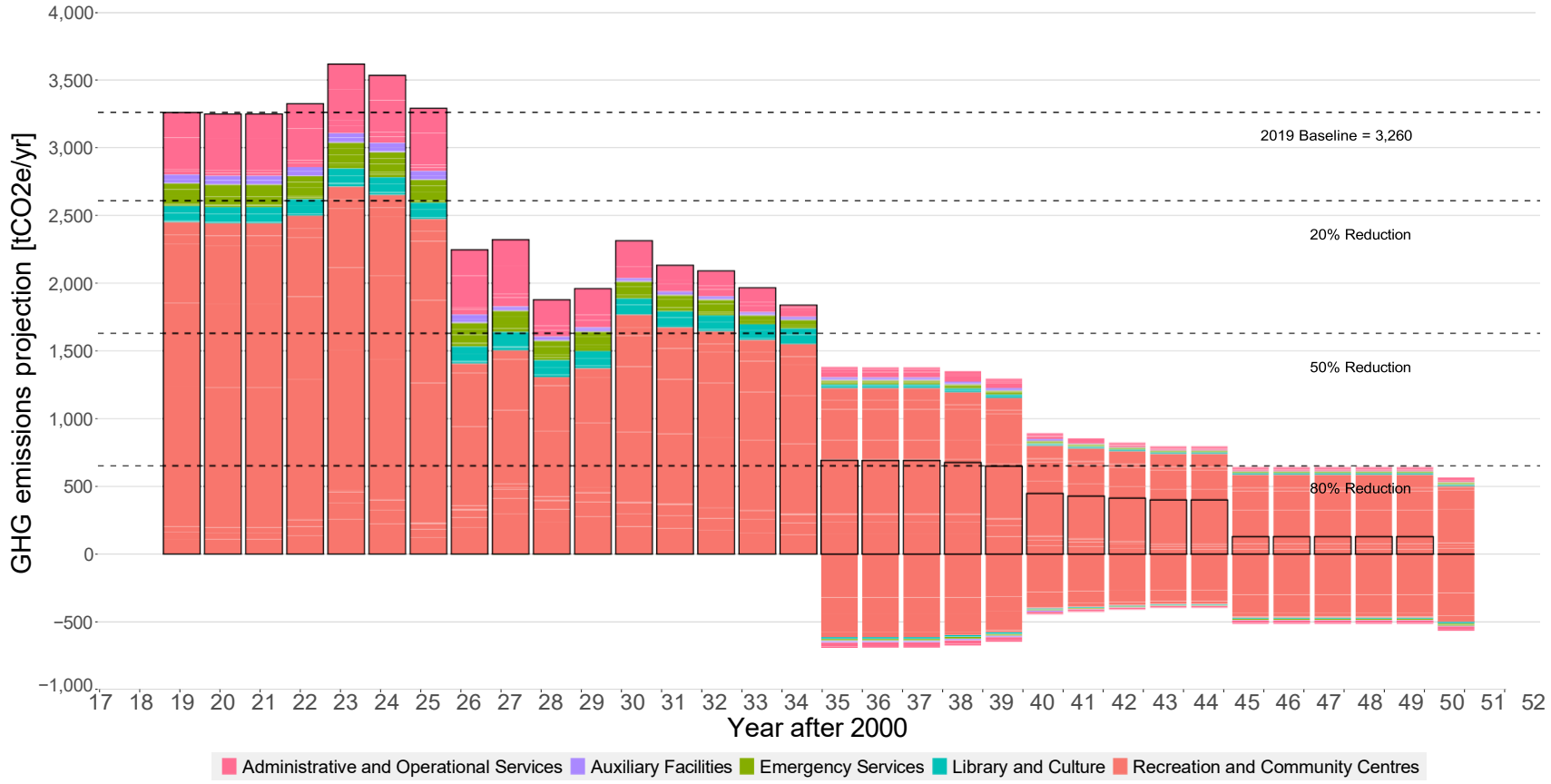


Figure 3: GHG Net-Zero Roadmap GHG emissions projection



Utility Costs

Figures 4 and 5 present how utility costs will change for the BAU and GHG Net-Zero Roadmap scenarios, respectively. As seen, utility costs will decrease for all other scenarios when compared to the BAU scenario.

In the scenario analysis, an escalation rate is applied to all utilities at a rate of 2% annually.

Comparing the BAU scenario to other scenarios, there are significant annual savings expected. By 2050, the cumulative savings exceed $9.6 million for the GHG Net Zero Roadmap over the BAU. Although the project cost is $7.7 million higher in the GHG Net Zero Roadmap when compared to the BAU scenario, the GHG Net Zero Roadmap is able to regain these costs through its cumulative utility cost savings. As a result, the GHG Net Zero Pathway is recommended.

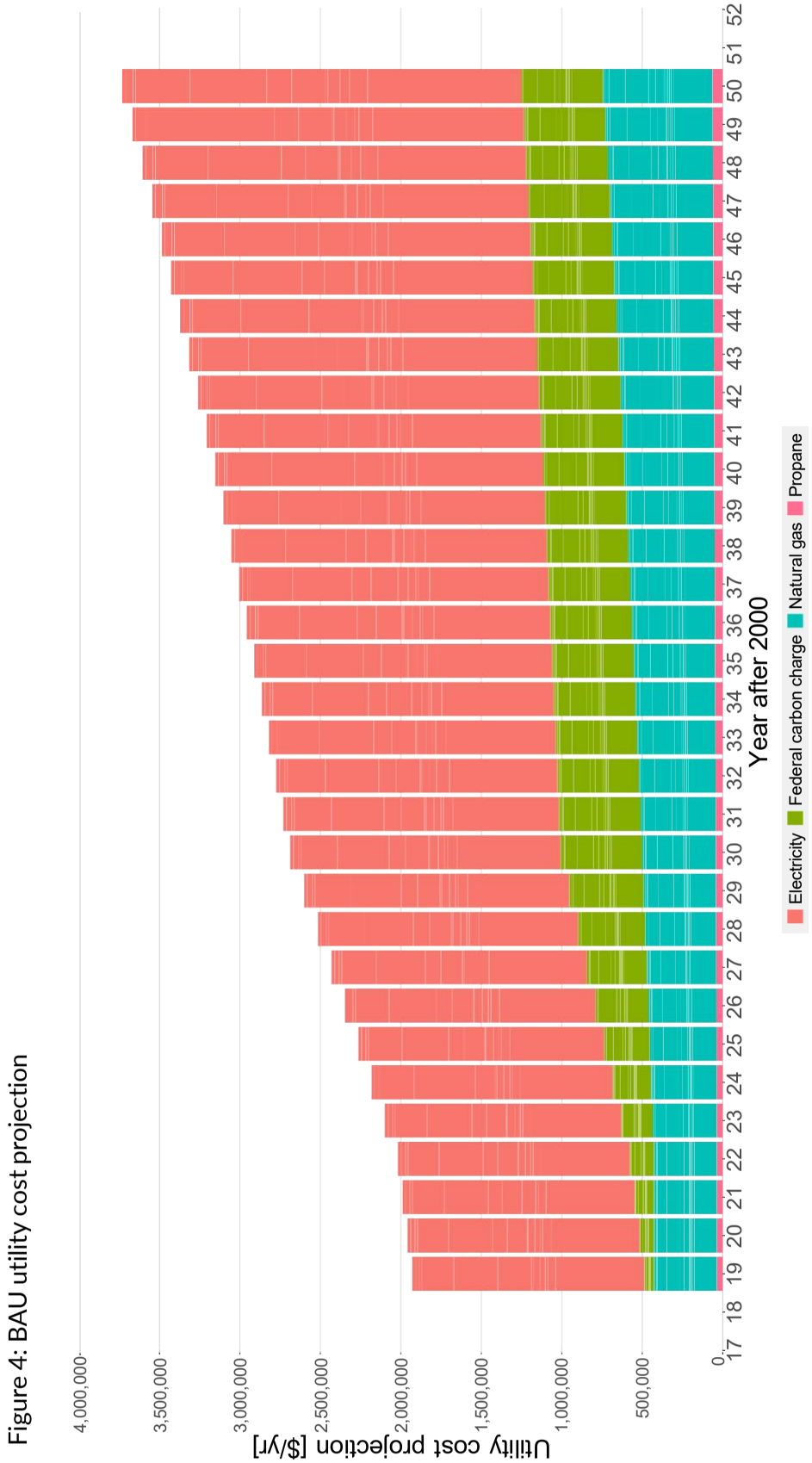
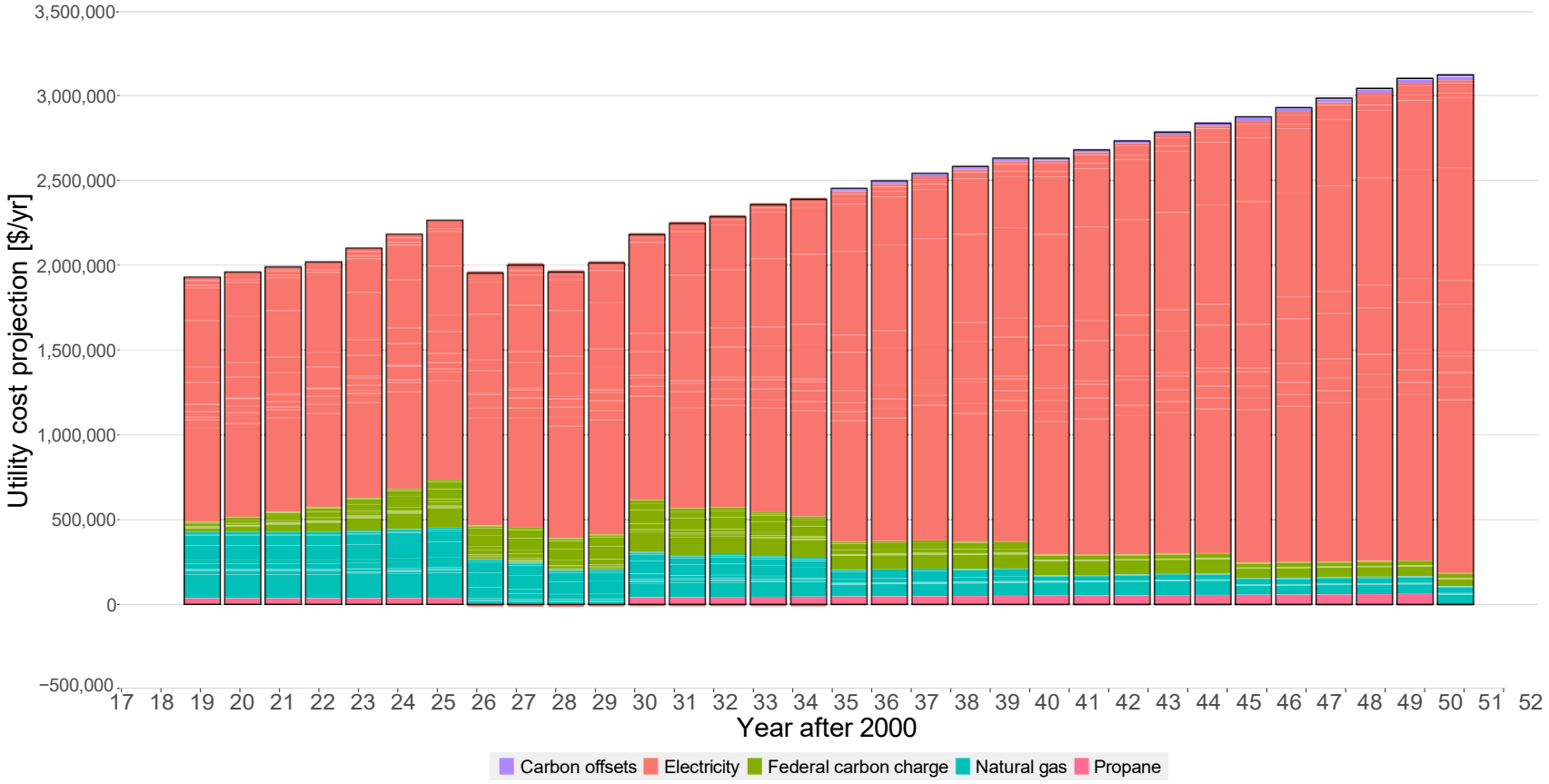


Figure 4: BAU utility cost projection

Figure 5: GHG Net-Zero Roadmap utility cost projection



Electricity End-Use

Figures 6 and 7 present how electricity will change for the BAU and GHG Net-Zero Roadmap scenarios, respectively. As seen, electricity will remain the same (BAU scenario) and increase in all other scenarios.

In the BAU scenario, electricity is set to remain consistent as it assumes a status quo approach. While it could be argued that electricity use may increase over time, this scenario is intended to illustrate what consumption would look like if the Town continues to operate and maintain its buildings in their current state.

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 are more efficient. Although electricity use increases in the GHG Net-Zero Roadmap, it is a result of converting natural gas to electricity allowing the Town to meet it's GHG reduction goals and is therefore the recommended scenario.

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

Figure 6: BAU electricity end use projection

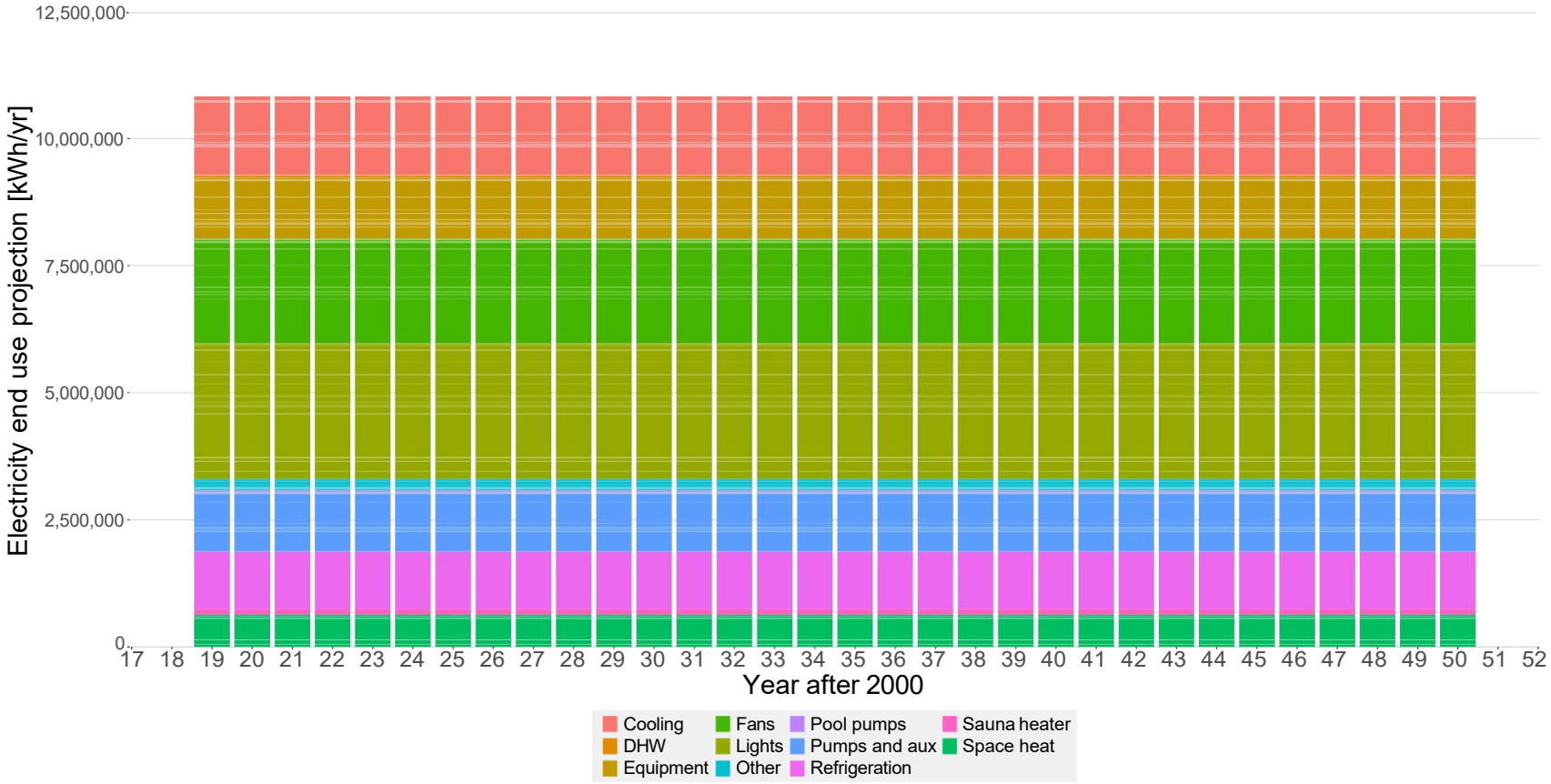
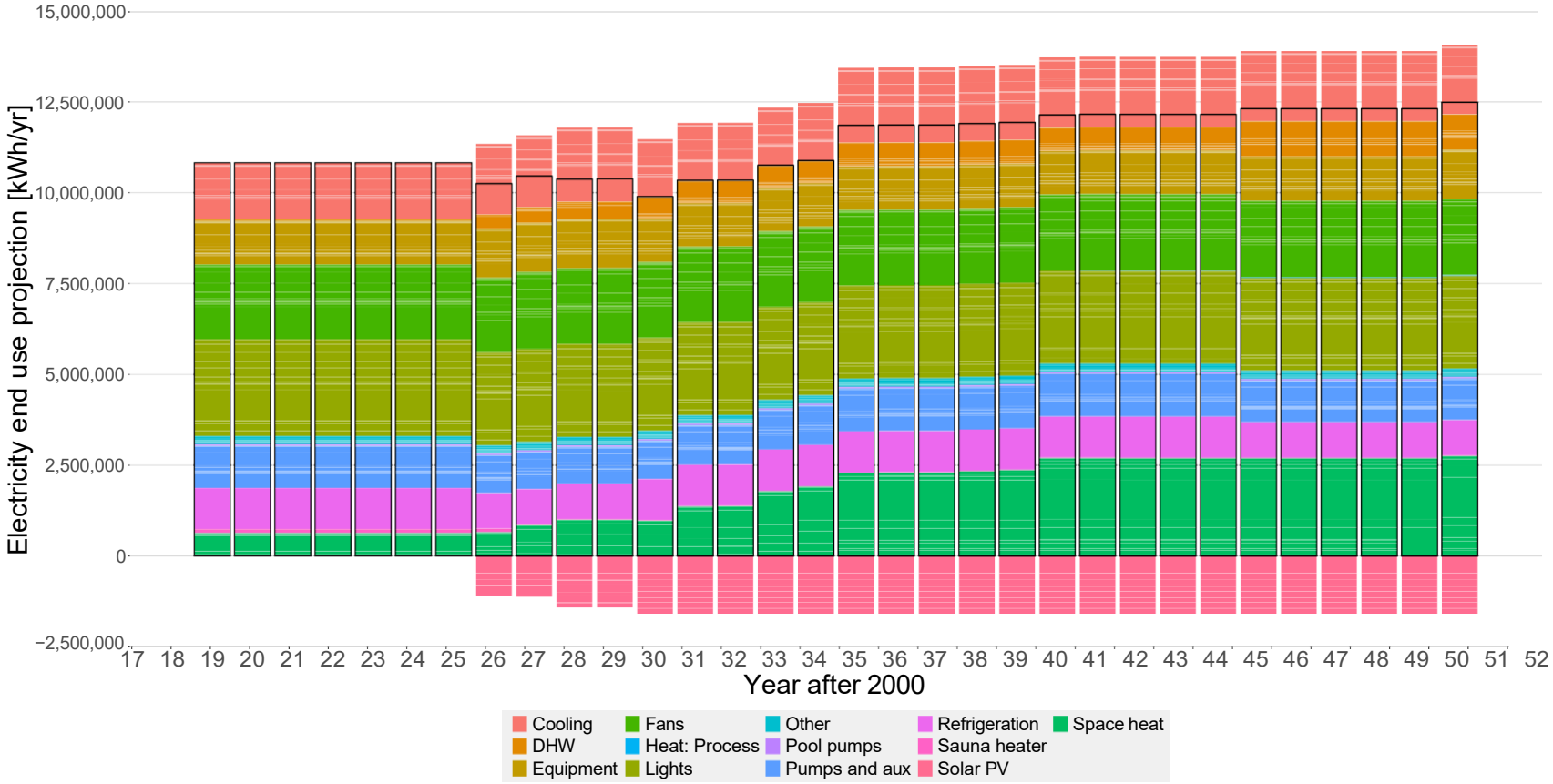


Figure 7: GHG Net-Zero Roadmap electricity end use projection



Natural Gas End-Use

Figures 8 and 9 present how natural gas will change the BAU and GHG Net-Zero Roadmap scenarios, respectively. As seen, natural gas will remain the same (BAU scenario) and decrease in all other scenarios.

