Bolton North Hill Secondary Plan Area

Community Energy and Emissions Reduction Plan

Prepared for: Bolton North Hill Landowners Group

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Pratus Group Inc.

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Issuance Approval

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Document Revision History

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A	2025-05-02	Draft for Review	Ahmad Kabiri; Simonne Varela	Eric Dunford; Christopher Mohabir	Oleksandra Onisko
B	2025-05-26	Secondary Plan Submission	Zaid Khan; Simonne Varela	Eric Dunford Christopher Mohabir	Oleksandra Onisko

Limitations

This report has been prepared by Pratus Group with the purpose of providing energy strategies for the proposed Bolton North Hill Secondary Plan Area for Bolton North Hill Landowners Group under the terms of our agreement. The material herein reflects Pratus Group's best judgement in light of the information available to it at the time of preparation. Any use that a third party makes regarding the information provided within this report including reliance on, or decisions to be made based on it, are the responsibility of such parties. Pratus Group accepts no responsibility for damages, if any suffered by any party as a result of decisions made or actions taken based on this report.

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1. Executive Summary

Pratus Group Inc. was retained by the Bolton North Hill Landowners Group to develop a Community Energy and Emissions Reduction Plan (CEERP) consistent with Section 5.6.20.14.17(d) of the Region of Peel Official Plan and the Town of Caledon Terms of Reference (TOR) for the Bolton North Hill Secondary Plan Area located in the Town of Caledon, Ontario. The purpose of this study was to:

1. Estimate expected energy requirements for the Secondary Plan Area based on prevailing development requirements for new building construction in the Town of Caledon communicated in the Green Development Standard (GDS), termed the **Baseline Scenario**
2. Identify strategies to improve energy conservation and reduce emissions within the Secondary Plan Area in alignment with the Town of Caledon's community-wide emissions reduction objectives, termed the **Near Net Zero Scenario**
3. Estimate the electrical demand of Electric Vehicle (EV) chargers throughout the secondary plan area and understand the costs associated with developing buildings to be EV charger ready
4. Assess the viability of community-based energy generation systems for subareas of the proposed Secondary Plan Area
5. Outline future actions that would contribute to energy conservation and reduced emissions and promote successful implementation of the strategies proposed in the **Near Net Zero Scenario**

The proposed Bolton North Hill Secondary Plan Area is expected to consist of 331.74 hectares of land, with 167.78 hectares of developable land area per statistics provided by the planning consultant, Bousfields. The Plan Area as currently envisioned is expected to be primarily low-density residential development. The proposed building mix for the planned community includes street-facing townhouses, single homes, medium density stacked and back-to-back townhouses and condos.

Building Energy Systems Assessed

The **Baseline Scenario** establishes the expected energy consumption based on the proposed development meeting the Town of Caledon's pilot Green Development Standard (GDS). The Green Development standard permits various prescriptive/performance compliance pathways for low rise residential buildings. The option to implement a three-season air-source heat pump system was selected for this study, as fuel switching strategies (such as incorporating air source heat pumps), are feasible and cost-effective means of meeting the GDS targets. These fuel switching strategies were considered a well-suited design choice that supports the required energy modeling.

A **Near Net Zero Scenario** was developed by evaluating potential additional low-carbon design strategies and technologies that go beyond the GDS requirements. Strategies were selected based on their evaluated capacity to achieve energy conservation and emissions reduction within the Secondary Plan Area. Geothermal heat pumps, air source heat pump domestic hot water heaters (with a natural gas backup), and rooftop solar photovoltaic (PV) systems were evaluated for the **Near Net Zero Scenario**, based on their potential energy and emissions performance.

Archetype Energy and Carbon Results

Full details of the future development are not available at the Secondary Plan development stage. To enable modeling of the required energy for the planned community, archetypes were established based on the expected development patterns per the conceptual plans provided by the Landowners Group. The relative energy and carbon emissions performance of the archetypes are illustrated in **Table 1**. For this study, the **Near Net Zero** energy system improvements were assumed to be implemented across all building archetypes.

Table 1: Energy and Carbon Emission Reduction Savings from Near Net Zero Scenarios

Category	Archetype	Baseline Design Scenario	Net Zero Design Scenario	% Savings over Baseline Energy	% Savings over Baseline Carbon
Residential	Single houses Stacked and back-to-back Townhouses	3 season air source heat pumps (ASHP) with natural gas backup	Solar PV panels, geothermal heat pump system for space cooling and heating, and upgrade of domestic hot water to ASHPs with supplemental gas and incorporating passive design measures	36%	72%
	Medium and Medium/High Density Blocks	Constant volume corridor make-up air unit (MUA) and constant volume in-suite ventilators served by condensing boilers and chillers		39%	82%
Commercial	Mixed Use areas	Fan coil units (FCUs) / Dedicated Outdoor Air Systems (DOAS) served by condensing boilers and chillers		41%	84%
Educational	Schools	Rooftop Units – Natural gas heating and DX cooling		43%	84%

The **Near Net Zero Scenario** demonstrates a potential pathway to achieve low-carbon development within the Plan Area that achieves near net zero carbon emissions. This potential roadmap is shown in **Figure 1** and **Figure 2**.