In the BAU scenario, natural gas is set to remain consistent as it assumes a status quo approach. While it could be argued that natural gas use may increase over time, this scenario is intended to illustrate what consumption would look like if the Town continues to operate and maintain its buildings in their current state.

The GHG Net-Zero Roadmap results in a natural gas reduction of over 1,250,000 m^3 in 2050 compared to the BAU scenario. This large decrease in natural gas use allows the portfolio to meet the GHG reduction targets outlined in this report, and is therefore the recommended scenario.

Through the GHG Net-Zero Roadmap, over 80% reductions in natural gas is achieved 2045 onwards, but fully eliminating the use of natural gas at a facility is not feasible. 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 8: BAU natural gas end use projection

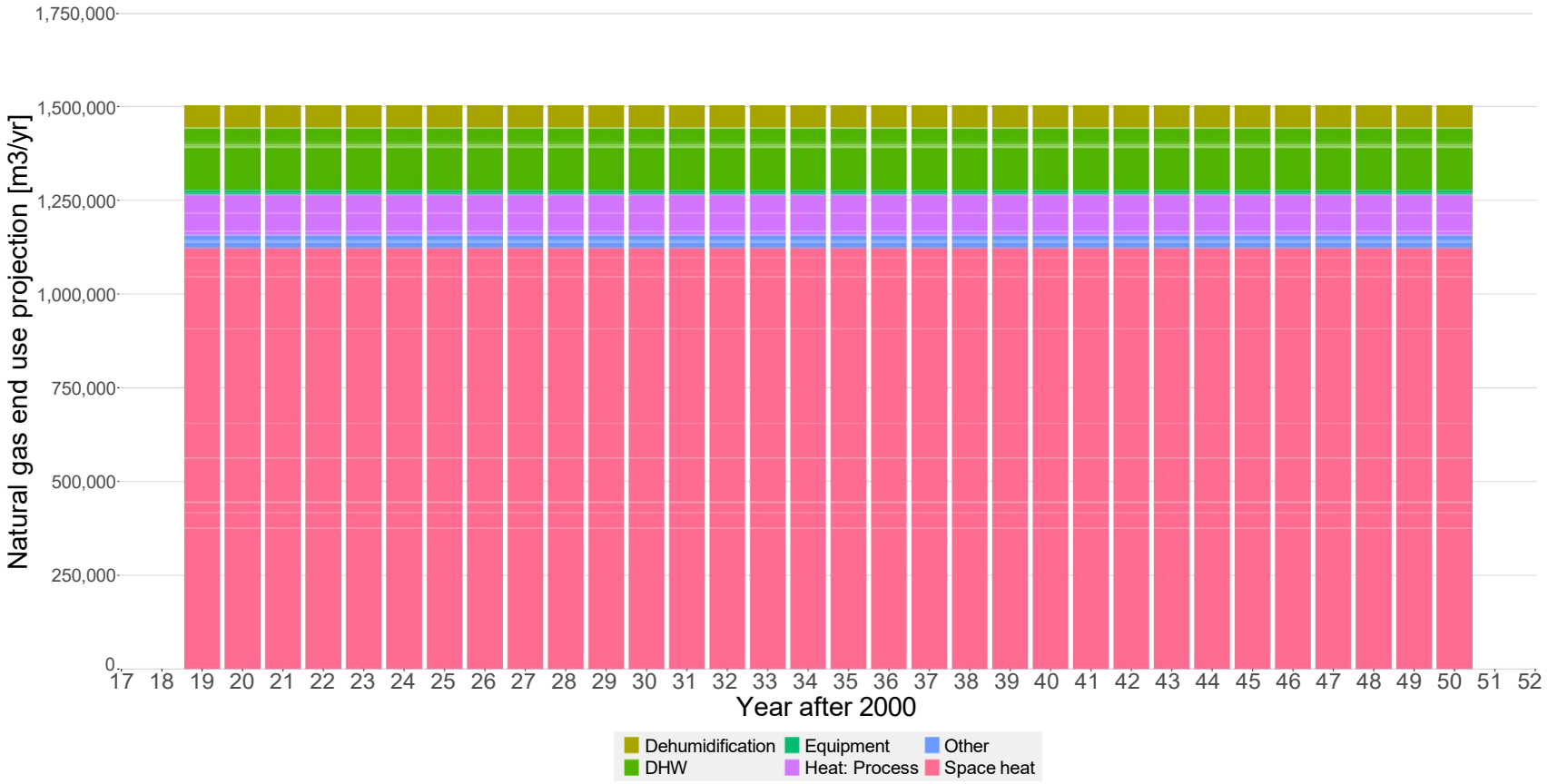
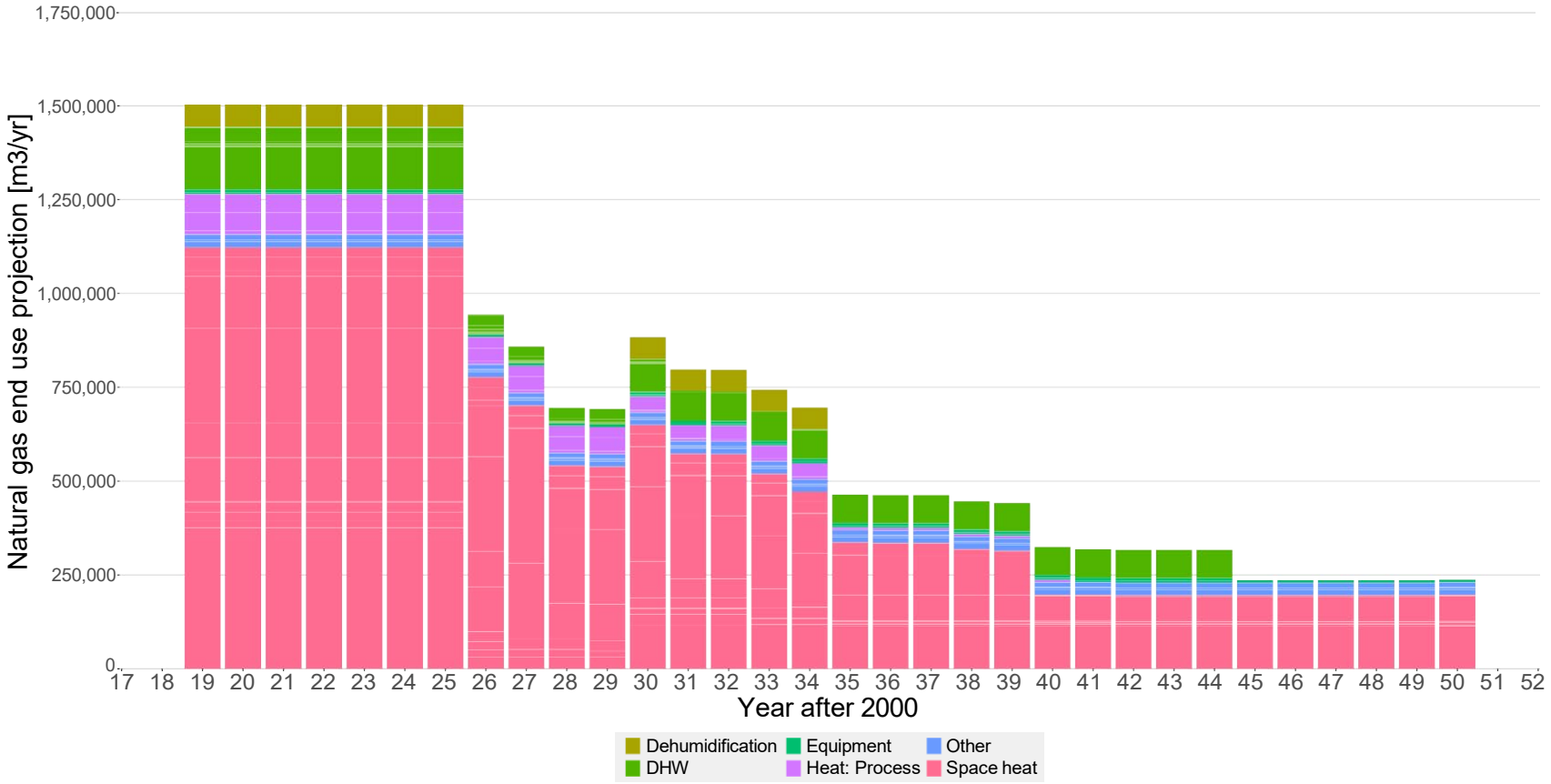


Figure 9: GHG Net-Zero Roadmap natural gas end use projection



Life Cycle Cost Present Value Projection

Figures 10 and 11 present the present value projection of the life cycle cost for the Business as Usual scenario and GHG Net-Zero Roadmap Scenario.

Figure 10: BAU LCC present value projection

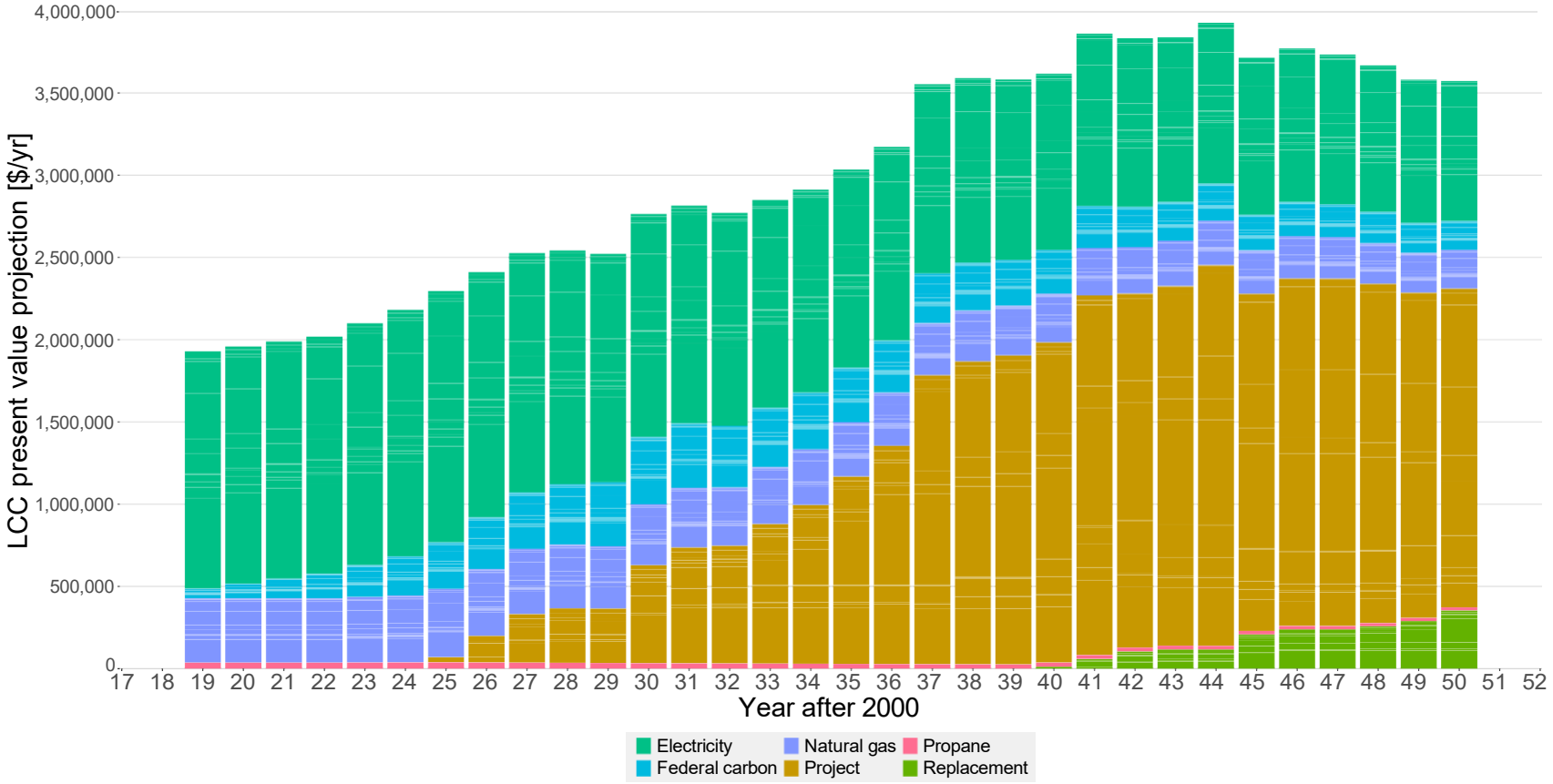
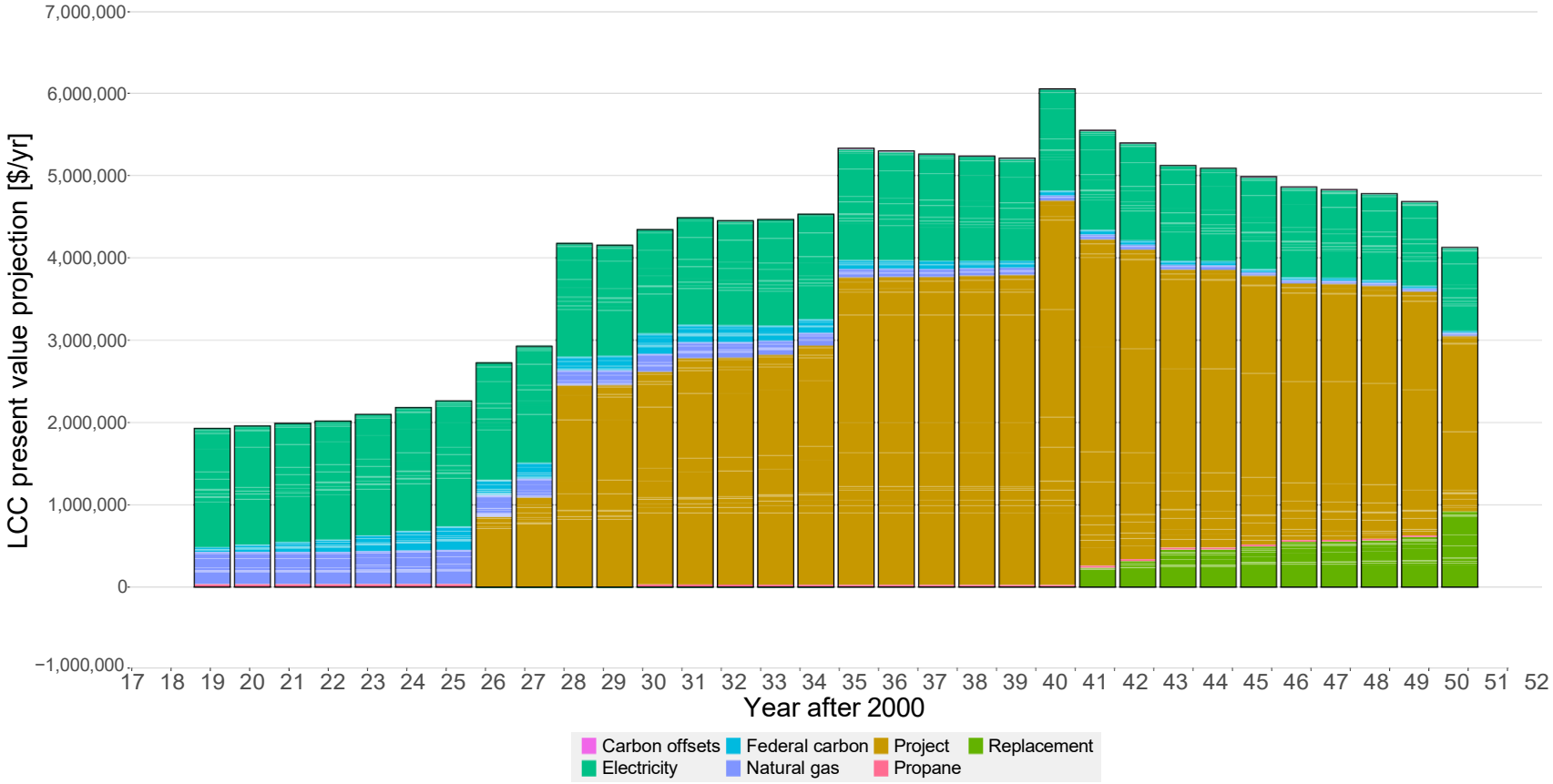


Figure 11: GHG Net-Zero Roadmap LCC present value projection



Financial

Figure 12 represents the financial summary of all four scenarios as outlined in Table 2. 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 BAU 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 GHG Net-Zero Roadmap expected project cost is just over $96 million. Compared to the BAU project cost of just over $89 million, this is an increase of just over $7 million, while reducing the GHG emissions of nearly 3,260 tonnes of CO2e, which is the equivalent of planting over 53,000 trees and growing them for 10 years.

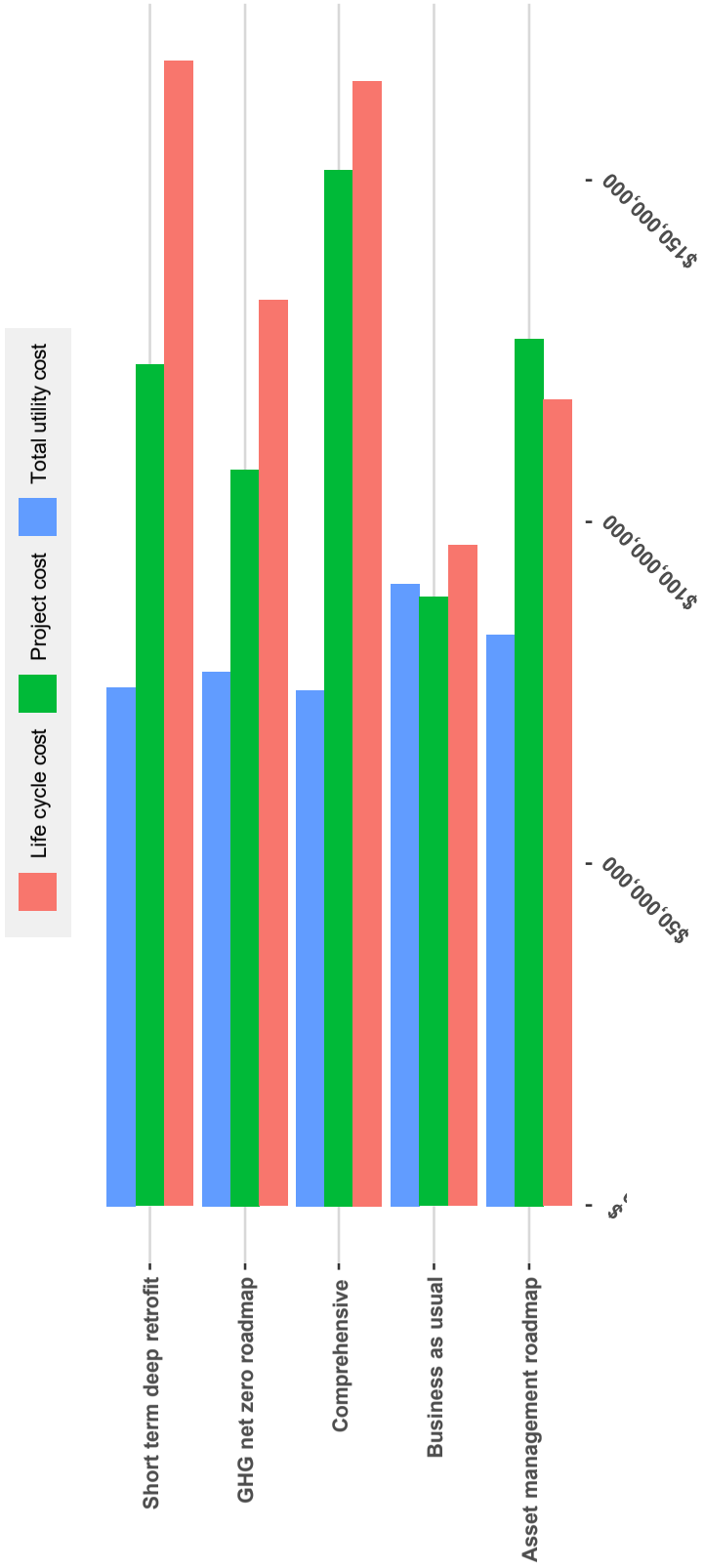


Figure 12: Cumulative financial metrics for each scenario compared

Financial Incentives and Opportunities

There are several financial opportunities offered for implementing the measures in the plans outlined above. These include, but are not limited to:

Grants offered through FCM's Green Municipal Fund:

- **Retrofit of existing municipal buildings.** Combined grant and loan up to $10 million for pursuing retrofit measures for a building or buildings to reduce GHG emissions by at least 50% in 10 years and best energy practice targets within 20 years.
- **GHG impact retrofit.** Combined grant and loan up to $5 million for pursuing a retrofit of a building or buildings to reduce emissions by at least 30%.
- **GHG reduction roadmap retrofit.** Combined grant and loan up to $5 million to pursue a sequence of GHG reduction measures to achieve a 50% GHG reduction within 10 years and 80% within 20 years.
- Source: https://greenmunicipalfund.ca/funding

Incentives offered through IESO's Save on Energy program:

- **Energy Performance Program.** This program pairs well with load minimization measures. The program allows participants to receive a performance incentive based on electricity saved in metered consumption when compared to a baseline energy model.
- **Instant Discounts Program.** Lighting retrofits and fixtures receive a discount amount per unit at a participating distributor.
- **Existing Building Commissioning Program** Provides incentives for participants who complete an investigation, implementation and persistence phase of a commissioning exercise.
- **Solar PV Distributed Energy Resources Incentive.** Provides incentives for behind-the-meter solar installations. An incentive of $1000/kW is available for projects less than 10kW, and $860/kW for large scale projects greater than 10kW up to 1000kW.
- **Retrofit Program Custom Stream.** Receive incentives for project costs for several energy-efficiency retrofit measures at $1200/kW of peak demand savings or $0.13/kWh of energy savings achieved in the project.
- Source: https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives

Incentives offered through Enbridge:

- **Custom Retrofit Incentives.** Receive $0.25/m3 of natural gas saved up to 50% of project upgrade costs up to a maximum of $100,000.
- Source: https://www.enbridgegas.com/ontario/business-industrial/incentives-conservation/progr and-incentives/retrofits-custom-projects/commercial-custom-retrofit-program

Incentives offered through Canada Infrastructure Bank:

- **Canada Infrastructure Bank Partners.** CIB offers incentives through multiple partners for project costs below $100 million. These partners include Ainsworth, Ameresco Canada,

Enbridge Sustain, Efficiency Capital, Johnson Controls Canada, Noventa Energy Partners, and SOFIAC.

- Source: https://cib-bic.ca/en/building-retrofits-initiative/

Other Recommendations

Revolving Fund

It is recommended that a revolving fund be established for the proposed projects included in the individual energy audits. The purpose of the revolving fund is to aid in project costs to implement the GHG Net-Zero Roadmap at each facility/archetype. As mentioned in the section above, there are a variety of incentive opportunities available that can help offset the project costs related to implementing the GHG Net-Zero Roadmap. The funds available through these incentive opportunities, along with operating budget/maintenance cost savings from completed GHG emission reduction projects, electricity cost savings from solar PV projects, and other applicable funding sources can be held in the revolving fund. Revolving funds have been implemented at multiple municipalities near the Town of Ajax including at the Town of Caledon, the City of Oshawa, and the Town of Whitby.

Corporate Green Building Standard

As part of the Corporate Net-Zero Emissions Plan, it is recommended that the Town develop and implement a Corporate Green Building Program to guide the design and construction of all new municipal facilities. This program would establish sustainability and emissions performance targets aligned with national standards such as the CaGBC's Zero Carbon Building Standard, ensuring that all future corporate buildings are energy-efficient, climate-resilient, and contribute meaningfully to the Town's long-term decarbonization goals.

Operational Efficiency

It is recommended that the Town assess the impacts of the energy conservation measures recommended in each facility's GHG Net-Zero Roadmap as it relates to day-to-day operations of the facility and consult with operations staff to determine the feasibility of each energy conservation measure. Steps should be taken to ensure efficient operation is possible with the upgraded equipment. This includes any necessary training to give operations and maintenance staff the resources to confidently operate and control the equipment.

Benefits of GHG Net-Zero Roadmap

The following benefits can be gained from pursuing the GHG Net-Zero Roadmap.

Reduced Greenhouse Gas Emissions

Less reliance on fossil fuels (for heating, cooling, electricity) means lower CO2 and other harmful emissions.

Healthier Indoor Environment

Better ventilation, reduced combustion indoors, and improved temperature regulation enhance occupant health and productivity especially in warming/cooling and air quality centers such as Ajax Community Centre.

Public Leadership

Demonstrates municipal leadership in sustainability, inspiring businesses and residents to follow suit, creating employment opportunities in green industries.

Lower Operating Costs

Energy-efficient systems (like heat pumps, LED lighting, or better insulation) reduce utility bills over time.

Incentives and Grants

Leverage financial support, tax incentives, or grants from Federal/Provincial governments for energy efficiency and renewable upgrades, which help in modernization of the municipal equipment at a reduced cost.

Increase Building Resilience

Modern, electrified systems often include backup or off-grid options, improving emergency preparedness.

Communication Framework

The purpose of this communication framework is to promote awareness, understanding, and support for the Town of Ajax's Corporate Net Zero Emissions Plan (CNZEP) among internal stakeholders, Council, and the public through a transparent and empowering approach.

1. **Objectives**.
    - Communicate the Town's commitment to conserve energy and achieve greenhouse gas emissions reductions to Town staff and Ajax community.
    - Engage elected officials and stakeholders in shared climate leadership.
    - Build accountability and transparency through consistent, accessible, and engaging communication.
    - Inspire broader community awareness and action to encourage behavioural change and participation from staff and the community.
2. **Key Messages**
    - CNZEP is the implementation pathway to achieve Town of Ajax's commitment to corporate GHG emissions reductions (compared to 2019 levels), including:
        - 20% by 2025.
        - 40% by 2030.
        - Net-zero by 2050.
    - CNZEP is action oriented and focuses on deep energy retrofits for the Town's existing municipal buildings to promote energy and cost savings.
    - CNZEP translates the Ajax's commitments into concrete actions and supports cost reduction, modernizes community buildings, increases building resiliency, improves community health, and drives innovation.
3. **Stakeholders**
    - Internal
        - Town Council & Senior Leadership: Secure endorsement and funding support; provide regular updates on progress.
        - Corporate Energy Team: A multidisciplinary team of Town staff from various departments who have shaped the development of CNZEP and will ensure the goals of CNZEP are met after the plan has been established.
        - Town Staff: Build internal alignment by clarifying implementation roles, and drive success through targeted training and awareness initiatives.
    - External
        - General Public: Foster community trust by showcasing key benefits including cost savings, improved health, and greater resilience and actively encouraging public feedback through engagement.

  - Community Partners: Encourage collaboration and knowledge-sharing among neighboring municipalities, advocacy groups, youth and educational institutions.
  - Government: Work in partnership with regional, provincial, and federal governments to align efforts and accelerate progress toward shared GHG reduction targets.

4. **Communication Channels**
   - Internal:
     - Town's intranet for updates (OLA).
     - Employee training sessions and CAO café.
     - Visual dashboards in Town buildings.
   - Council:
     - Annual Council reports and presentations.
   - Public:
     - Town's Environmental Sustainability webpage, IMO Ajax and social media.
     - Community events, open houses and pop-up booths.
     - Educational awareness campaigns and workshops.
5. **Approach** Phase 1: Announcement and Vision Setting
   - Media release after Mayor/Council endorsement.
   - CNZEP explainer video on social media platforms and Town's website
   - Key message briefings for staff and Councilors.

   Phase 2: Education and Engagement
   - Host workshops to engage departments and align roles.
   - Publish myth-busting information for staff and residents
   - Identify and feature municipal energy champions (staff or departments)

   Phase 3: Implementation and Progress Sharing
   - Leverage Corporate Energy Team to facilitate implementation and share progress.
   - Use interactive dashboards or reports for transparency
   - Share progress on key milestones annually (or bi-annually).
   - Celebrate and publicize completed actions (e.g. solar panel installation, building retrofits).

   Phase 4: Long-Term Integration
   - Embed net zero into internal decision-making and procurement policies.
   - Integrate climate lens for regular council reporting.
   - Reinforce through council events, awards, and youth initiatives.

6. **Roles and Responsibilities**
    - Sustainability Team: Lead CNZEP implementation, provide technical content, coordinate internal engagement and ensure alignment with Council priorities and feedback.
    - Building Maintenance Team: Implementation of CNZEP capital projects and ensure operational efficiency.
    - Facility Managers and staff: Collaborate with Sustainability and Building Maintenance teams to optimize the performance and efficiency of energy-saving equipment.
    - Department Leads: Act as CNZEP champions within their teams.
    - Public Strategies & Affairs: Support with grant identification and coordination.
    - Finance Team: Identify and coordinate sustainable funding solutions to support implementation of projects identified in the CNZEP.
    - Communications Team: Lead content design and development, social media publishing and media relations.
7. **Risk Mitigation** Risk: Perception of inaction.
    - Response: Provide regular, verifiable progress reports with clear metrics.

    Risk: Pushback or changes from stakeholders
    - Response: Emphasize co-benefits (cost savings, health, resilience).

    Risk: Public disengagement or confusion
    - Response: Use plain language, storytelling, and inclusive visuals.

    Risk: Staff burnout or lack of clarity
    - Response: Provide regular updates, tools, and recognition.
8. **Evaluation Metrics**
    - Achievement of key emissions reduction milestones.
    - Energy and cost savings through measurement and verification of energy efficiency projects.
    - Staff awareness and engagement (surveys, attendance at briefings)
    - Community attendance, satisfaction and feedback through surveys and workshops.
    - Social media engagement (shares, comments, reach).

Conclusion and Next Steps

The collaborative efforts between WalterFedy and the Town of Ajax have resulted in various GHG Reduction Roadmaps for 15 of the Town's facilities. The recommended scenarios and measures outlined in the study aim to guide the Town in achieving significant reductions in GHG emissions while considering financial viability and operational efficiency. The completion of this feasibility study enables the Town to apply for further FCM funding for retrofit project implementation through the Community Buildings Retrofit initiative.

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

Appendix

GHG Inventory

Tables 4 and 5 contain GHG emission inventories for municipal buildings included in this project and municipal lighting, respectively.

Table 4: GHG inventory for municipal facilities

Facilities	2019 GHG emissions [tCO2e/yr]	2024 GHG emissions [tCO2e/yr]
Ajax Community Centre	1,237	1,079
Ajax Fire Station 1 (formerly Ajax Fire Headquarters)	71	83
Ajax Fire Station 2	50	52
Ajax Fire Station 3 (formerly Ajax Fire Station 1)	46	44
Ajax Main Branch Library	65	58
Ajax Memorial Pool	31	29
Ajax Municipal Building	257	219
Ajax Operations Centre	203	145
Audley Recreation Centre	665	484
McLean Community Centre	471	458
Rotary Park Pavillion	35	97
St. Andrews Community Centre	76	66
St. Francis Centre	54	52
Storage Archetypes	0.44	0.46
Washroom Archetypes	0.46	3

Table 5: GHG inventory for street and park lighting

Lighting service area	2019 GHG emissions [tCO2e/yr]	2024 GHG emissions [tCO2e/yr]
Streetlighting	140	220
Soccer pitches	0.1	0.65
Paulyn Park lighting	0.17	0.3
Home Playground lighting	0.1	0.18
General parks maintenance	0.29	0.64
Baseball diamonds	5.5	11.4

Measure Analysis Summary

The tables below display the results of the energy conservation measure analysis for each building and archetype. The highlighted items in column 1 in the tables below indicate the proposed measures under the GHG Net Zero Roadmap Scenario.