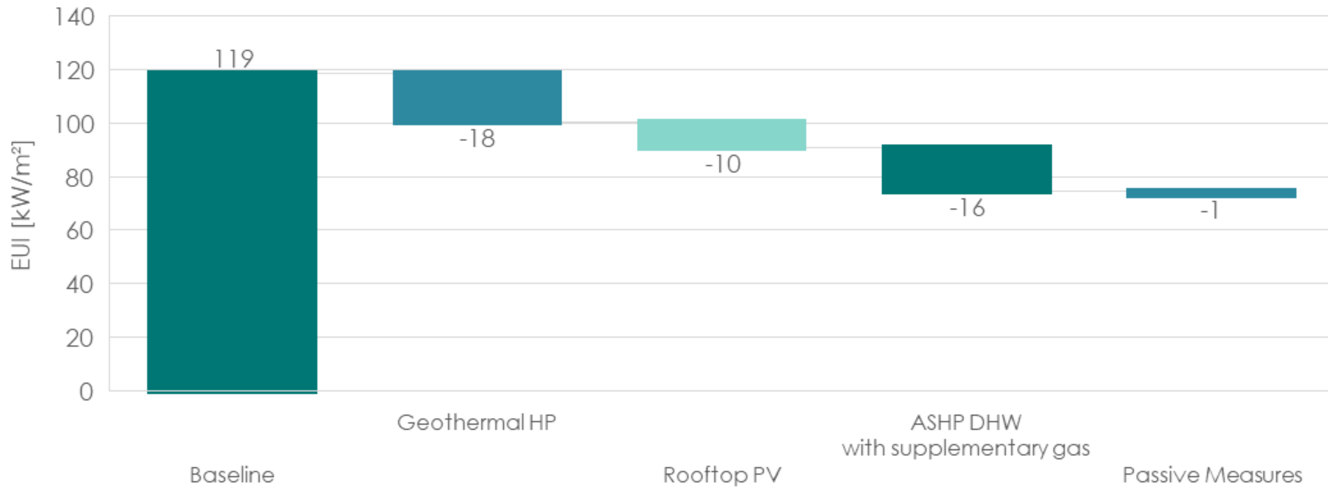

Figure 1: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential

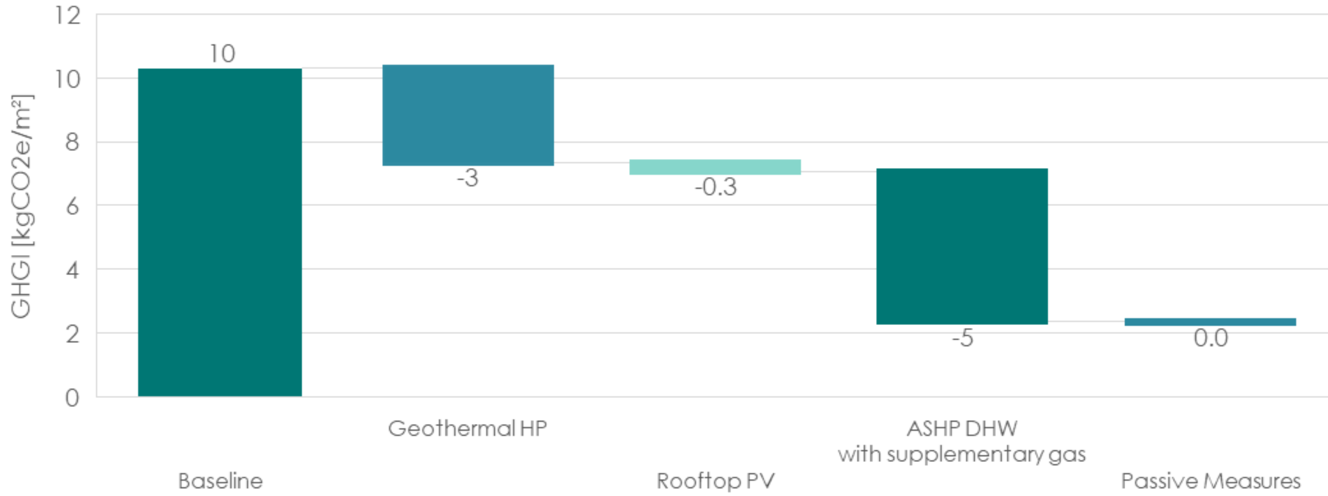

Figure 2: Greenhouse Gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

Introduction of building-scale geothermal heat pumps, rooftop solar photovoltaic systems, air-source heat pump domestic hot water systems and passive measures would reduce GHG emissions by 78% in the Bolton North Hill Secondary Plan Area.

The incremental capital cost of implementing these technologies beyond the requirements of the Town of Caledon Green Development Standard is estimated to be approximately $3.3B based on the Class D cost estimate conducted. The 20-year net present value (NPV) total cost of implementing the strategies described in the Near Net Zero Scenario is estimated at $6.1B based on the Class D cost estimate conducted, which is approximately $4.5B greater than baseline NPV.

Grid-based electricity has inherent emissions associated with its consumption which means that the Secondary Plan Area cannot achieve net zero emissions without future action by the Province of Ontario and provincial utilities to achieve a zero-carbon electricity grid.

Transportation Systems Assessed

The GDS requires that all single-family residential dwellings, 50% of multi-unit residential buildings and 20% of all other types of dwellings be equipped with the required infrastructure to be EV charger ready. To understand the electrical demand the Secondary Plan Area can experience associated with transportation upgrades, the cases shown in **Table 2** were used to describe the potential energy demand associated with various scenarios in which EV chargers are installed and utilized within the Secondary Plan area. **Transportation Case 1** is used as the baseline in this analysis for comparison with other scenarios.

Table 2: Transportation Scenarios Assessed

Category	Baseline Design Scenario	Net Zero Design Scenarios
Transportation 	***Transportation Case 1*** *25% of residential and 20% of non-residential spaces utilize EV chargers*	***Transportation Case 2*** 50% of residential and 20% of non-residential spaces utilize EV chargers
		Transportation Case 3 100% of residential and 20% of non-residential spaces utilize EV chargers
		Transportation Case 4 100% of residential and 100% of non-residential spaces utilize EV chargers

The estimated overall energy demand associated with the different scenarios for EV adoption is summarized in **Table 3**. The potential electricity demand posed by the electric vehicle charging scenarios is substantial and would require engagement with utility providers to determine feasibility.

Table 3: Estimated EV Charger Demand

Scenarios Assessed	Level 2 EV Chargers		Level 2 EV Chargers Demand [kW]	Total Carbon Emissions [$kgCO_2e$]	Increase in Energy Consumption
	Residential	Non-Residential			
Transportation Case 1	857	3	4,227	211	-
Transportation Case 2	1,715	3	8,449	422	2x
Transportation Case 3	3,429	3	16,892	845	4x
Transportation Case 4	3,429	13	16,914	846	5x

Average costs for EV charging stations, installation and infrastructure are estimated to be ~$1,200 per Level 2 charger based on discussions with major Canadian equipment suppliers. Approximately 65% and

85% of this cost is associated with the conduits, and electrical cables for residential and non-residential buildings, respectively. These costs are expected to be borne by the Landowners. Based on the GDS requirements to make buildings EV charger ready, this results in a high-level estimated cost of **$2,677,431**.

Economies of scale factors were excluded from the calculations. Further analysis will need to be conducted on the anticipated installation of the EV chargers which is beyond the scope of this study. While service upgrades are not required to make single-family homes EV charger ready, multi-unit residential and non-residential spaces will likely require higher capacity transformers and sub-stations due to the shift to electrification in buildings and transportation services. This will depend on the anticipated usage of the site and require further coordination during the design development stage.

District Energy System Considerations

The Secondary Plan Area includes subareas that encompass medium and higher density dwellings and mixed-use areas as shown in **Figure 3**. The feasibility of district systems was explored for these denser subareas. Solar photovoltaic, sewage wastewater heat exchange and geothermal district energy systems were assessed. A geothermal district energy system is potentially feasible within the development node centred on Emil Kolb Parkway and Regional Road 50. Wastewater heat exchange systems were determined to not be feasible based on the projected development scenario.

Figure 3: Area of Consideration for DES Feasiblity

2. Introduction and Context

The Bolton North Hill Secondary Plan Area is a proposed community development located within the boundary of the Town of Caledon, Ontario, a constituent municipality of the Region of Peel. A Community Energy and Emissions Reduction Plan (CEERP) is a required component of the Secondary Plan submission per the requirements of the Region of Peel Official Plan 2051((Region of Peel, 2022), and the requirements of the Town of Caledon's Terms of Reference.

The purpose of this CEERP is to explore opportunities to achieve significant energy conservation and emissions reduction in comparison to baseline practices for the future community that will be constructed within the Secondary Plan Area. Alternative energy systems and technologies were evaluated to determine how low-emission buildings and transportation strategies could be utilized to achieve low-carbon operating conditions within the Bolton North Hill Secondary Plan Area. Potential solutions were assessed based on their technical, spatial, and financial viability and their impact on GHG emissions for the proposed community development as it is currently envisioned.

The CEERP also reviews opportunities to implement community-scale energy systems which can maximize GHG reductions within the proposed development, if feasible per the requirements of the Region of Peel's Official Plan and the Town of Caledon's Terms of Reference (TOR).