Table 6: Ajax Community Centre measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	401,463	0	31,527	0	734,285	0	71.0	0	61,802	0	15	0	1,814,912	0	-	-
ASHP MTWL - Boilers to WSHPs	-1,092,344	-25.3	246,234	45.8	1,507,077	14.5	445	36	-39,555	-5.1	15	4,022,561	26,745,203	-5,100,798	9,047	-
ASHP MTWL - RTUs to WSHPs	-80,800	-1.9	16,585	3.1	94,278	0.90	29.8	2.4	-2,841	-0.36	15	623,295	22,427,395	-782,990	20,945	-
ASHP Medium Temperature Loop	0	0	0	0	0	0	0	0	0	0	15	4,270,725	26,928,893	-5,284,487	Inf	Inf
Carbon offsets 100	0	0	0	0	0	0	1,237	100	-29,681	-3.8	15	0	22,331,807	-687,401	0	-
Carbon offsets 50	0	0	0	0	0	0	618	50	-14,840	-1.9	15	0	21,988,106	-343,701	0	-
Carbon offsets 80	0	0	0	0	0	0	989	80	-23,745	-3.0	15	0	22,194,326	-549,921	0	-
Cold Water Flooding	198,394	4.6	53,180	9.9	759,797	7.3	107	8.7	42,627	5.4	15	153,900	20,857,667	786,739	1,434	3.6
DHU1 DHU2 Electrification	-502,596	-11.6	60,071	11.2	131,559	1.3	102	8.3	-38,021	-4.9	15	904,163	23,349,884	-1,705,479	8,836	-
DHW Heaters to ASHPs	-448,704	-10.4	75,759	14.1	351,061	3.4	134	10.8	-29,867	-3.8	15	557,888	22,720,046	-1,075,640	4,167	-
Electric Ice Resurfacers	-125,016	-2.9	3,020	0.56	330,249	3.2	93.7	7.6	26,442	3.4	15	827,213	22,014,576	-370,170	8,828	>20
Geothermal MTWL - Boilers to WSHPs	-1,225,246	-28.3	364,216	67.7	2,619,684	25.1	668	54	-12,989	-1.7	15	4,022,561	25,911,384	-4,266,978	6,024	-
Geothermal MTWL - Infrastructure	0	0	0	0	0	0	0	0	0	0	15	6,159,848	29,266,445	-7,622,040	Inf	Inf
Geothermal MTWL - RTUs to WSHPs	-174,310	-4.0	18,259	3.4	18,445	0.18	30.5	2.5	-13,486	-1.7	15	623,295	22,631,794	-987,389	20,407	-
Geothermal Medium Temperature Loop	0	0	0	0	0	0	0	0	0	0	15	3,645,506	26,155,263	-4,510,857	Inf	Inf
HV1 and HV2 Hydronic Conversion	0	0	0	0	0	0	0	0	0	0	15	423,225	22,168,093	-523,688	Inf	Inf
HVAC Optimization and Recommissioning	22,170	0.51	10,191	1.9	129,751	1.2	20.2	1.6	5,855	0.75	15	779,119	22,466,620	-822,215	38,660	>20
RTUs to ASHPs with Electric Backup	-86,097	-2.0	18,015	3.3	104,079	1.00	32.4	2.6	-2,375	-0.30	15	689,857	22,496,811	-852,406	21,313	-
RTUs to ASHPs with Gas Backup	-66,243	-1.5	15,233	2.8	94,571	0.91	27.5	2.2	-1,396	-0.18	15	412,452	22,141,735	-497,330	14,976	-
Radiant Heater Electrification	-26,019	-0.60	5,029	0.94	27,073	0.26	9	0.73	-1,968	-0.25	15	231,812	21,956,561	-312,156	25,801	-
Roof Upgrade to High Performance	7,189	0.17	21,813	4.1	237,458	2.3	42.1	3.4	8,384	1.1	15	15,801,683	40,974,752	-19,330,346	375,436	>20
Solar PV on roof	470,938	10.9	0	0	470,938	4.5	12.2	0.99	55,922	7.1	30	1,611,000	21,943,553	-299,148	131,571	>20
Wall Upgrade to High Performance	-4,171	-0.096	20,569	3.8	212,969	2.0	39.4	3.2	6,855	0.88	15	5,055,615	27,711,113	-6,066,708	128,301	>20
Window and Door Upgrade to High Performance	1,058	0.024	4,267	0.79	46,108	0.44	8.2	0.67	1,600	0.20	15	2,270,025	24,410,581	-2,766,176	275,981	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	14,817,353	-	-	-	-
Total BAU Cost												10,995,196				
Total Incremental Cost												3,822,157				

Table 7: Ajax Fire Station 1 (formerly Fire headquarters) measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	401,463	0	31,527	0	734,285	0	71.0	0	61,802	0	15	0	1,814,912	0	-	-
Boiler replacement with WSHP	-68,820	-17.1	30,465	96.6	252,787	34.4	56.7	79.9	577	0.93	15	382,826	2,200,779	-385,866	6,748	>20
Boilers to Air Source Heat Pump	-80,938	-20.2	27,286	86.5	207,117	28.2	50.3	70.9	-652	-1.1	15	479,014	2,359,404	-544,491	9,521	-
Carbon offsets 100	0	0	0	0	0	0	71.0	100	-1,704	-2.8	15	0	1,858,820	-43,908	0	-
Carbon offsets 50	0	0	0	0	0	0	35.5	50	-852	-1.4	15	0	1,836,866	-21,954	0	-
Carbon offsets 80	0	0	0	0	0	0	56.8	80	-1,363	-2.2	15	0	1,850,039	-35,126	0	-
DHW to ASHP	-7,028	-1.8	1,062	3.4	4,187	0.57	1.9	2.6	-531	-0.86	15	98,111	1,948,387	-133,474	52,804	-
HVAC Optimization and Recommissioning	8,347	2.1	-911	-0.029	8,251	1.1	0.20	0.28	992	1.6	15	115,425	1,940,336	-125,424	578,282	>20
Heat Pump Upgrade	11,302	2.8	-0.011	-0.0000	11,302	1.5	0.29	0.41	1,741	2.8	15	512,198	2,429,437	-614,525	1,743,120	>20
Parking lot solar PV	167,061	41.6	0	0	167,061	22.8	4.3	6.1	17,815	28.8	30	688,703	2,023,070	-208,158	158,556	>20
Window and door upgrade to high performance	12,645	3.1	1,436	4.6	27,809	3.8	3.1	4.3	1,969	3.2	15	5,326,864	8,554,226	-6,739,314	1,724,926	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	2,276,277	-	-	-	-
Total BAU Cost												1,609,542				
Total Incremental Cost												666,735				

Table 8: Ajax Fire Station 3 (formerly Station 1) measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	109,820	0	22,241	0	344,616	0	45.6	0	22,589	0	15	0	695,112	0	-	-
AHU to Air Source Heat Pump (ASHP)	-17,327	-15.8	4,354	19.6	28,642	8.3	7.9	17.4	-630	-2.8	15	125,044	855,491	-160,379	15,800	-
Boilers to Air Source Heat Pump	-68,032	-61.9	20,053	90.2	143,665	41.7	36.8	80.6	-1,626	-7.2	15	307,800	1,064,340	-369,228	8,375	-
Carbon offsets 100	0	0	0	0	0	0	45.6	100	-1,094	-4.8	25	-	723,300	-28,188	-	-
Carbon offsets 50	0	0	0	0	0	0	22.8	50	-547	-2.4	25	-	709,206	-14,094	-	-
Carbon offsets 80	0	0	0	0	0	0	36.5	80	-875	-3.9	25	-	717,662	-22,550	-	-
Domestic Hot Water to Air Source	-9,526	-8.7	1,617	7.3	7,546	2.2	2.9	6.3	-692	-3.1	15	98,111	830,539	-135,427	34,319	-
HVAC Optimization and Recommissioning	1,449	1.3	1,284	5.8	15,006	4.4	2.5	5.5	645	2.9	15	45,000	734,596	-39,484	17,966	>20
Install new energy recovery ventilator (ERV)	-9,546	-8.7	3,232	14.5	24,575	7.1	6.0	13.1	-87.5	-0.39	15	67,331	773,383	-78,271	11,296	-
Roof upgrades	7,516	6.8	3,851	17.3	48,165	14.0	7.6	16.7	2,377	10.5	15	434,768	1,185,789	-490,677	57,264	>20
Solar PV on roof	167,061	152	0	0	167,061	48.5	4.3	9.5	14,670	64.9	30	115,425	201,469	493,643	26,574	7.9
Wall upgrades	7,803	7.1	3,742	16.8	47,310	13.7	7.4	16.2	2,377	10.5	15	221,231	914,066	-218,954	29,929	>20
Window and door upgrades	3,175	2.9	1,677	7.5	20,878	6.1	3.3	7.2	1,020	4.5	15	460,161	1,254,164	-559,052	139,270	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	1,218,872	-	-	-	-
Total BAU Cost												269,909				
Total Incremental Cost												1,095,387				

Table 9: Ajax Fire Station 2 measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	206,607	0	22,970	0	449,091	0	49.5	0	42,153	0	15	0	1,242,534	0	-	-
Carbon offsets 100	0	0	0	0	0	0	49.5	100.0	-1,188	-2.8	25	-	1,273,143	-30,609	-	-
Carbon offsets 50	0	0	0	0	0	0	24.7	50.0	-594	-1.4	25	-	1,257,838	-15,305	-	-
Carbon offsets 80	0	0	0	0	0	0	39.6	80	-950	-2.3	15	-	1,267,021	-24,487	-	-
Domestic Hot Water to Air Source	-37,519	-18.2	1,529	6.7	-21,374	-4.8	2.0	4.0	-3,844	-9.1	15	76,500	1,411,698	-169,164	38,983	-
F-1 to ASHP	9,579	4.6	6.2	0.027	9,645	2.1	0.26	0.53	862	2.0	15	49,500	1,285,374	-42,740	189,670	>20
HVAC Optimization and Recommissioning	3,630	1.8	29.8	0.13	3,944	0.88	0.15	0.31	431	1.0	15	45,000	1,288,625	-46,091	296,943	>20
RTU replacement with ASHPs Electric-Backup	-11,466	-5.5	2,379	10.4	13,647	3.0	4.3	8.6	-2,739	-6.5	15	375,000	1,752,142	-509,608	87,787	-
Roof upgrade to high performance	2,397	1.2	524	2.3	7,931	1.8	1.1	2.2	493	1.2	15	315,495	1,617,300	-374,766	295,018	>20
Solar PV on roof	33,148	16.0	0	0	33,148	7.4	0.86	1.7	3,706	8.8	30	173,138	1,307,094	-64,560	192,375	>20
Unit heaters conversion	-127,365	-61.6	19,057	83.0	73,810	16.4	33.3	67.3	-9,161	-21.7	15	90,000	1,488,691	-246,157	2,703	-
Wall upgrade to high performance	4,333	2.1	361	1.6	8,140	1.8	0.81	1.6	667	1.6	15	411,683	1,732,007	-489,473	511,188	>20
Window and door upgrade to high performance	5,497	2.7	8,839	38.5	98,806	22.0	17.1	34.6	3,852	9.1	15	1,131,165	2,523,093	-1,280,559	66,064	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	2,351,986	-	-	-	-
Total BAU Cost												2,937,760				
Total Incremental Cost												-585,774				

Table 10: Ajax Main Branch Library measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	322,629	0	29,500	0	634,052	0	65.1	0	53,574	0	15	0	1,579,694	0	-	-
Boiler replacement with WSHP	-51,276	-15.9	21,357	72.4	174,187	27.5	39.7	61.0	1,677	3.1	15	263,554	1,816,216	-236,521	6,640	>20
Boilers to Air Source Heat Pump	-67,268	-20.9	21,357	72.4	158,195	24.9	39.3	60.4	-278	-0.52	15	313,571	1,922,605	-342,910	7,983	-
Carbon offsets 100	0	0	0	0	0	0	65.1	100	-1,561	-2.9	15	0	1,619,927	-40,232	0	-
Carbon offsets 50	0	0	0	0	0	0	32.5	50	-781	-1.5	15	0	1,599,811	-20,116	0	-
Carbon offsets 80	0	0	0	0	0	0	52.0	80	-1,249	-2.3	15	0	1,611,880	-32,186	0	-
Domestic Hot Water to Air Source	-9,040	-2.8	2,709	9.2	19,561	3.1	5.0	7.6	-125	-0.23	15	27,894	1,610,016	-30,322	5,613	-
Geothermal Infrastructure	0	0	0	0	0	0	0	0	0	0	15	4,583,334	7,418,930	-5,839,236	Inf	Inf
HVAC Optimization and Recommissioning	4,740	1.5	103	0.35	5,831	0.92	0.32	0.49	637	1.2	15	82,500	1,670,602	-90,907	256,374	>20
RTU replacement with ASHPs Electric-Backup	-28,922	-9.0	2,887	9.8	1,555	0.25	4.8	7.4	-2,963	-5.5	15	1,485,135	3,528,003	-1,948,308	309,803	-
RTU replacement with ASHPs NG-Backup	-28,813	-8.9	2,871	9.7	1,498	0.24	4.8	7.3	-2,958	-5.5	15	1,408,185	3,429,900	-1,850,206	295,429	-
RTU replacement with WSHPs	-17,495	-5.4	2,887	9.8	12,982	2.0	5.1	7.8	-1,304	-2.4	15	1,789,088	3,879,019	-2,299,324	351,428	-
Roof upgrade to high performance	811	0.25	887	3.0	10,174	1.6	1.7	2.7	434	0.81	15	1,690,976	3,721,946	-2,142,251	980,422	>20
Window and door upgrade to high performance	-866	-0.27	5,059	17.1	52,537	8.3	9.7	14.9	1,738	3.2	15	1,748,689	3,754,776	-2,175,081	180,368	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	1,832,150	-	-	-	-
Total BAU Cost												5,467,565				
Total Incremental Cost												-3,635,415				

Table 11: Ajax Memorial Pool measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	58,743	100	15,226	100	219,480	100	30.8	100	12,587	100	15	0	363,030	0	-	-
ASHP Pool Heaters	-29,213	-49.7	10,124	66.5	77,665	35.4	18.7	60.7	-914	-7.3	15	246,240	658,868	-295,838	13,176	-
Carbon offsets 100	0	0	0	0	0	0	30.8	100	-739	-5.9	15	0	380,137	-17,107	0	-
Carbon offsets 50	0	0	0	0	0	0	15.4	50	-369	-2.9	15	0	371,584	-8,553	0	-
Carbon offsets 80	0	0	0	0	0	0	24.6	80.0	-591	-4.7	15	0	376,716	-13,685	0	-
Domestic Hot Water to Air Source	-19,141	-32.6	3,694	24.3	19,856	9.0	6.6	21.4	-2,522	-20.0	15	75,026	495,632	-132,601	11,370	-
Infrared Tube Heater Electrification	-8,018	-13.7	1,083	7.1	3,416	1.6	1.9	6.1	-682	-5.4	15	33,666	415,196	-52,166	17,981	-
Pool Cover	0	0	1,095	7.2	11,558	5.3	2.1	6.8	390	3.1	15	230,850	638,129	-275,099	109,758	>20
Pool make-up water heat recovery and bather count system	0	0	1,130	7.4	11,926	5.4	2.2	7.1	402	3.2	15	38,475	399,754	-36,723	17,729	>20
Solar Thermal Pool Heating	0	0	2,912	19.1	30,736	14.0	5.6	18.2	1,037	8.2	15	101,959	461,139	-98,109	18,229	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	495,366	-	-	-	-
Total BAU Cost												194,530				
Total Incremental Cost												300,836				

Table 12: Ajax Municipal Building measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	887,211	0	121,570	0	2,170,591	0	257	0	165,339	0	15	0	4,963,160	0	-	-
Air Side Heat Recovery	-130,902	-14.8	10,760	8.9	-17,307	-0.80	18	7.0	-10,230	-6.2	15	510,000	5,804,904	-841,743	28,333	-
Boiler replacement with WSHP	-155,953	-17.6	65,945	54.2	540,212	24.9	123	47.9	3,067	1.9	15	1,065,000	6,060,049	-1,096,889	8,659	>20
Boilers to Air Source Heat Pump	-174,667	-19.7	65,945	54.2	521,498	24.0	122	47.5	590	0.36	15	1,702,500	6,926,304	-1,963,144	13,955	>20
Carbon offsets 100	0	0	0	0	0	0	257	100	-6,168	-3.7	25	-	5,122,092	-158,931	-	-
Carbon offsets 50	0	0	0	0	0	0	128	50	-3,084	-1.9	25	-	5,042,626	-79,466	-	-
Carbon offsets 80	0	0	0	0	0	0	206	80.0	-4,934	-3.0	15	-	5,090,305	-127,145	-	-
Geothermal Infrastructure	0	0	0	0	0	0	0	0	0	0	70	4,631,428	6,683,405	-1,720,245	Inf	Inf
HVAC Optimization and Recommissioning	849	0.096	0.31	0.0003	853	0.039	0	0	840	0.051	15	82,500	5,066,434	-103,274	Inf	>20
RTU replacement with ASHPs Electric-Backup	-290,829	-32.8	65,361	53.8	399,171	18.4	118	45.9	-17,034	-10.3	15	1,942,200	7,618,371	-2,655,210	16,459	-
RTU replacement with ASHPs NG-Backup	-289,554	-32.6	64,552	53.1	391,901	18.1	116	45.1	-17,127	-10.4	15	2,260,022	8,027,186	-3,064,025	19,483	-
RTU replacement with WSHPs	-272,004	-30.7	65,389	53.8	418,293	19.3	119	46.3	-15,673	-9.5	20	2,809,637	8,209,626	-3,246,465	23,610	-
Roof upgrade to high performance	3,009	0.34	1,435	1.2	18,154	0.84	3	1.2	833	0.50	15	3,695,524	9,649,192	-4,686,032	1,231,841	>20
Solar PV on roof	132,594	14.9	0	0	132,594	6.1	3	1.2	16,048	9.7	30	510,000	5,054,896	-91,735	170,000	>20
Window and door upgrade to high performance	2,496	0.28	11,346	9.3	122,274	5.6	22	8.6	4,302	2.6	15	2,370,830	7,856,685	-2,893,524	107,765	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	7,035,530	-	-	-	-
Total BAU Cost												16,298,156				
Total Incremental Cost												-9,262,626				

Table 13: Ajax Operations Centre measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	682,918	0	96,254	0	1,699,044	0	203	0	122,987	0	15	0	3,708,838	0	-	-
Boilers to Air Source Heat Pump	-203,463	-29.8	90,249	93.8	749,265	44.1	168	82.8	2,590	2.1	15	2,137,500	6,110,657	-2,401,819	12,723	>20
Carbon offsets 100	0	0	0	0	0	0	203	100	-4,872	-4.0	15	-	3,834,376	-125,537	-	-
Carbon offsets 50	0	0	0	0	0	0	102	50	-2,436	-2.0	15	-	3,771,607	-62,769	-	-
Carbon offsets 80	0	0	0	0	0	0	162	80	-3,898	-3.2	15	-	3,809,268	-100,430	-	-
Domestic Hot Water to Air Source Heat Pump	-41,092	-6.0	3,187	3.3	-7,447	-0.44	5	2.5	-3,804	-3.1	15	124,500	3,940,989	-232,150	24,900	-
Geothermal Heat Pump Upgrade (replacement)	29,856	4.4	-0.18	-0.0002	29,854	1.8	1	0.49	4,265	3.5	15	292,800	3,988,742	-279,904	292,800	>20
HVAC Optimization and Recommissioning	328	0.048	4,043	4.2	43,011	2.5	8	3.9	1,505	1.2	15	67,500	3,750,381	-41,543	8,438	>20
Lighting fixture and controls upgrade	98,343	14.4	-4,488	-4.7	50,961	3.0	-6	-3.0	10,903	8.9	15	7,500	3,493,140	215,699	-1,250	0.7
Parking lot solar PV	184,526	27.0	0	0	184,526	10.9	5	2.5	19,664	16.0	30	642,533	3,836,650	-127,812	128,507	>20
Roof upgrade to high performance	6,025	0.88	2,179	2.3	29,024	1.7	4	2.0	1,585	1.3	15	3,385,800	7,981,207	-4,272,368	846,450	>20
Wall upgrade to high performance	3,021	0.44	1,771	1.8	21,713	1.3	3	1.5	1,010	0.82	15	1,238,895	5,259,541	-1,550,703	412,965	>20
Window and door upgrade to high performance	29,989	4.4	16,304	16.9	202,101	11.9	32	15.8	9,878	8.0	15	3,393,495	7,768,407	-4,059,568	106,047	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	6,598,328	-	-	-	-
Total BAU Cost												6,416,419				
Total Incremental Cost												181,909				

Table 14: Audley Recreation Centre measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	2,037,523	0	318,613	0	5,401,034	0	665	0	387,460	0	15	0	11,729,854	0	-	-
AHU-2 and AHU-3 to Electric Heat	-442,976	-21.7	32,201	10.1	-103,038	-1.9	51	7.7	-45,915	-11.9	15	134,663	12,756,756	-1,026,902	2,640	-
Boiler Plant to High Temperature ASHP	-670,927	-32.9	160,783	50.5	1,026,417	19.0	292	43.9	-25,181	-6.5	15	9,493,706	23,424,926	-	32,513	-
														11,695,072		
Carbon offsets 100	0	0	0	0	0	0	665	100	-15,960	-4.1	25	0	12,121,146	-391,292	0	-
Carbon offsets 50	0	0	0	0	0	0	332	50	-7,980	-2.1	25	0	11,925,500	-195,646	0	-
Carbon offsets 80	0	0	0	0	0	0	532	80	-12,768	-3.3	25	0	12,042,887	-313,034	0	-
DHW plant to ASHP (Independent)	-50,269	-2.5	9,446	3.0	49,446	0.92	17	2.6	-3,216	-0.83	10	180,000	12,048,719	-318,865	10,588	-
Drain water heat recovery	-0.0040	-0.0000	1,212	0.38	12,797	0.24	2	0.30	415	0.11	15	48,094	11,776,352	-46,498	24,047	>20
General Recommissioning	42,464	2.1	18,611	5.8	238,939	4.4	37	5.6	11,426	2.9	15	86,569	11,545,832	184,021	2,340	7.6
Natural Gas Fireplace Removal	-9,828	-0.48	7,421	2.3	68,516	1.3	14	2.1	1,491	0.38	25	19,500	11,696,582	33,272	1,393	13
Pool Cover	100,236	4.9	14,343	4.5	251,656	4.7	30	4.5	14,559	3.8	15	230,850	11,668,984	60,870	7,695	16
RTU-1 to ASHP with Electric Backup	-228,485	-11.2	36,217	11.4	153,843	2.8	64	9.6	-26,808	-6.9	15	490,556	12,785,241	-1,055,387	7,665	-
RTU-1 to ASHP with Gas Backup	-160,237	-7.9	27,129	8.5	126,155	2.3	48	7.2	-12,733	-3.3	15	337,500	12,330,374	-600,520	7,031	-
RTU-1 to Electric Heat	-249,278	-12.2	36,230	11.4	133,192	2.5	64	9.6	-21,271	-5.5	15	221,231	12,339,856	-610,002	3,457	-
RTU-4 to Electric Heat	-9,593	-0.47	2,468	0.77	16,465	0.30	5	0.75	-513	-0.13	15	138,510	11,903,434	-173,580	27,702	-
Roof upgrades	8,660	0.43	4,358	1.4	54,662	1.0	8	1.2	2,415	0.62	25	4,087,969	15,676,258	-3,946,404	510,996	>20
Solar PV on roof	113,879	5.6	0	0	113,879	2.1	3	0.45	13,431	3.5	25	537,881	11,978,501	-248,647	179,294	>20
Window and door upgrades	73,683	3.6	32,796	10.3	419,899	7.8	65	9.8	19,764	5.1	25	18,110,183	28,987,853	-	278,618	>20
														17,257,999		
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	29,470,512	-	-	-	-
Total BAU Cost												20,806,084				
Total Incremental Cost												11,985,916				

Table 15: McLean Community Centre measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	1,402,416	0	226,574	0	3,794,294	0	471	0	275,534	0	15	0	8,342,002	0	-	-
Boilers to ASHP	-419,530	-29.9	148,182	65.4	1,144,781	30.2	273	58.0	1,872	0.68	15	7,954,706	17,624,971	-9,282,969	29,138	>20
Carbon offsets 100	0	0	0	0	0	0	471	100	-11,304	-4.1	25	0	8,619,143	-277,141	0	-
Carbon offsets 50	0	0	0	0	0	0	236	50	-5,652	-2.1	25	0	8,480,572	-138,570	0	-
Carbon offsets 80	0	0	0	0	0	0	377	80	-9,043	-3.3	25	0	8,563,715	-221,713	0	-
DHW to ASHP	-493,821	-35.2	77,226	34.1	321,435	8.5	135	28.7	-33,991	-12.3	15	144,281	9,004,032	-662,030	1,069	-
Decommission Sauna	93,718	6.7	-6,696	-3.0	23,034	0.61	-11	-2.3	8,885	3.2	15	57,713	8,247,166	94,836	-5,247	6.5
Drain water heat recovery	0	0	17,110	7.6	180,621	4.8	33	7.0	6,098	2.2	10	37,500	8,224,858	117,144	1,136	6.1
General Recommissioning	44,751	3.2	15,453	6.8	207,884	5.5	30	6.4	9,612	3.5	15	67,500	8,180,381	161,621	2,250	7.0
Install Energy Recovery Ventilators (ERVs) for AC-3 to AC-6	-35,108	-2.5	16,982	7.5	144,167	3.8	31	6.6	2,714	0.98	15	-	8,236,515	105,487	-	-
Integrated ASHP	-846,316	-60.3	223,756	98.8	1,515,813	39.9	407	86.4	-23,083	-8.4	15	11,802,206	22,641,550	-	28,991	-
														14,299,548		
Integrated Ground Source Heat Pump	-735,053	-52.4	214,269	94.6	1,526,928	40.2	391	83.0	-11,907	-4.3	15	16,236,450	27,868,421	-	41,525	-
														19,526,419		
Pool Cover (hot tub)	14,762	1.1	4,899	2.2	66,474	1.8	9	1.9	3,187	1.2	10	3,000	8,266,094	75,908	333	0.9
Roof and wall upgrades	-4,079	-0.29	6,225	2.7	61,637	1.6	11	2.3	1,776	0.64	25	4,580,449	12,779,772	-4,437,770	416,404	>20
Solar PV on roof	167,061	11.9	0	0	167,061	4.4	4	0.85	18,830	6.8	25	1,319,693	9,245,368	-903,366	329,923	>20
Variable Speed Fans AC-2 to AC-6	4,821	0.34	-600	-0.26	-1,517	-0.040	-1	-0.21	-295	-0.11	15	146,205	8,529,137	-187,135	-146,205	-
Window and door upgrades	-4,292	-0.31	4,531	2.0	43,544	1.1	7	1.5	940	0.34	25	5,476,916	13,680,427	-5,338,424	782,417	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	23,535,340	-	-	-	-
Total BAU Cost												19,517,337				
Total Incremental Cost												4,018,003				

Table 16: Rotary Park Pavilion measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	94,560	0	16,923	0	273,212	0	35	0	22,298	0	15	0	585,204	0	-	-
Carbon offsets 100	0	0	0	0	0	0	35	100	-840	-3.8	15	0	606,848	-21,644	0	-
Carbon offsets 50	0	0	0	0	0	0	17.5	50	-420	-1.9	15	0	596,026	-10,822	0	-
Carbon offsets 80	0	0	0	0	0	0	28	80	-672	-3.0	15	0	602,520	-17,315	0	-
Domestic hot water to ASHP	-21,226	-22.4	2,816	16.6	8,505	3.1	5	14.3	-2,899	-13.0	15	44,246	676,353	-91,149	8,849	-
Domestic hot water to electric hot water heater	-17,526	-18.5	2,116	12.5	4,817	1.8	3.7	10.6	-2,572	-11.5	15	46,170	676,682	-91,478	12,478	-
Gas fired unit heater to electric	-8,209	-8.7	1,220	7.2	4,669	1.7	2.1	6.0	-1,219	-5.5	15	111,578	741,741	-156,537	53,132	-
RTU replacement with ASHP	-53,060	-56.1	12,887	76.1	82,981	30.4	23.4	66.9	-3,980	-17.8	15	471,319	1,190,097	-604,893	20,142	-
Roof upgrade to high performance	1,047	1.1	399	2.4	5,256	1.9	0.90	2.6	310	1.4	15	140,434	757,092	-171,888	156,038	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	627,143	-	-	-	-
Total BAU Cost												266,705				
Total Incremental Cost												408,421				

Table 17: St Andrews Community Centre measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	179,310	0	37,267	0	572,727	0	76.3	0	39,197	0	15	0	1,201,285	0	-	-
Boiler to A2W Heat Pump	-48,154	-26.9	19,308	51.8	165,676	27.2	35.8	47.0	1,266	3.2	15	315,495	1,518,950	-317,666	8,803	>20
CC - AirSide Heat Recovery and HV-1 Replacement	-16,510	-9.2	9,142	24.5	79,998	14.0	17.1	22.5	1,125	2.9	15	423,225	1,689,124	-487,839	24,703	>20
CC - RTU replacement with ASHP	-57,383	-32.0	13,382	35.9	83,882	14.6	24.2	31.8	-2,810	-7.2	15	185,065	1,459,183	-257,898	7,643	-
Carbon offsets 100	0	0	0	0	0	0	76.3	100	-1,830	-4.7	15	-	1,248,440	-47,155	-	-
Carbon offsets 50	0	0	0	0	0	0	38.1	50	-915	-2.3	15	-	1,224,862	-23,577	-	-
Carbon offsets 80	0	0	0	0	0	0	61.0	80	-1,464	-3.7	15	-	1,239,009	-37,724	-	-
Domestic Hot Water to Air Source	793	0.44	0	0	793	0.14	0.021	0.027	177	0.45	15	57,713	1,270,954	-69,669	2,797,368	>20
Gym - Changeroom exhaust fan to ERV	-5,031	-2.8	283	0.76	-2,047	-0.36	0.41	0.54	-787	-2.0	15	57,713	1,291,174	-89,890	140,019	-
Roof upgrade to high performance	3,237	1.8	2,153	5.8	25,967	4.5	4.2	5.5	1,218	3.1	15	909,934	2,327,642	-1,126,357	215,612	>20
Solar PV car port	23,204	12.9	0	0	23,204	4.1	0.60	0.79	3,113	7.9	30	100,800	1,220,678	-19,393	167,080	>20
Solar PV on roof	79,556	44.4	0	0	79,556	13.9	2.1	2.7	9,653	24.6	30	256,800	1,213,167	-11,883	124,150	>20
Wall upgrade to high performance	2,841	1.6	2,400	6.4	28,181	4.9	4.7	6.1	1,271	3.2	15	296,258	1,543,936	-342,651	63,236	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	2,545,290	-	-	-	-
Total BAU Cost												2,891,179				
Total Incremental Cost												-345,889				

Table 18: St Francis Centre measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	122,471	0	26,706	0	404,404	0	54.5	0	31,255	0	15	0	834,515	0	-	-
Carbon offsets 100	0	0	0	0	0	0	54.5	100	-1,308	-4.2	15	0	868,210	-33,695	0	-
Carbon offsets 50	0	0	0	0	0	0	27.2	50	-654	-2.1	15	0	851,363	-16,848	0	-
Carbon offsets 80	0	0	0	0	0	0	43.6	80	-1,046	-3.3	15	0	861,471	-26,956	0	-
HVAC Optimization and Recommissioning	722	0.59	2,358	8.8	25,618	6.3	4.5	8.3	953	3.0	15	45,000	864,717	-30,202	9,892	>20
Heating boiler to ASHP	-86,115	-70.3	25,607	95.9	184,213	45.6	47.0	86.2	-4,786	-15.3	15	457,853	1,374,828	-540,313	9,751	-
Roof upgrade to high performance	747	0.61	2,588	9.7	28,067	6.9	5.0	9.2	1,041	3.3	15	402,064	1,317,057	-482,542	80,559	>20
Solar PV on roof	12,120	9.9	0	0	12,120	3.0	0.32	0.58	1,947	6.2	30	142,358	925,527	-91,012	451,741	>20
Window and door upgrade to high performance	-558	-0.46	3,501	13.1	36,397	9.0	6.7	12.3	1,151	3.7	15	273,173	1,146,655	-312,140	40,711	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	645,211	-	-	-	-
Total BAU Cost												1,434,171				
Total Incremental Cost												-788,960				

Table 19: Storage Archetypes measure analysis summary

Measure ID	Utility use		Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	8,878	100	8,878	100	0.23	100	1,328	100	15	0	34,104	0	-	-
Carbon offsets 100	0	0	0	0	0.23	100	-5.5	-0.42	15	0	34,232	-128	0	-
Carbon offsets 50	0	0	0	0	0.12	50	-2.8	-0.21	15	0	34,168	-64.2	0	-
Carbon offsets 80	0	0	0	0	0.18	80.0	-4.4	-0.33	15	0	34,207	-103	0	-
LED Lighting	4,439	50.0	4,439	50.0	0.12	50.0	664	50.0	15	17,314	42,499	-8,395	150,014	>20
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	17,314	-	-	-	-

Table 20: Washroom Archetypes measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial					
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$/yr/tCO2e]	[yr]
Baseline	9,230	100	5,326	100	65,455	100	10.5	100	2,996	100	15	0	90,851	0	-	-
Carbon offsets 100	0	0	0	0	0	0	10.5	100	-251	-8.4	15	0	96,672	-5,820	0	-
Carbon offsets 50	0	0	0	0	0	0	5.2	50	-126	-4.2	15	0	93,762	-2,910	0	-
Carbon offsets 80	0	0	0	0	0	0	8.4	80	-201	-6.7	15	0	95,508	-4,656	0	-

Gas-Fired Furnaces to ASHP with electric backup	-40,813	-442	5,326	100	15,412	23.5	9.2	87.6	-3,482	-116	15	136,586	314,075	-223,224	14,895	-
LED Lighting	3,107	33.7	-232	-4.4	656	1.0	-0.37	-3.5	281	9.4	15	4,617	91,665	-814	-12,638	16
Total GHG Net Zero Roadmap Projects' Cost	-	-	-	-	-	-	-	-	-	-	-	141,203	-	-	-	-