2.1. Secondary Plan Area

The Bolton North Hill Secondary Plan Area development is planned for the southern lands of the Town of Caledon, Ontario as shown in **Figure 4**. The Bolton North Hill Secondary Plan (BNHSP) area is located north of Columbia Way, spanning both sides of Highway 50. It extends west past Duffy's Lane and Emil Kolb Parkway, and east beyond Mount Hope Road, as depicted in **Figure 5.** The conceptual plan for the proposed Secondary Plan Area includes the following types of neighborhoods:

- Residential Area – including street facing townhomes, single family homes, apartments, stacked and back-to-back townhomes and mixed-use spaces.
- Schools – Includes existing and new proposed public schools; and,
- Commercial area – includes a mix of commercial services and retail

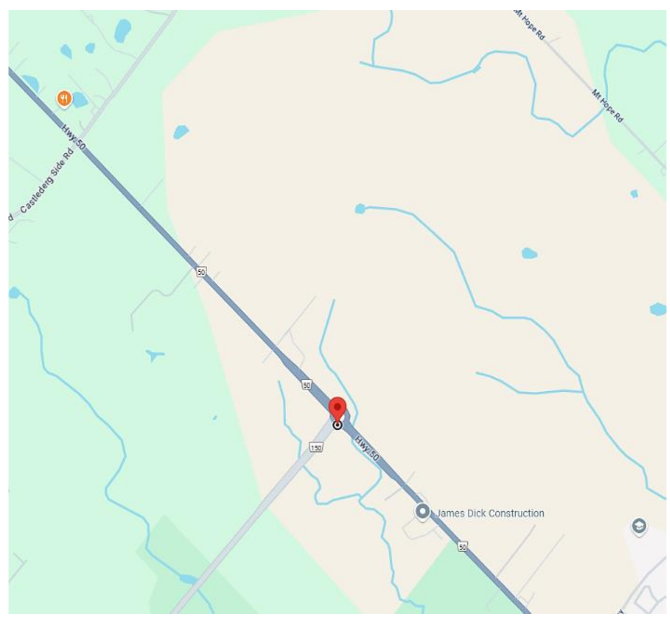

Figure 4: Approximate site location centred at the intersecion of Emil Kolb Parkway and Highway 50 in Caledon, Ontario

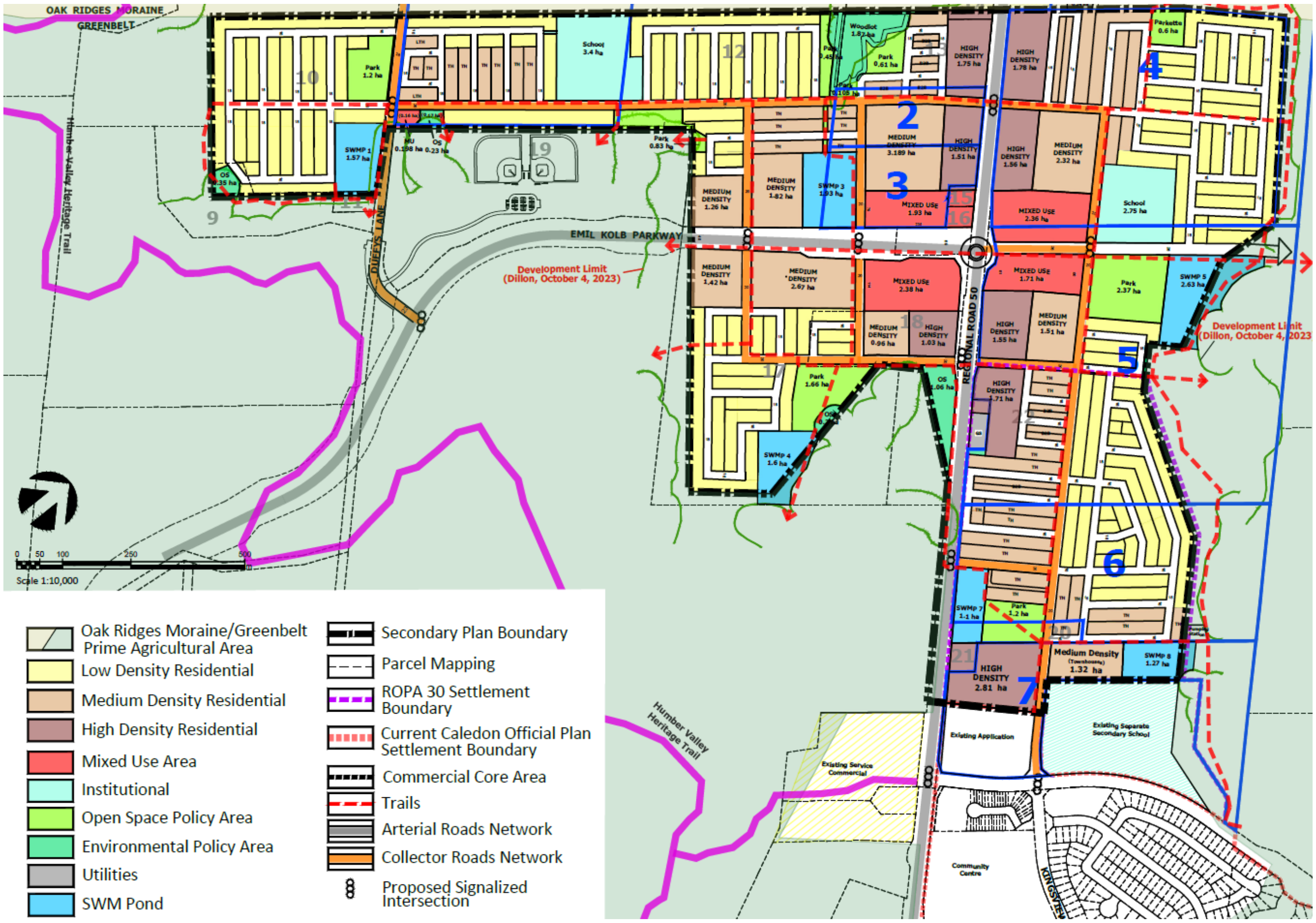

Figure 5 : Preliminary Concept Plan Option for the Bolton North Hill Secondary Area (Bousfields Inc., May 26, 2025)

2.2. Demographics, Site statistics and Building Types

The Bolton North Hill Secondary Plan Area includes a land area of ~332 hectares with a mix of land uses. Of the total 332 hectares of land, approximately 168 hectares are developable areas containing residential, mixed-use, and institutional spaces. 164 hectares consist of collector roads and non-developable areas within the secondary plan area. These lands were excluded from the analysis conducted as they are not expected to support building construction. Areas were selected for exclusion based on their classification of the current land use policies and the proposed Land Use Plan.

The proposed development plan for the community includes a variety of building types such as street facing townhouses, single family homes, medium density stacked and back-to-back townhouses, apartments, mixed use areas comprising of retail, and commercial services, schools, community centres and parks.

2.2.1. Details per Building Type

The current Bolton North Hill Secondary Plan Area concept plan consists of several land use profiles (See **Appendix B** for details). These building types and areas are listed in **Table 4** for reference. **Figure 6** provides a distribution of the building types within the currently proposed Secondary Plan Area development.