Scenario Analysis Figures

GHG Emissions

Figure 13: Comprehensive GHG emissions projection

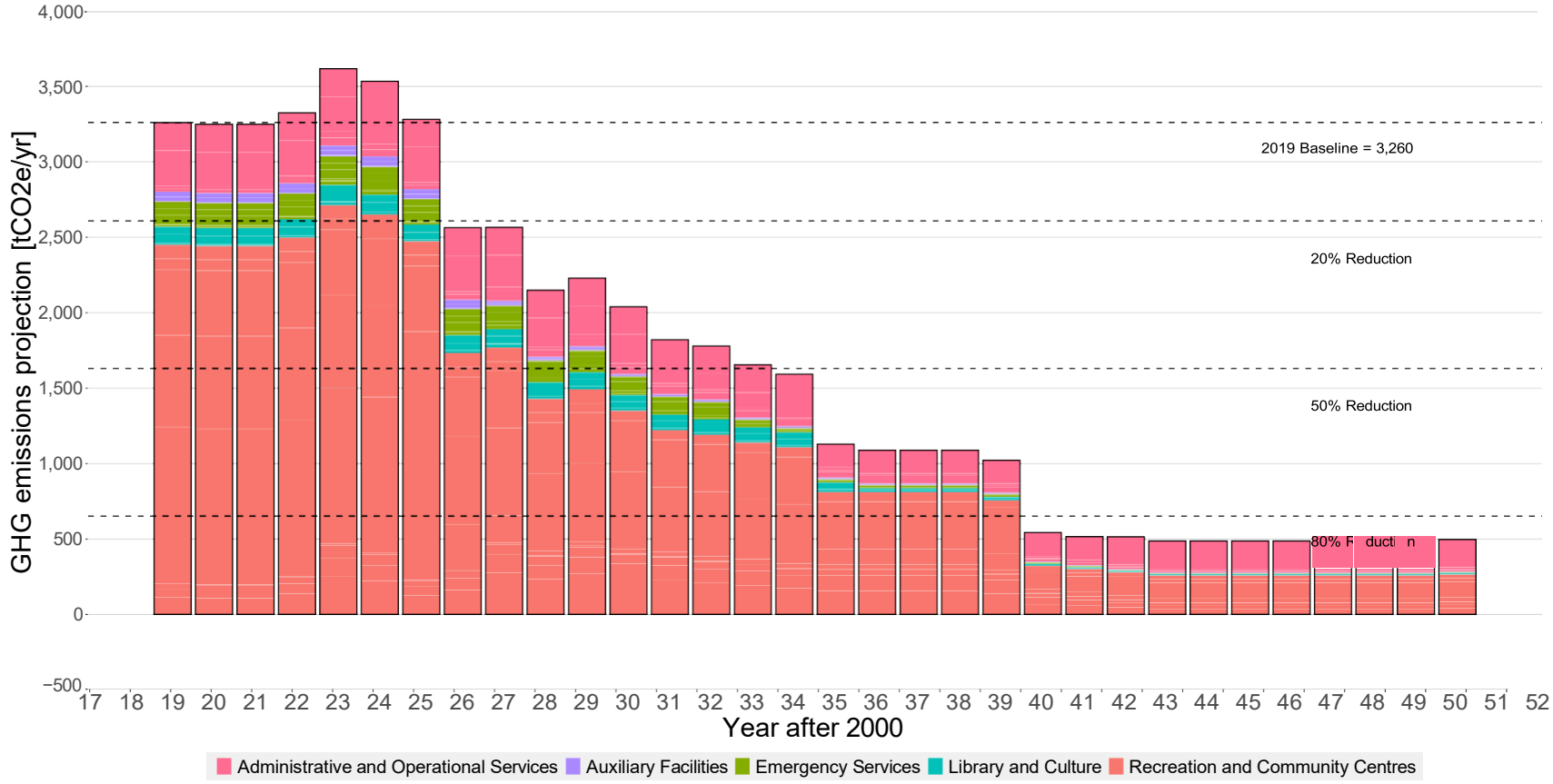


Figure 14: Short Term Deep Retrofit GHG emissions projection

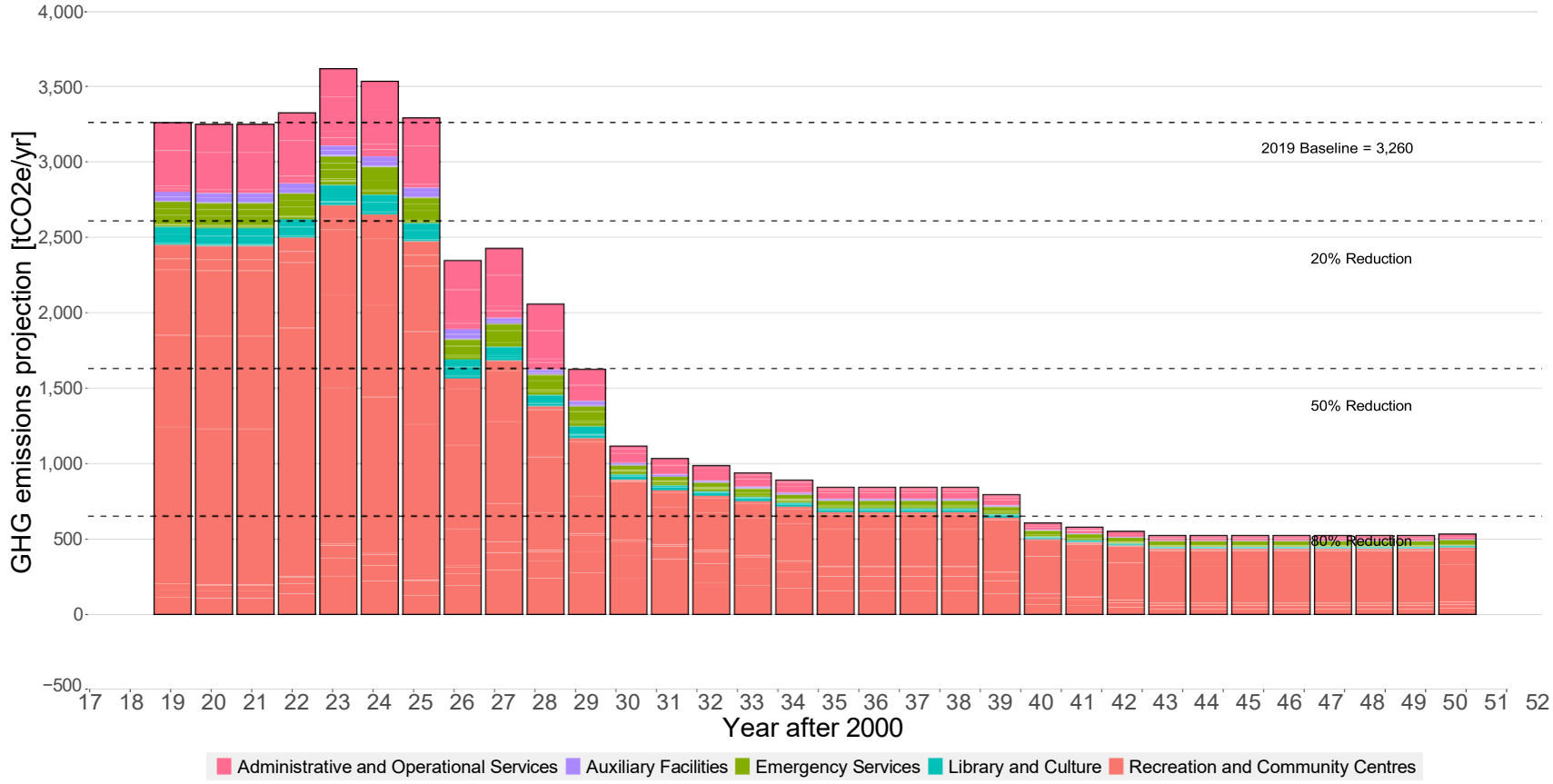
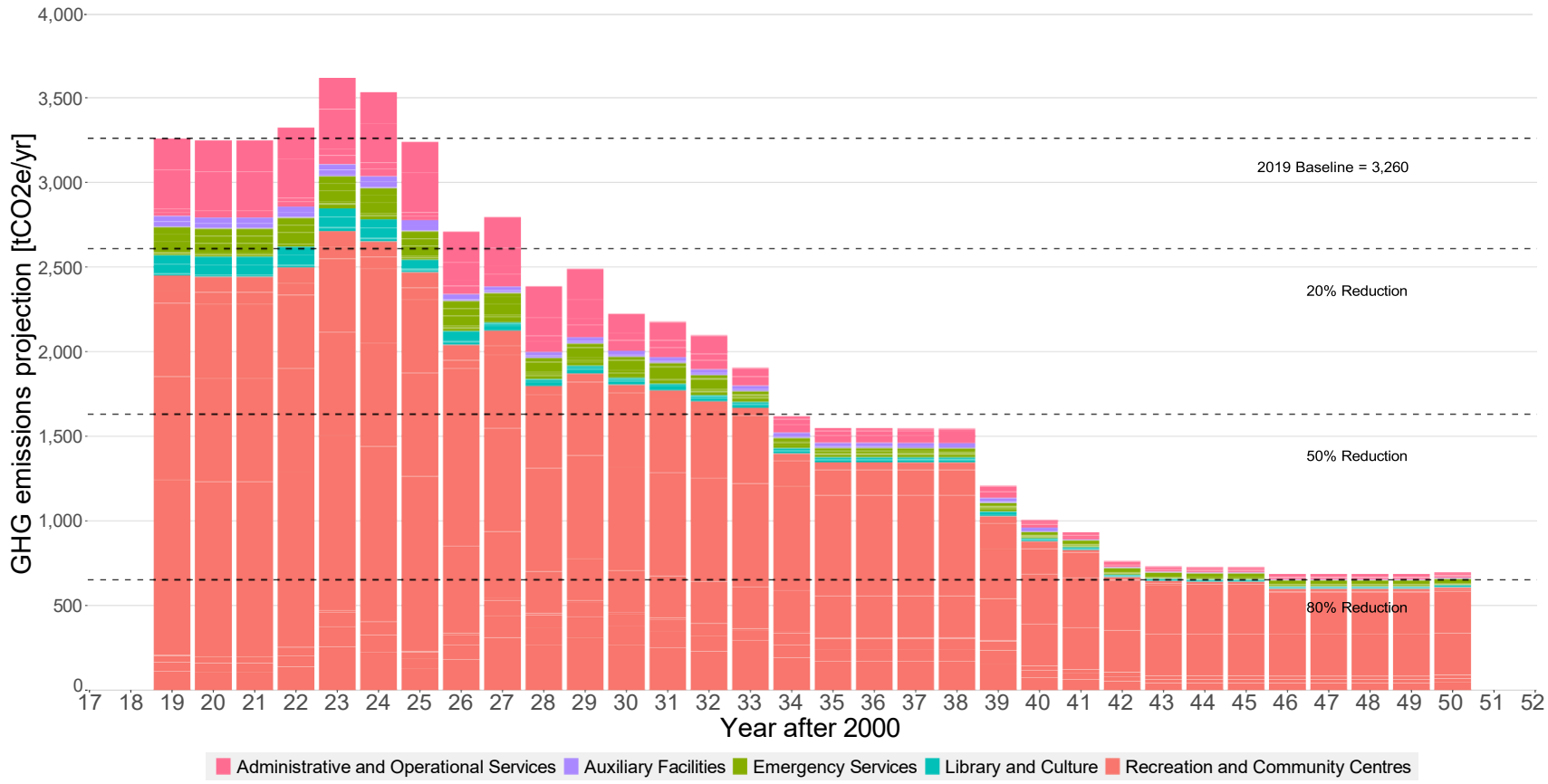


Figure 15: Asset Management GHG emissions projection



Utility Costs

Figure 16: Comprehensive utility cost projection

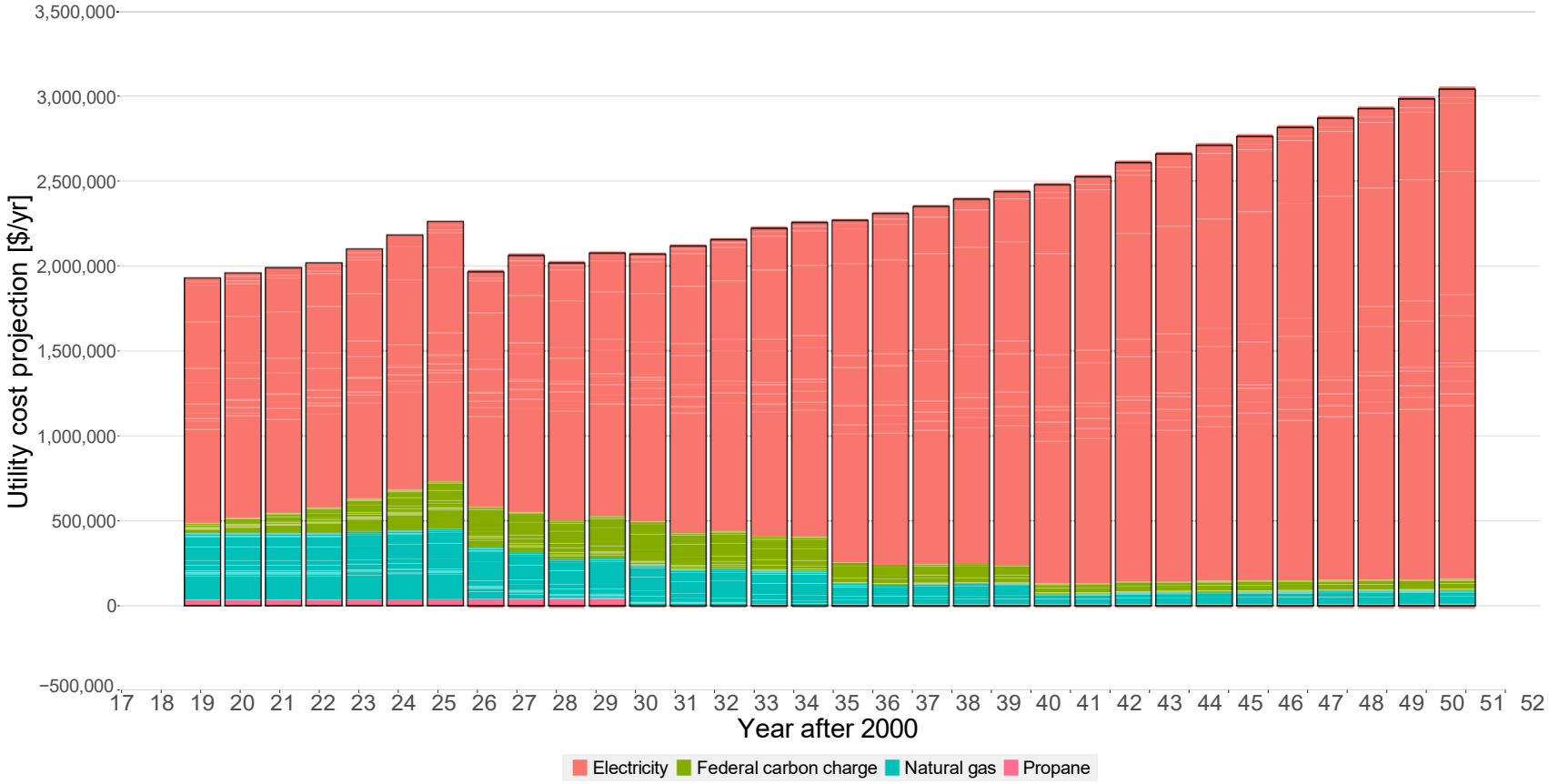
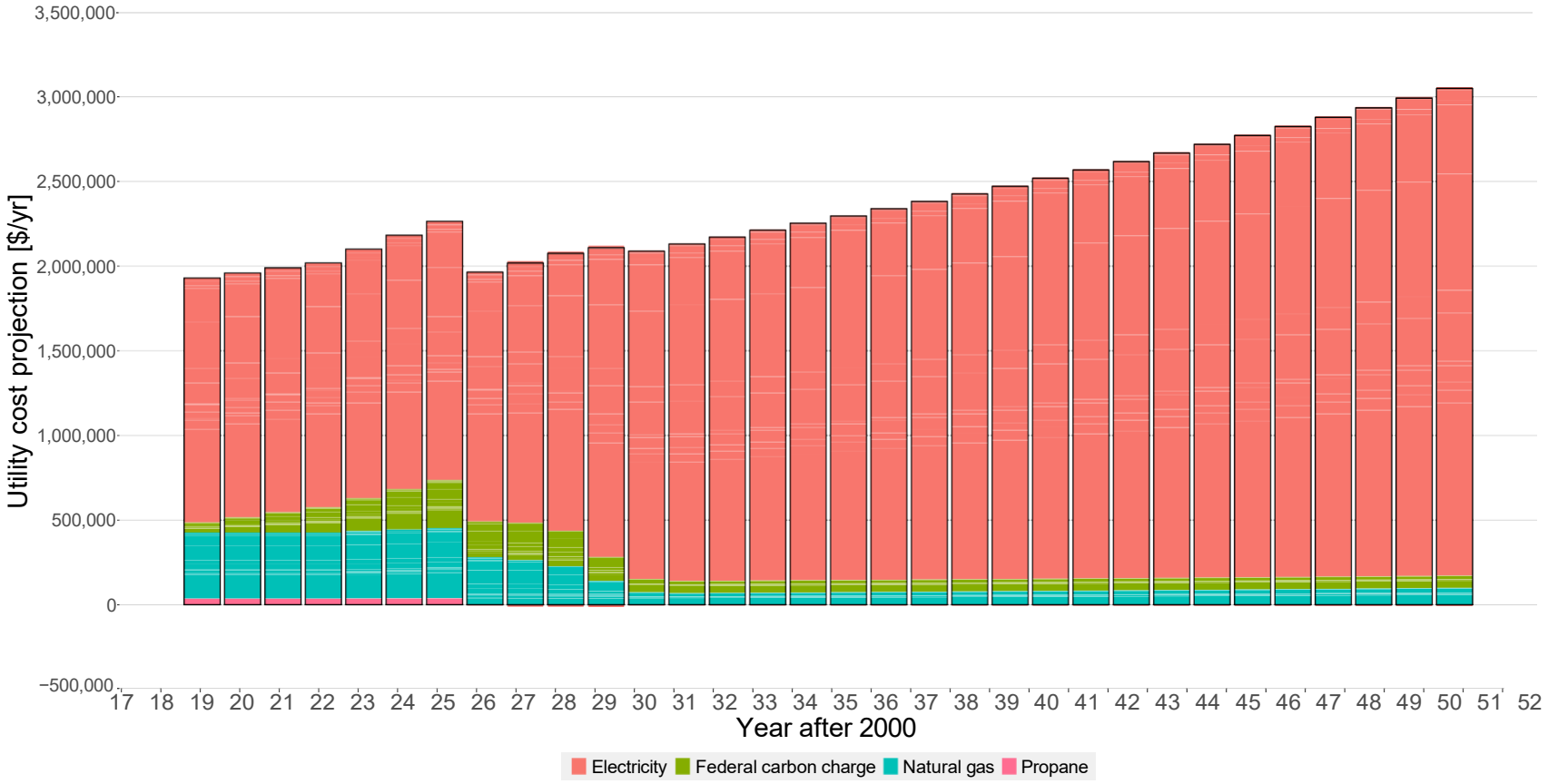