Table 4: Bolton North Hill Secondary Plan Area Building Type Descriptions

Residential Building Types – Total 233 ha / 3,782 units	
Low Rise (3 storeys or less)	**MURB (≤ 6 storeys)**
	
Low Density Residential Single homes 124 ha / 1,278 Units Low Density Street Townhomes 70 ha / 819 Units Low Density Stacked and Back-to-Back Townhomes 13 ha / 230 Units	Medium Density Blocks 14 ha / 719 Units Medium / High Density Blocks 12 ha / 736 Units

Non-Residential and Mixed-Use Building Types - Total 15 ha	
Schools	**Mixed Use Spaces**
	
2 Public School Buildings 6 ha	Mixed Use buildings with Commercial Services and Retail Spaces at Ground Level 8 ha

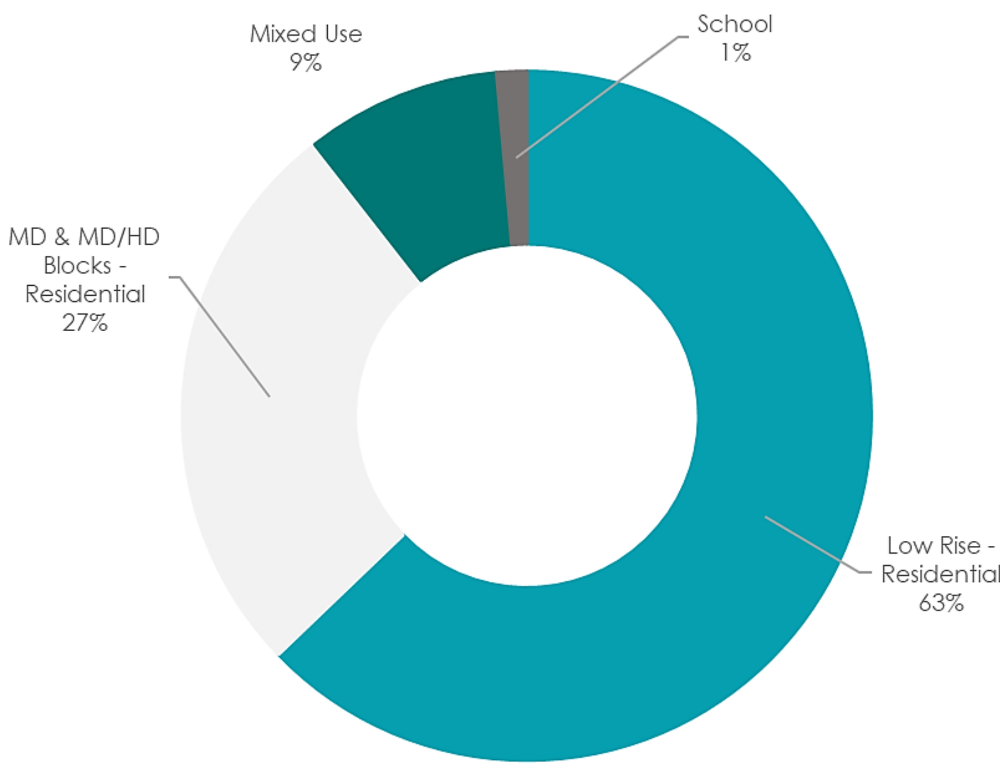

Figure 6: Bolton North Hill Secondary Plan Area Building Type Distribution (Gross Floor Area)

2.3. CEERP and Net Zero Targets

The Region of Peel Official Plan, approved on November 4th, 2022, introduced requirements for secondary plan areas to complete a CEERP under s.5.6.20.14.17(d) of the Official Plan (Region of Peel, 2022).

In alignment with the Region's Official Plan requirements, the Town of Caledon implemented a Terms of Reference document in early 2023 outlining similar requirements for secondary plan areas. Caledon Town

Council also previously passed a motion declaring a climate change emergency and adopted a community-wide greenhouse gas (GHG) emissions reduction target of net zero emissions by 2050 and an interim target of 36% emission reduction below 2016 levels by 2030 (Town of Caledon, 2021). The Town subsequently developed the Resilient Caledon Community Climate Change Action Plan (*Resilient Caledon Plan*) which outlines initiatives the Town plans to undertake to prepare for the expected future impacts of climate change. Additional information on the Energy and Carbon Environment can be found in **Appendix C**.

2.4. Caledon Green Development Standard

The Town of Caledon's Green Development Standard GDS establishes guidance for low-carbon building construction. The GDS consists of absolute performance requirements with supporting guidelines that promote sustainable sites and building designs. Minimum building performance requirements of the GDS are mandatory for the planning approval process.

The current targets for Caledon's GDS are outlined in **Table 5**. Further details about the standard and metrics can be found in **Appendix C**.

Table 5: Town of Caledon's GDS Absolute Performance Targets (Town of Caledon, 2024a)

Building Type	Energy and Carbon Performance Measures			EV Charger-Ready Requirements*
	TEUI [kWh/m2/yr.]	TEDI [kWh/m^2/yr.]	GHGI [kgCO2e/m2/yr.]	
Low Rise Residential (<3 storeys)	Energy Star or equivalent OR NBC Tier 3 performance and 20% reduction in GHG emissions from OBC		15	Minimum one charging space per dwelling unit
Multi-unit Residential (>6 storeys)	135	50	15	Minimum 50% of parking spaces are EV-ready
Multi-unit Residential (≤6 storeys)	130	40	15	
Commercial Office	130	30	15	Total of 20% parking spaces are EV-ready
Commercial Retail	120	40	10	
Industrial	130	60	15	Minimum 5% of spaces to be equipped with EV Supply Equipment (EVSE)

**For all building sites: Encourage dedicated parking spaces for carshare services or carpooling and charging spaces for e-bike and scooters.*

3. Building Energy Systems

3.1. Building Energy Analysis Considerations

Energy and operational GHG emissions for the individual archetypes and the entirety of the buildings proposed in the Bolton North Hill Secondary Plan Area were estimated using a simulation-based approach which included:

- Establishing baseline energy consumption
- Simulating potential energy conservation and emissions reduction measures
- Analysis and interpretation of modeling results

This approach was used to evaluate how the buildings in the proposed Secondary Plan Area are influenced by a range of potential energy conservation and emissions reduction measures outlined in **Appendix D**.

Potential energy conservation measures were selected based on low-carbon design principles, with the exception that active measures (i.e., HVAC system implementation) were considered prior to passive measures (i.e., enclosure performance, massing, building orientation, building shading and air tightness considerations). The energy and carbon emission reductions achieved by passive measures have not been defined at this stage of planning and are expected to vary across the Secondary Plan Area.

Table 6 summarizes the technologies that were assessed as part of the development of this study. The technologies include various heat pump system options. Other technologies that were studied included domestic hot water (DHW) energy source options in which efficient and low-carbon HVAC options were suggested to serve DHW loads from buildings; a change from traditional natural-gas sources.

Table 6 - Low-Carbon Building Technologies Assessed

Building Strategies and Technologies Assessed		Description
Heat Pumps Options	Geothermal Heat Pumps	Ground source heat exchange or ground source heat pumps use the ground as a heat source in the heating season and a heat sink during the cooling season to extract and reject heat from the building spaces, respectively.
	Air-Source Heat Pumps (ASHP)	Air source heat pumps extract heat energy from the outside air (and use some energy to re-heat it) in the winter to provide heat to interior spaces and reject heat from the interior spaces to the outside during the summer months.
	Hybrid Heat Pumps	Hybrid heat pump systems incorporate both electric and natural gas sources to take advantage of the efficiency gains associated with electrification while retaining some of the more practical elements associated with traditional natural gas systems.