Figure 17: Short Term Deep Retrofit utility cost projection



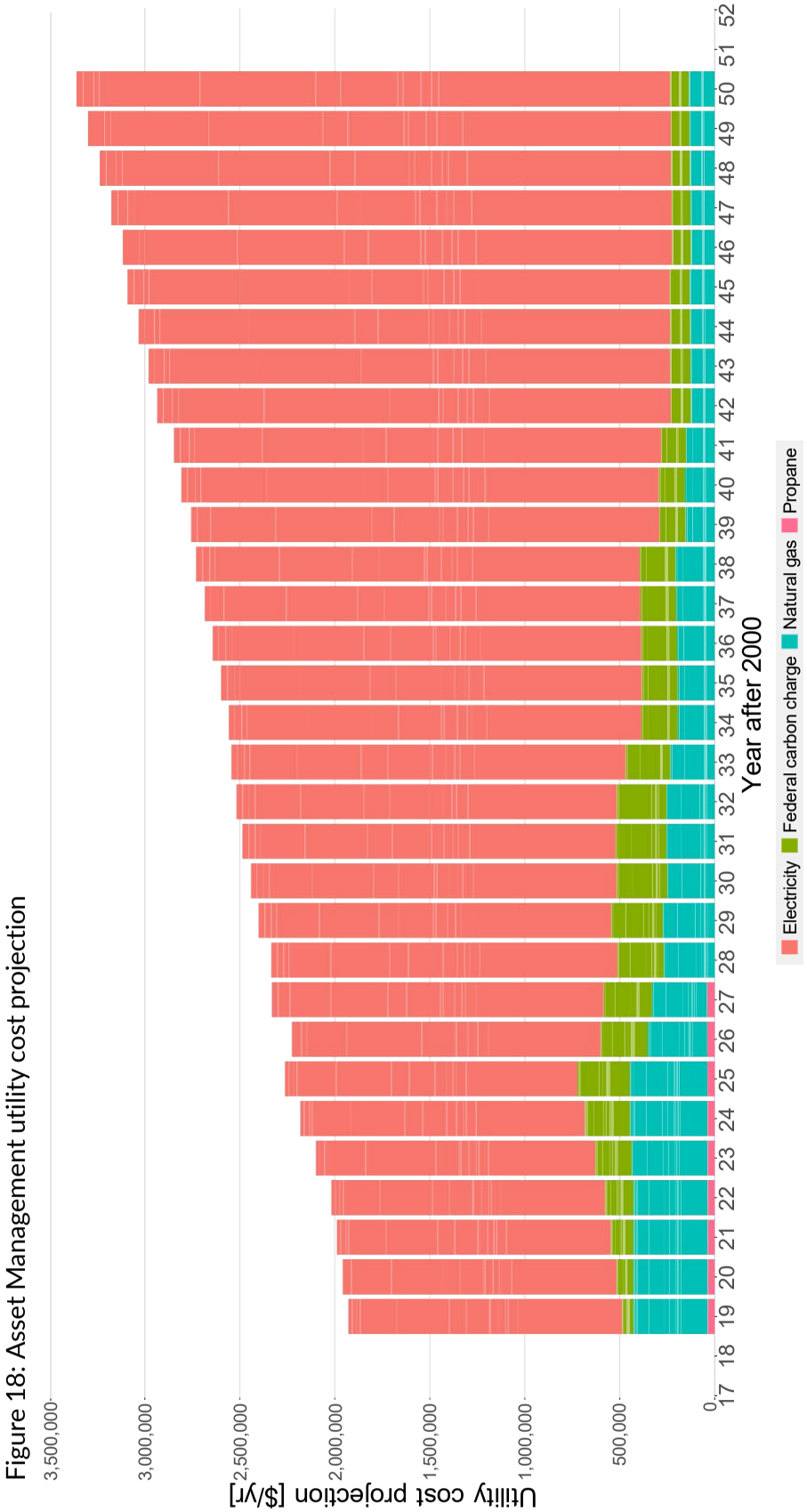


Figure 18: Asset Management utility cost projection

Electricity End-Use

Figure 19: Comprehensive electricity end use projection

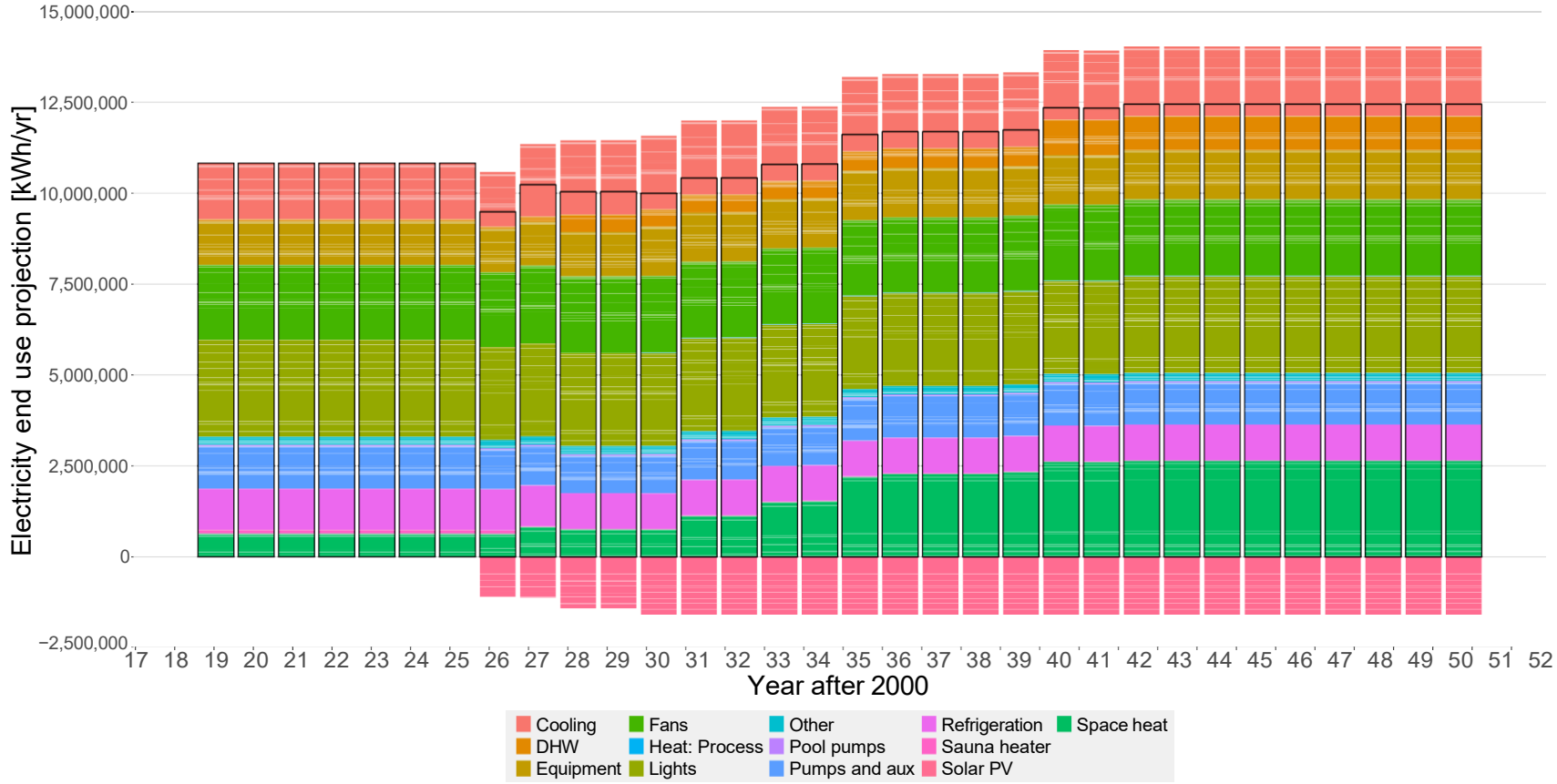


Figure 20: Short Term Deep Retrofit electricity end use projection

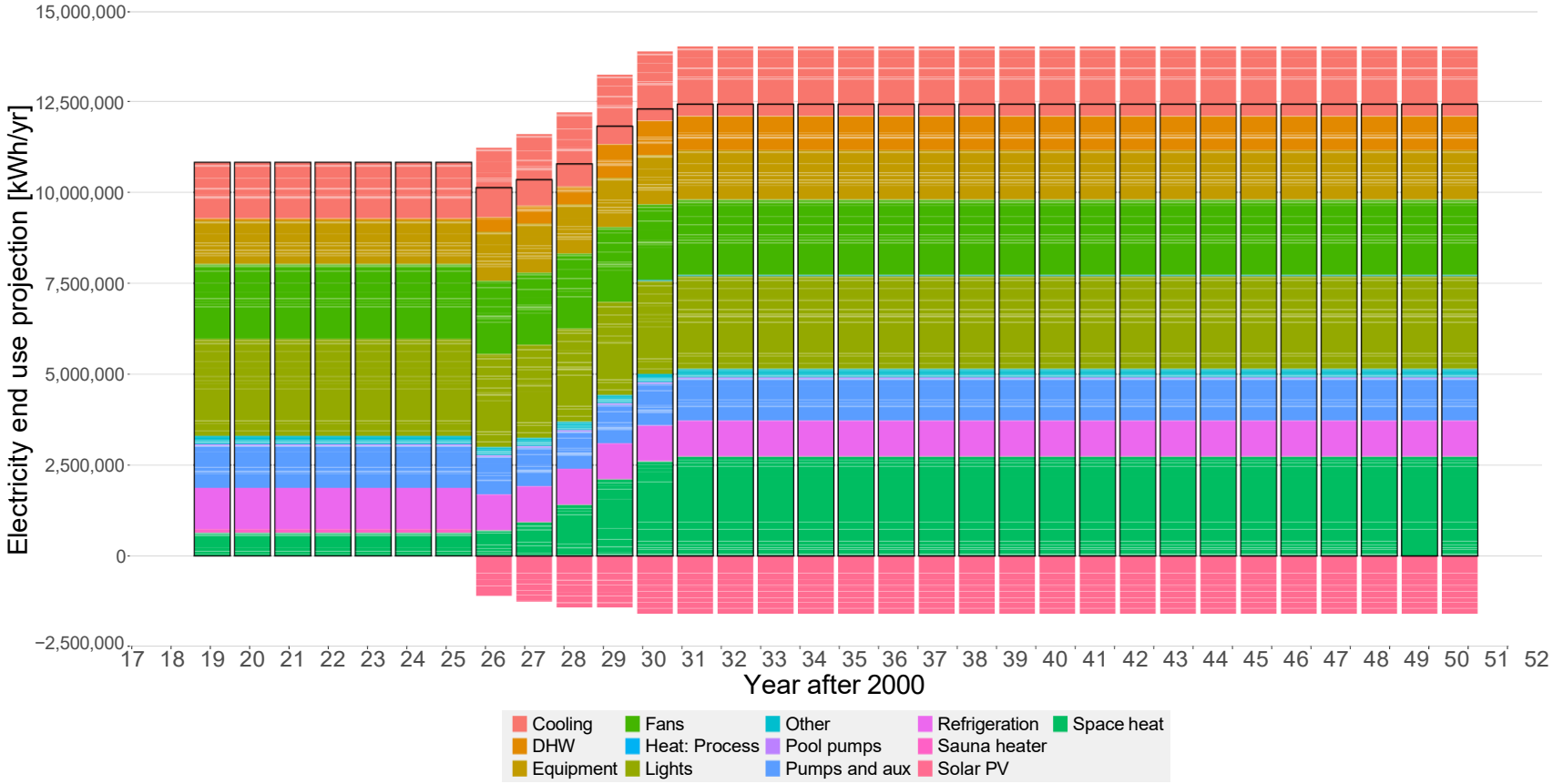
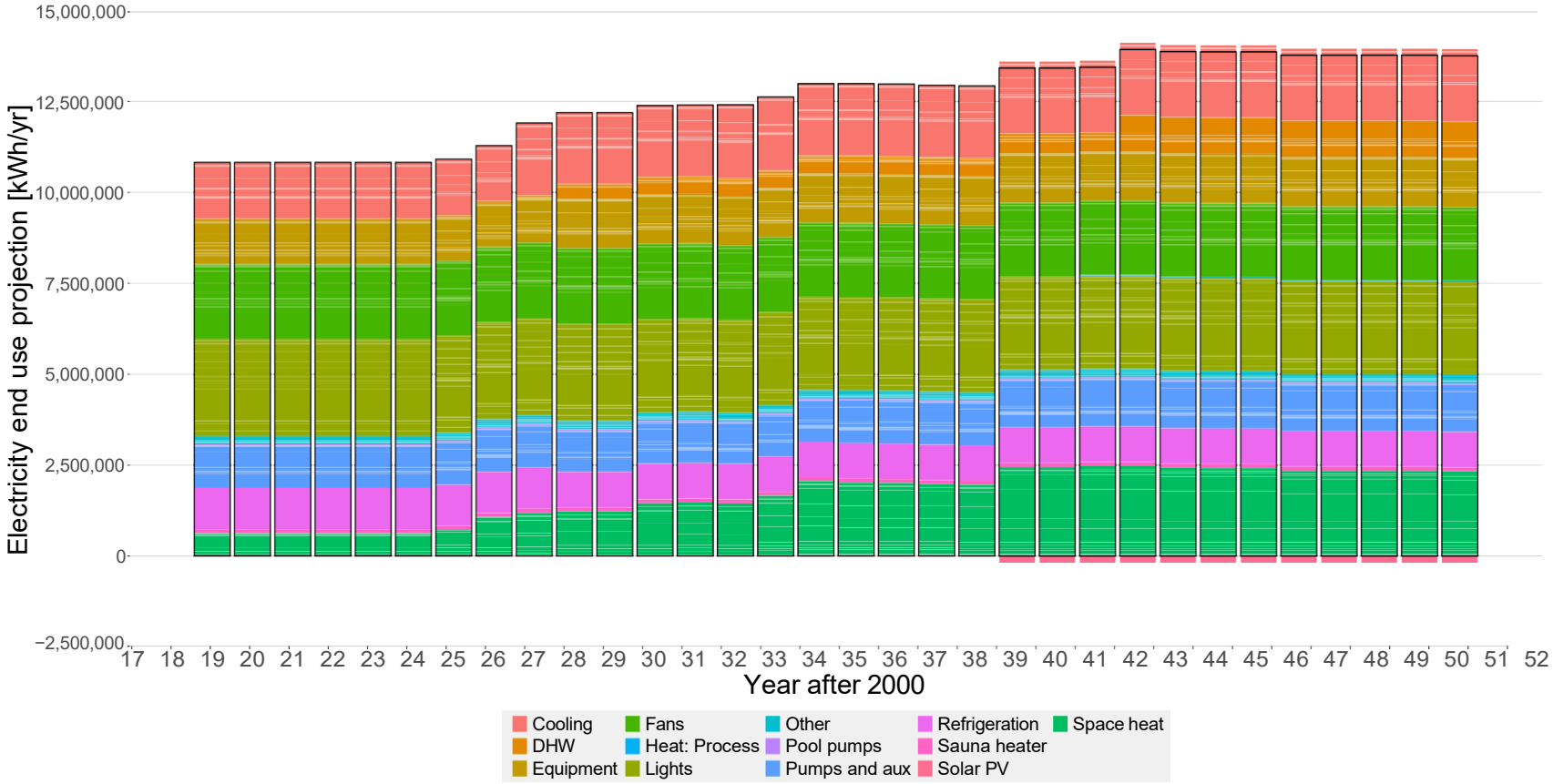