Building Strategies and Technologies Assessed		Description
Domestic Hot Water (DHW) Options	Wastewater Heat Recovery	Wastewater heat recovery systems extract heat from sanitary water going down drains to preheat incoming water used for DHW loads in the building.
	ASHP with Electric Backup & Natural Gas Backup	ASHPs (as mentioned above) were considered to service the DHW loads of the buildings with both electric and natural gas backup, if required.
	Solar Water Heaters	Solar water heaters harness solar energy to heat domestic hot water (DHW)
Solar Energy Generation	Solar Photovoltaics (PV)	Rooftop solar photovoltaic panels installed on building roofs convert solar energy into electrical energy.

The following scenarios were developed to guide and inform the analysis as follows:

- **Baseline Scenario** – Developed per the Town of Caledon GDS (Refer to **Table 5** in **Section 2.4**)
- **Near Net Zero Scenario** – A potential pathway to near net zero energy and emissions

The Near Net Zero Scenario consists of building-scale energy conservation strategies beyond those required by the GDS. This scenario accomplishes additional Total Energy Use Intensity (TEUI) and GHGI reductions, reducing the demand for energy generation.

The evaluation of individual energy systems and technologies for the **Near Net Zero Scenario** was completed based on the following factors:

- Relative energy conservation potential
- Relative GHG potential reduction
- Spatial feasibility
- Relative ease or difficulty of implementation
- Operations and maintenance considerations
- Estimated capital cost

3.2. Building Energy and Carbon Results

The relative energy and carbon emissions performance of the archetypes modeled for this CEERP are illustrated in **Table 7**. The medium and higher density sub-developments within the Secondary Plan Area discussed in **Section 3.3.1** of the report were evaluated for feasibility of district-level energy systems. In terms of energy performance, system efficiencies may be comparable between local and district energy approaches, as the technologies used for heating, cooling, and energy production operate based on the same fundamental principles. For this study, the **Near Net Zero Scenario** energy system improvements were implemented across all building archetypes.

Table 7 : Energy and Carbon Emission Reduction Savings from Near Net Zero Designs

<table>
<tr><th>Category</th><th>Archetype</th><th>Baseline Design Scenario</th><th>Net Zero Design Scenario</th><th>% Savings over Baseline Energy</th><th>% Savings over Baseline Carbon</th></tr>
<tr><td rowspan="2">Residential</td><td>Single houses

Stacked and back-to-back Townhouses</td><td>3 season air source heat pumps (ASHP) with natural gas backup</td><td rowspan="4">Solar PV panels, geothermal heat pump system for space cooling and heating, and upgrade of domestic hot water to ASHPs with supplemental gas and incorporating passive design measures</td><td>36%</td><td>72%</td></tr>
<tr><td>Medium and Medium/High Density Blocks</td><td>Constant volume corridor make-up air unit (MUA) and constant volume in-suite ventilators served by condensing boilers and chillers</td><td>39%</td><td>82%</td></tr>
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<tr><td>Educational</td><td>Schools</td><td>Rooftop Units –Natural gas heating and DX cooling</td><td>43%</td><td>84%</td></tr>
</table>

Although energy use and carbon emissions are correlated, when considering net zero designs, net zero carbon balance is achieved through the adoption of carbon-free energy production (either generated on-site or off-site) in conjunction with the elimination of on-site combustion of fossil fuels, while net zero energy focuses on meeting a net zero energy balance through energy use reduction or generation and is independent of fuel source.

Geothermal heat pumps (GSHPs), air source heat pumps (ASHPs), and hybrid heat pumps were all categorized as low-carbon space heating options while wastewater heat exchange, ASHP domestic hot water heater (with both natural gas and electric backup options), and solar water heaters were considered as low-carbon domestic hot water (DHW) options. A summary of the analysis highlighting the impacts of these systems is outlined in the following sections.

Each energy conservation measure was evaluated by building archetype and across the site as a blended scenario that encompasses all archetypes based on their respective gross floor area. The blended scenario results are presented in the following report sections. Analyses conducted for each building archetype are reported in **Appendix F**.

An assessment of individual performance for each energy and carbon emission reduction measure for the entire site was conducted for the **Near Net Zero Scenario**. A combination of individual measures was created as a scenario that would align with the Town of Caledon net zero targets.

Across all building archetypes, the most efficient active measures were found to be:

1. Geothermal heat pumps
2. Solar photovoltaic (PV) panels
3. Domestic hot water heat pump with natural gas backup

3.2.1. Energy

Figure 7 illustrates the Energy Use Intensities (EUI) of the **Baseline Scenario**. Heating and domestic hot water (DHW) are the primary contributors to energy use and greenhouse gas emissions. Therefore, energy conservation measures targeting heating and DHW were applied to determine the most impactful and feasible strategies for reducing emissions and energy use.

As most of the site consists of low-rise residential buildings, which tend to accommodate more efficient enclosure design, the Thermal Energy Demand Intensity (TEDI) for the entire site is lower than the overall demand for DHW. As a result, measures aimed at improving DHW efficiency are more impactful than those focused on space heating.

Among these measures, wastewater heat recovery stands out as the most efficient, achieving approximately 17% energy savings compared to the baseline.

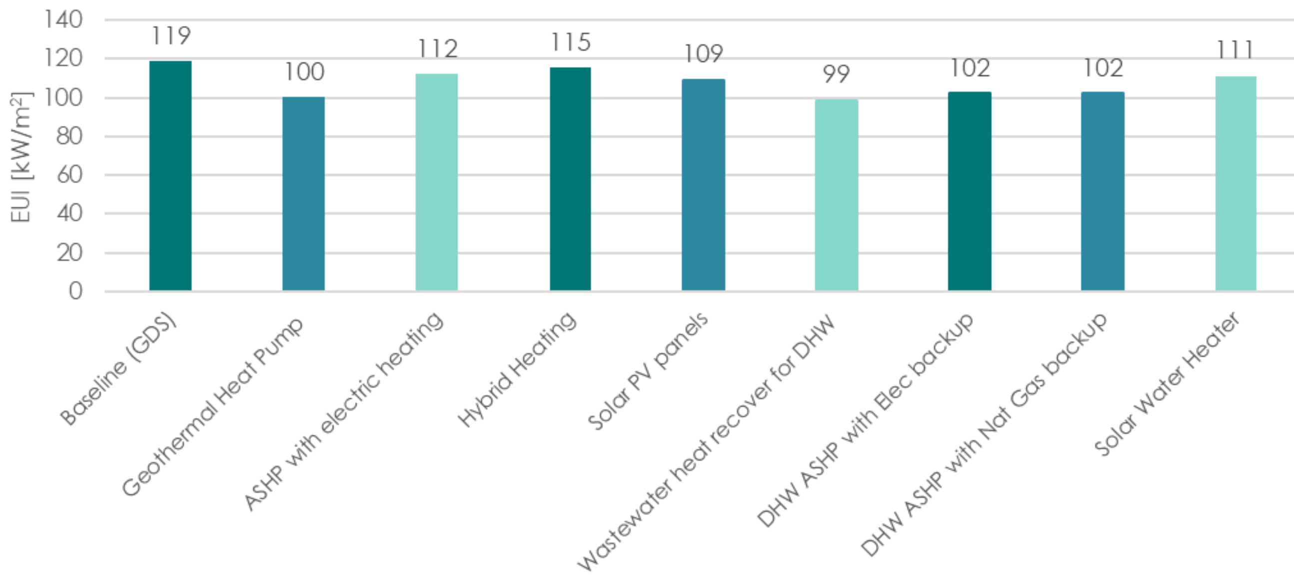

Figure 7: Energy Use Intensity Results for Each HVAC and DHW System Assessed

3.2.2. Carbon

Figure 8 below illustrates the greenhouse gas intensities (GHGI) of the **Baseline Scenario**. Similar to the energy results, space heating and DHW are the primary contributors to GHG emissions for the proposed community development. Therefore, energy conservation measures targeting space heating and DHW were applied to determine the most feasible strategies that reduce emissions.

The most impactful emission reduction measure assessed for the entire site is the use of air-source heat pumps for DHW with electric backup. Measures focused on DHW are particularly effective in reducing emissions as the baseline scenario relies entirely on natural gas for DHW, which accounts for approximately 50% of the GHG emissions in the **Baseline Scenario**. This reliance highlights significant potential for reducing GHG emissions through DHW measures. While hybrid heating systems can achieve energy savings, their overall GHG performance is slightly better than conventional systems. This is primarily due to the reliance on natural gas during peak heating conditions (typically below -10°C), which increases emissions intensity.

In contrast, measures focused on heating have less impact on GHG intensity compared to DHW measures. This is because a significant portion of the heating in the **Baseline Scenario** was assumed to be electric (heat pumps), due to assumed use of three-season air heat pumps in low-rise residential areas to meet the GDS requirements. As low-rise residential buildings constitute approximately 63% of the site floor area, low-carbon space heating was already assumed for the majority of the Plan Area, reducing the impact of low-carbon strategies for reducing emissions in these areas.

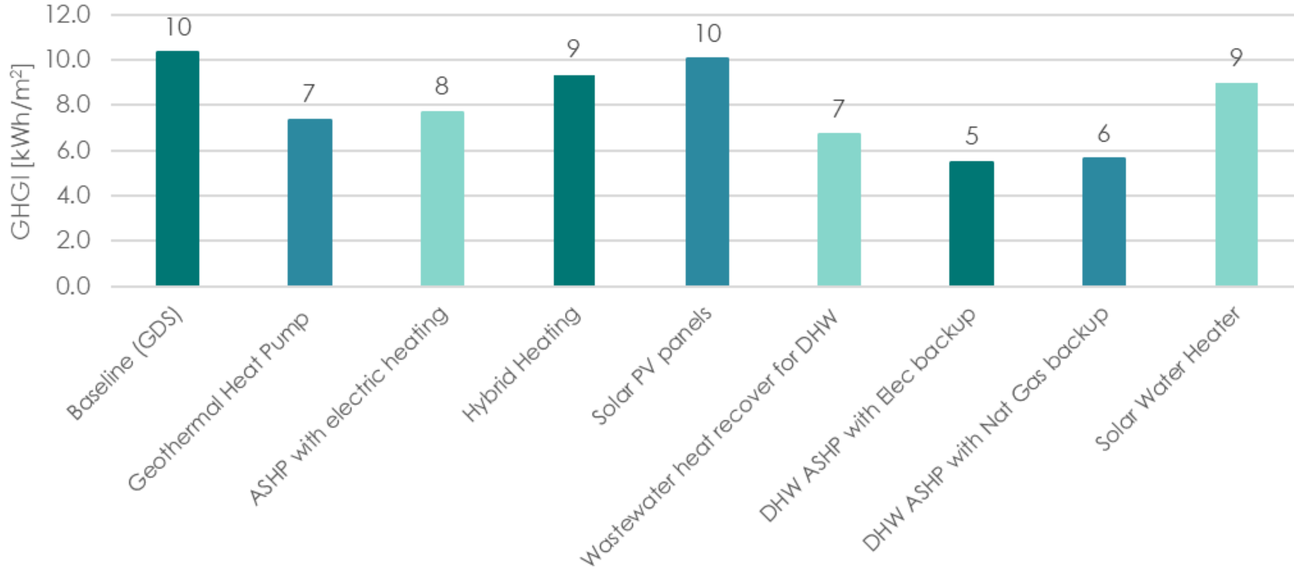

Figure 8: Greenhouse Gas Use Intensity Results for Each HVAC and DHW System Assessed

3.2.3. Cost

Cost estimates (in net present value) over a 20-year period were evaluated for each of the proposed HVAC and DHW options using **Equation 1**, as outlined in **Figure 9** below. Total costs were used to evaluate relative costs between alternate system types over an extended period. Costs are detailed for each system as outlined in **Table 8** below.

Equation 1 – Total Cost

$$\text{"}NPV\ Total\ Cost\ (20-year\ period)\text{"} = Upfont\ Capital\ Cost + Energy\ Costs + Maintenance\ Costs + \ Replacement\ Costs + Carbon\ Costs$$

Total costs consist of several components as highlighted below:

Total Cost (20-year period)	*Total cost (in net present value) of implementing and operating the proposed system*
Upfront Capital Cost	*Initial capital cost of the proposed system*
Annual Maintenance Cost	*Cost to maintain the proposed system for a period of one year*
Annual Energy Cost	*Utility (gas/electricity) cost incurred over the period of one year*
Replacement Cost	*Cost to replace system components over the 20-year study period*
Carbon Cost	*Cost associated with operational carbon emissions*