Figure 21: Asset Management electricity end use projection



Natural gas end-use

Figure 22: Comprehensive natural gas end use projection

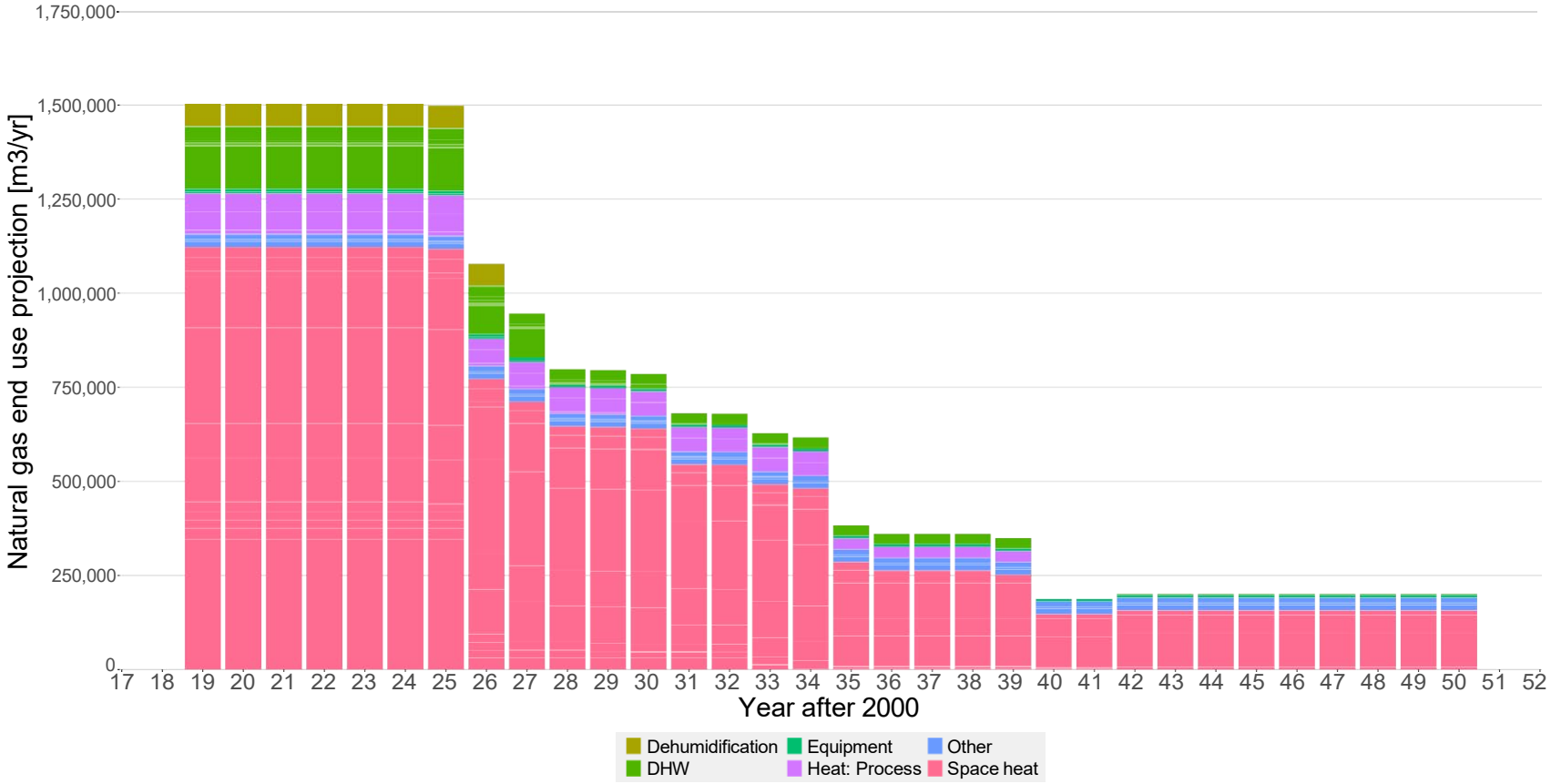


Figure 23: Short Term Deep Retrofit natural gas end use projection

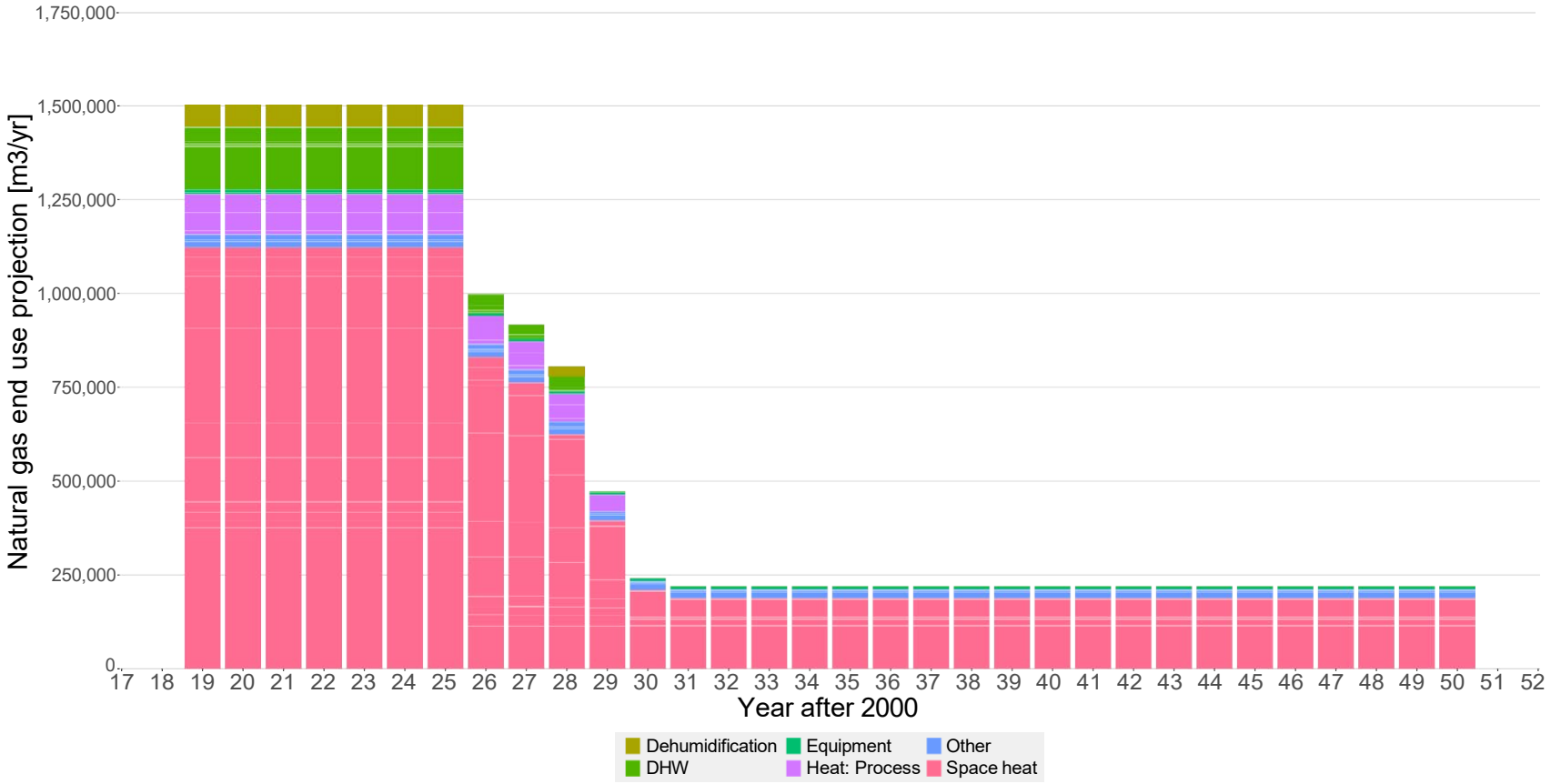
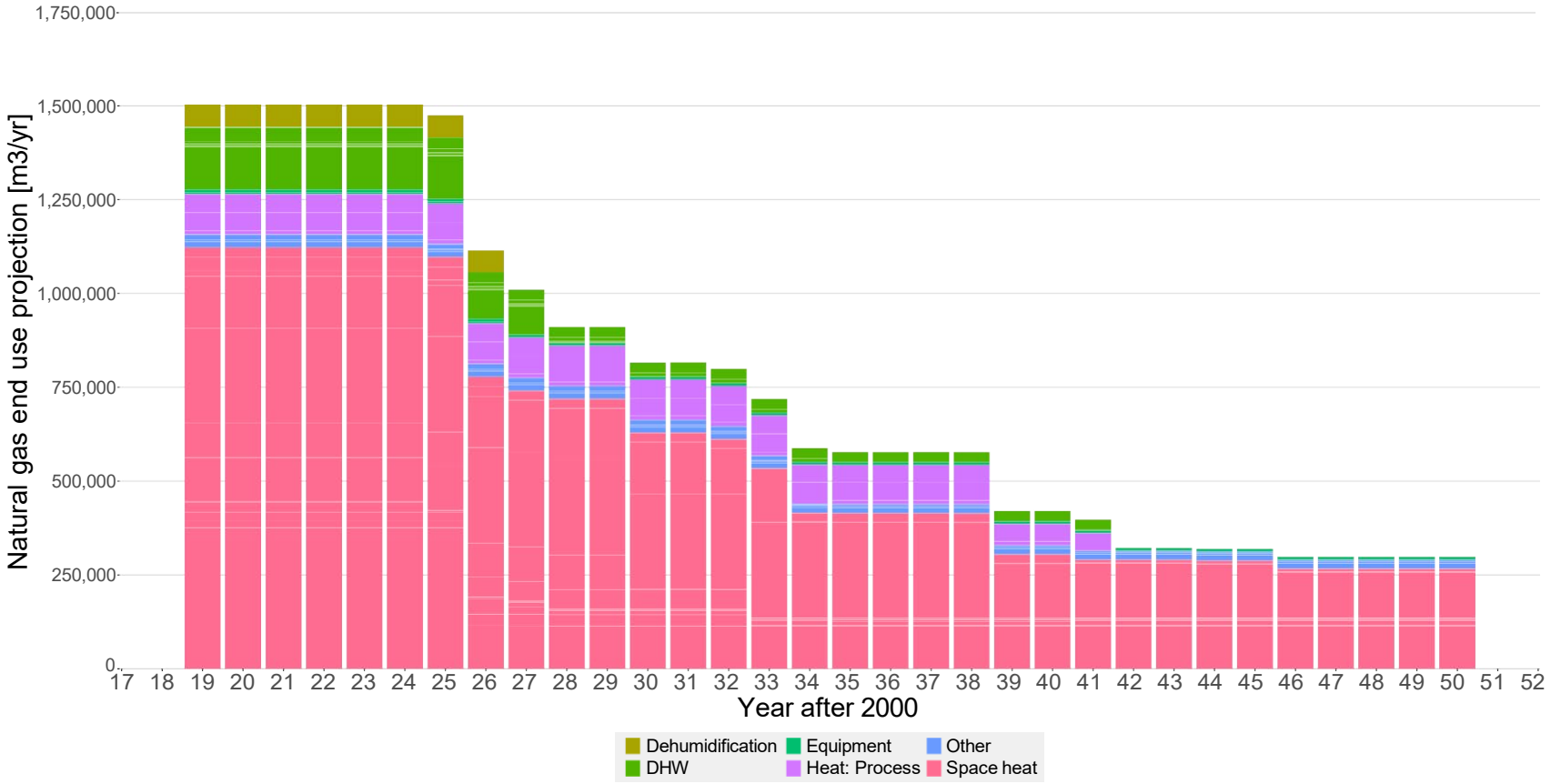


Figure 24: Asset Management natural gas end use projection



LCC Present Value Projection

Figure 25: Comprehensive LCC present value projection

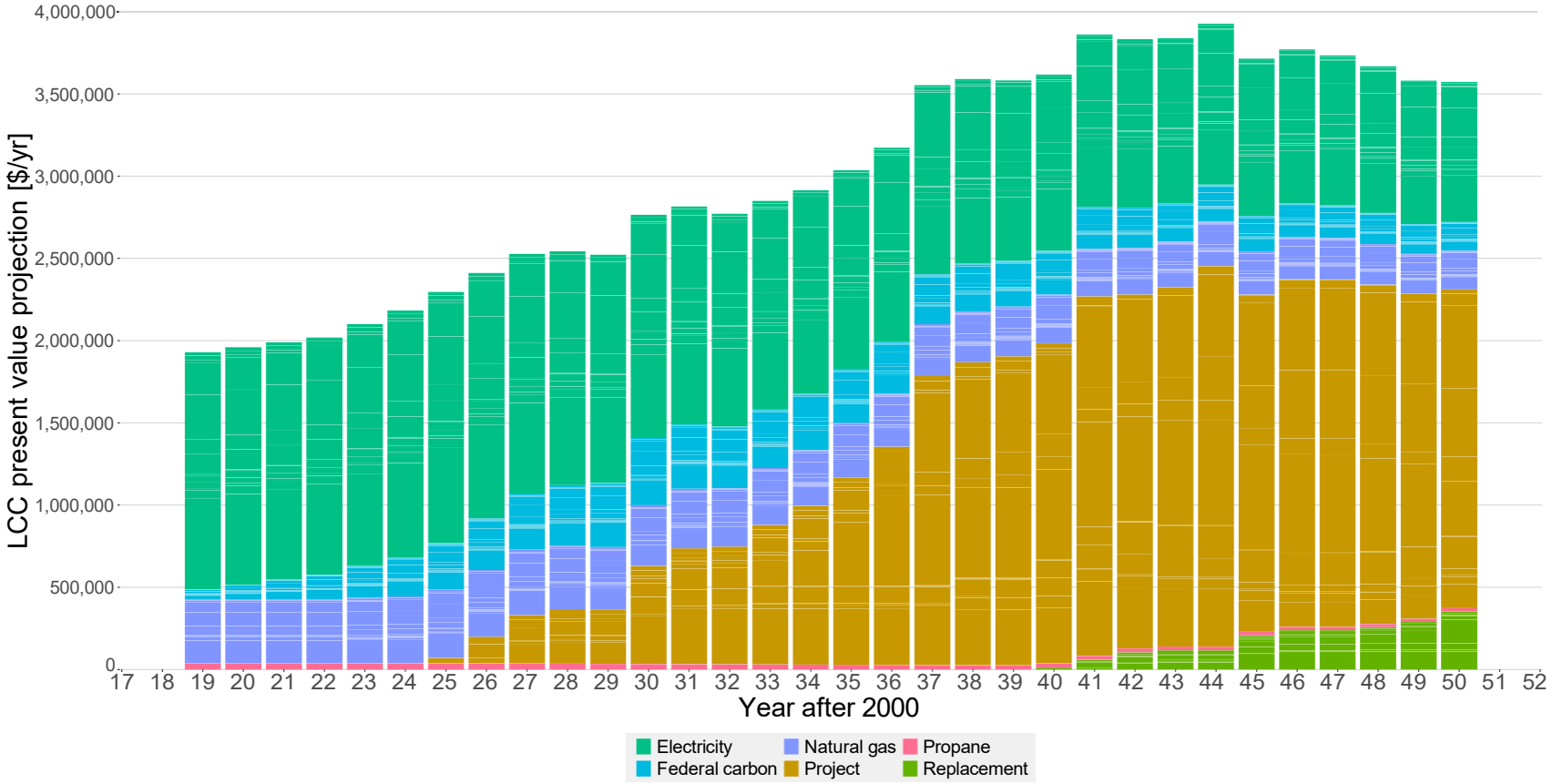


Figure 26: Short Term Deep Retrofit LCC present value projection

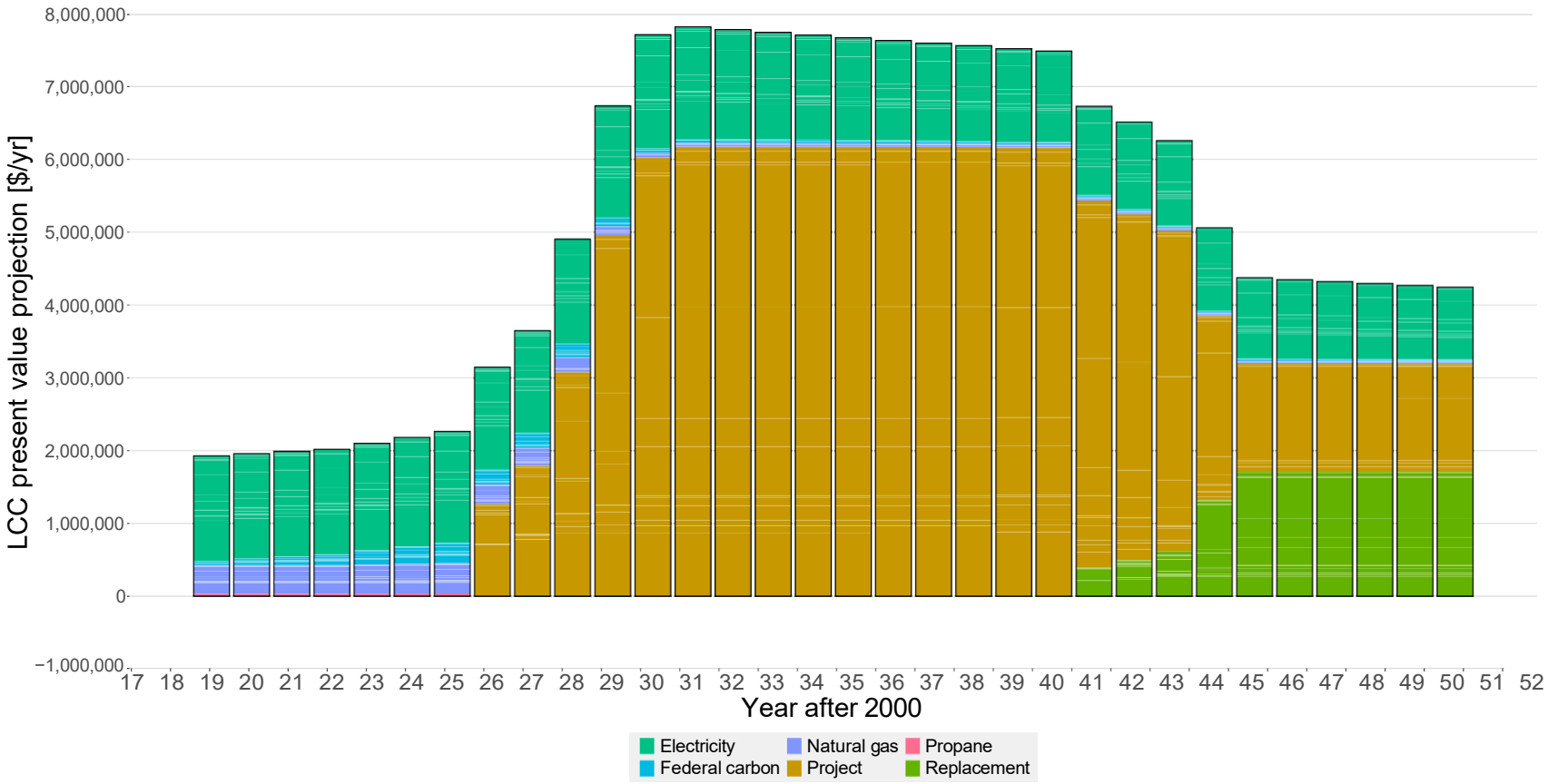
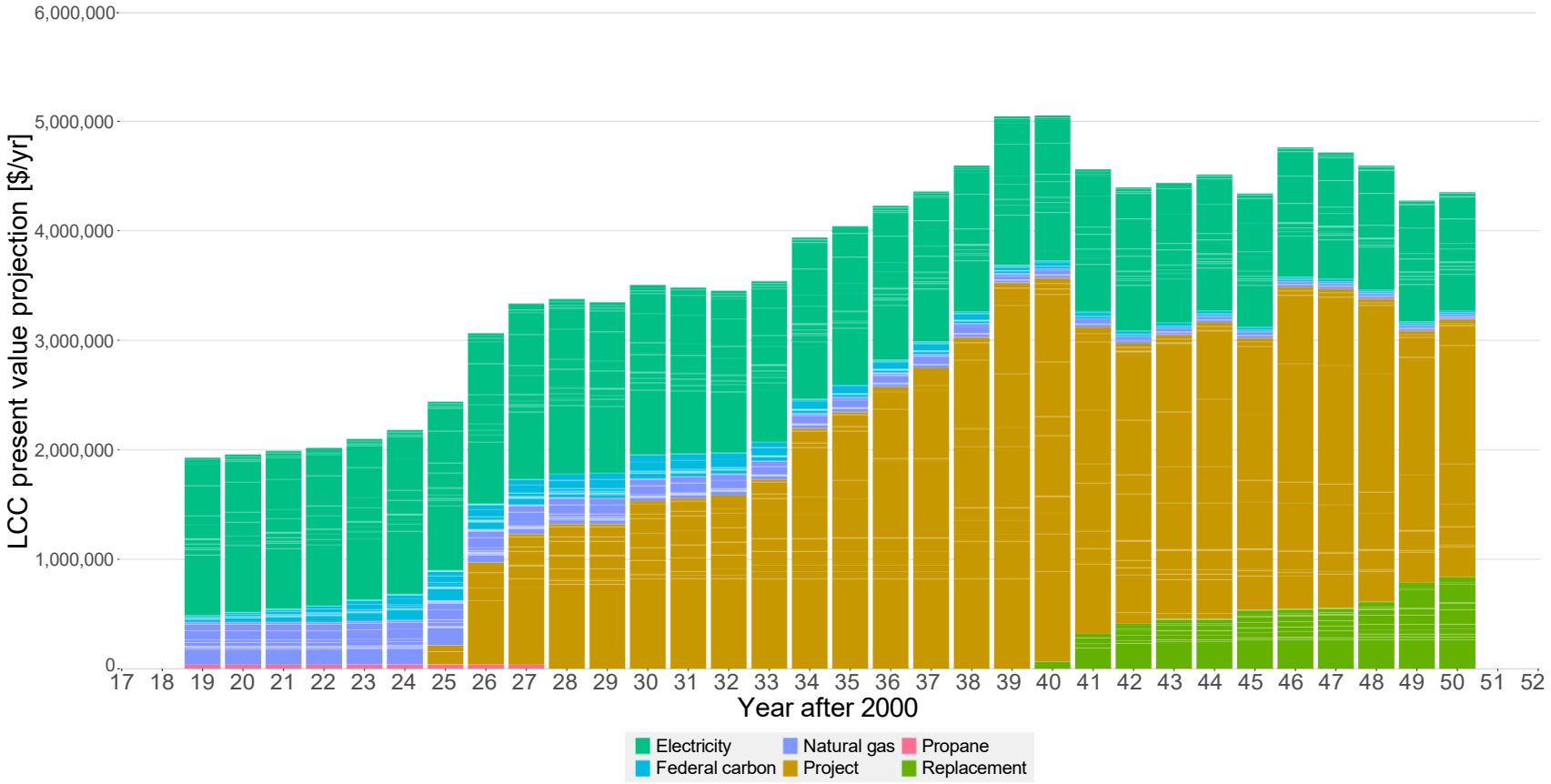


Figure 27: Asset Management LCC present value projection



END

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