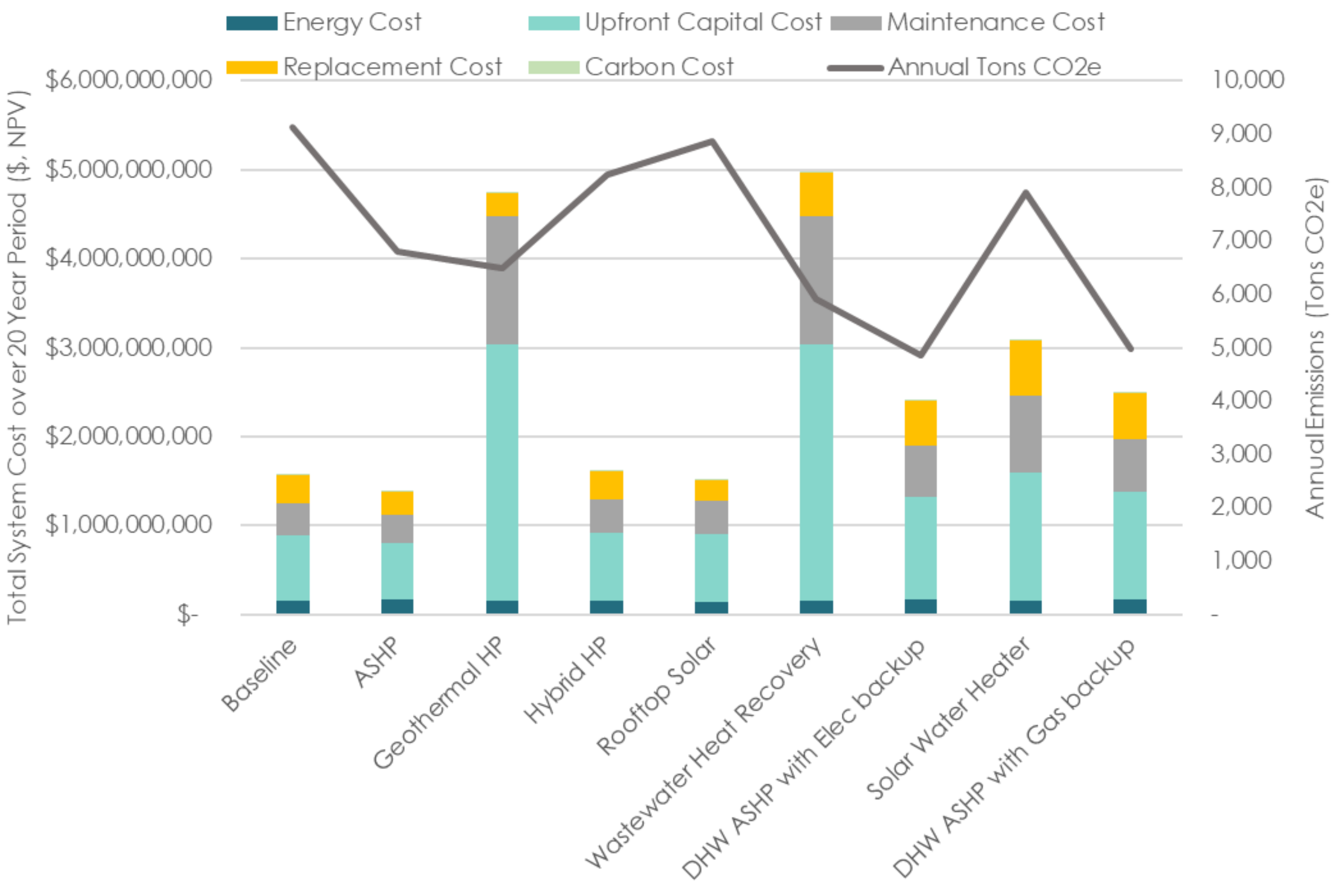

Figure 9: Total System Cost over 20 Year Period (NPV) of Each System Assessed Along with Annual CO2e Associated with Each Measure

20-year costs are detailed by their respective cost component. The costs presented within the report are an estimated value and reflect a Class D estimate which has a variance of ±20% per the Public Services and Procurement Canada (Public Services and Procurement Canada, 2020).

The HVAC and DHW options and systems were assessed based on GHG impact as well as cost performance. Note that for the **Baseline Scenario**, it was assumed that no solar energy would be used, and that space heating and domestic hot water would be provided with traditional natural gas sources. An overview of the cost analysis is outlined in **Table 8** (See **Appendix G** for details).

Table 8: HVAC System Class D Estimate Cost Analysis

HVAC Option	System Type	Cost Analysis	Est. 20-Year NPV Cost (Baseline Scenario)	Incremental Capital Cost Over Baseline
Baseline HVAC	Per GDS	Aligns with GDS requirements	$1,581,073,000	N/A
ASHP	Heat Pump	Significantly reduces GHG emissions at little incremental cost over the Baseline Scenario. Barriers include higher upfront capital cost as well as impact on site kW demand.	$1,392,743,000	-$188,330,000
Geothermal HP	Heat Pump	Notable impact on GHG emissions. Barriers include higher upfront capital cost and impact on site kW demand. Complexity and uncertainty relating to willingness of individual buildings to opt into district energy system given the number of freehold and detached homes. Costs do not account for required infrastructure; however, these costs are usually paid by the user.	$4,748,279,000	$3,167,206,000
Hybrid HP	Heat Pump	Moderate impact on GHG emissions reduction at reduced incremental cost over the Baseline Scenario. On-site kW demand is a non-factor for this system type.	$1,618,735,000	$37,662,000
Renewables	**System Type**	**Cost Analysis**	**Est. 20-Year NPV Cost (Baseline Scenario)**	**Incremental Capital Cost Over Baseline**
Rooftop Solar	Electricity Production	Negligible impact on GHG with significant additional cost.	$1,526,157,000	-$54,916,000
DHW Option	**System Type**	**Cost Analysis**	**Est. 20-Year NPV Cost (Baseline Scenario)**	**Incremental Capital Cost Over Baseline**
Wastewater Heat Recovery	DHW Heating	Notable impact on GHG emissions but may be complex to implement. Uncertainty relating to willingness of individual buildings to opt into district energy system given the amount of freehold and detached homes. Costs do not account for required infrastructure; however, these are usually paid by the user.	$4,970,567,000	$3,389,494,000

ASHP DHW Heater w/ Electrical backup	DHW Heating	Notable impact on GHG emissions. The inclusion of electrical backup heating system gives furthermore GHG savings as compared to option with natural gas backup	$2,412,597,000	$831,524,000
Solar Water Heater	DHW Heating	Reduced GHG benefits as other DHW upgrades at costs relatively comparable to an ASHP Heater.	$3,087,837,000	$1,506,764,000
ASHP DHW Heater w/ Natural Gas backup	DHW Heating	Notable impact on GHG emissions. The inclusion of natural gas backup heating systems mitigates on site kW impacts.	$2,493,706,000	$912,633,000

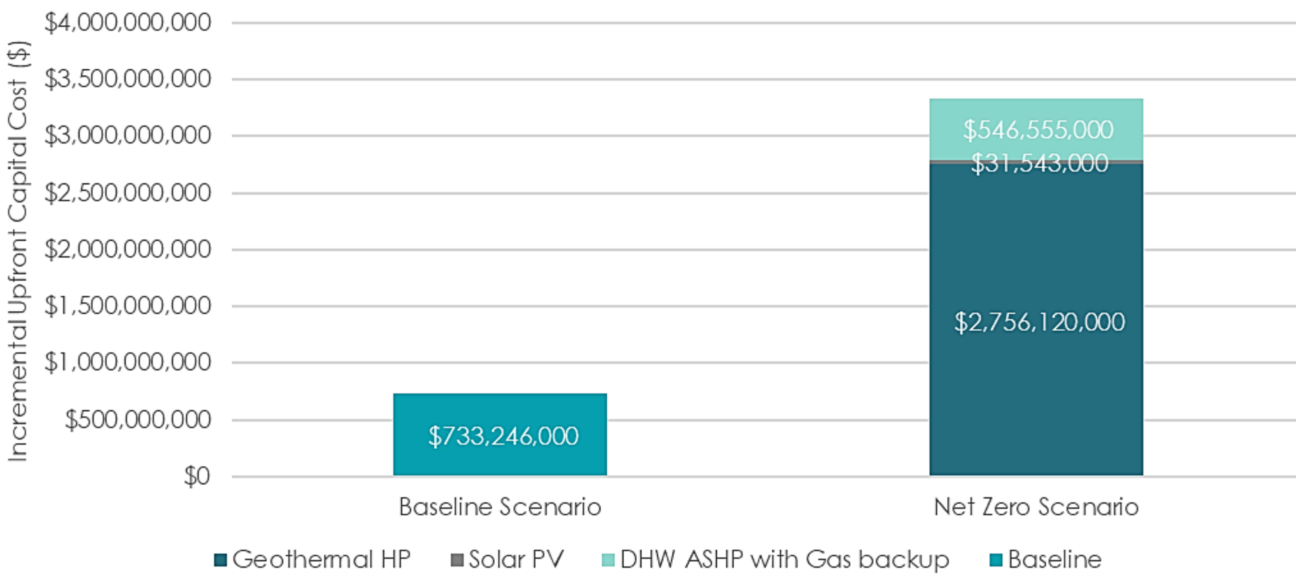

Figure 10: Total Incremental Upfront Capital Cost vs. Baseline Scenario

The implementation of the ECMs in the **Near Net Zero Scenario** includes the installation of geothermal heat pump systems, rooftop solar PVs and domestic hot water served by air source heat pump with gas backup across the site. This would lead to a substantial increase in capital costs as compared to the **Baseline Scenario** as shown in **Figure 10**. **Figure 10** also illustrates the incremental upfront capital cost distribution for each measure in the **Near Net Zero Scenario**.

Geothermal heat pump systems and air source heat pump for domestic hot water are the highest contributors to the incremental upfront costs. The expected increase in the upfront capital cost for the Near Net Zero Scenario is approximately $2.6B, or 355%. While this represents a significant investment at the development stage, it's important to note that the Near Net Zero scenario is expected to reduce operational costs from approximately $157.8M (Baseline) to $139.4M, resulting in long-term savings that would benefit future building owners.

3.3. Roadmap to Near Net Zero

Table 9 summarizes the **Near Net Zero Scenario**, a potential lower carbon development pattern. This scenario incorporates strategies to achieve additional energy and carbon emission reductions beyond the **Baseline Scenario**. The percentage of individual measure reduction is shown below with the summative total, representing individual measure reduction potentials and final **Near Net Zero Scenario** solution results. The **Near Net Zero Scenario** as modeled achieves an EUI of 73 kWh/m^2 and a GHGI of 2 kg CO_2e/m^2. This represents a 38% reduction in EUI and a 78% reduction in GHGI over the **Baseline Scenario**.

Table 9: Estimated EUI and GHGI Reduction Potential

Baseline Scenario	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures	Results	
EUI [kWh/m^2]					Total Reduction Potential EUI [kWh/m^2]	Near Net Zero Scenario EUI [kWh/m^2]
119	-18	-10	-16	-1	-46	73
% of individual reduction	16%	8%	14%	1%	39%	
GHGI [kgCO2e /m^2]					Total Reduction Potential GHGI [kgCO_2e /m^2]	Near Net Zero Scenario GHGI [kgCO_2e /m^2]
10	-3.0	-0.3	-4.7	0.0	-8	2
% of individual reduction	29%	3%	46%	0%	78%	

The **Near Net Zero Scenario** demonstrates a potential pathway to near net zero carbon emissions for the Bolton North Hill Secondary Plan Area. This potential roadmap is shown in **Figure 11** and **Figure 12**.

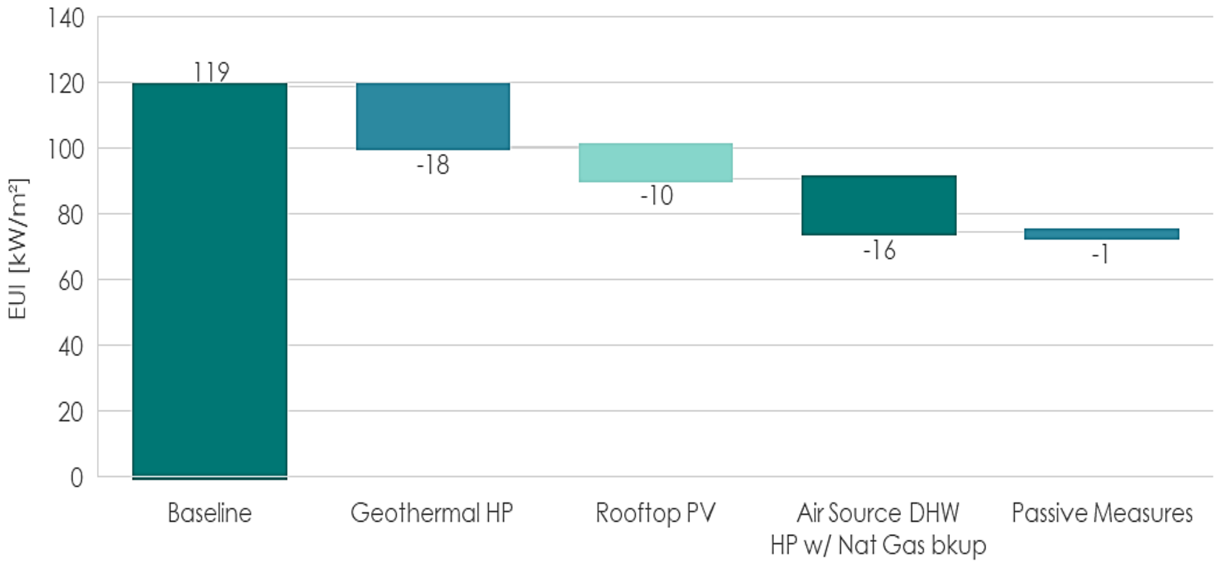

Figure 11: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential

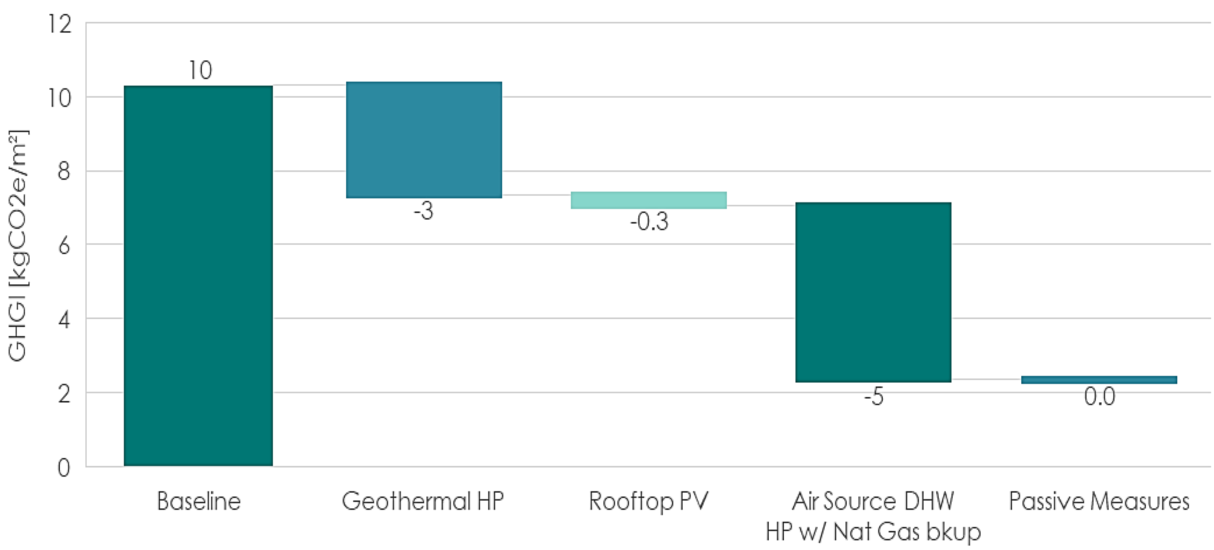

Figure 12: Greenhouse Gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

Table 10, and **Figure 13,** summarize the results of the **Near Net Zero Scenario** compared to the **Baseline Scenario** and to a building built to the requirements of the Ontario Building Energy Code Requirements. The energy requirements of the Town of Caledon's GDS are consistent with the green standards used by other southern Ontario municipalities, but these standards are more stringent than the provincial code. This means that the Baseline Scenario already represents energy conservation and emissions reductions than code requirements.

Table 10: Estimated EUI and GHGI Reduction Potential Comparison to OBC and Baseline Scenario

	Ontario Building Energy Code	Baseline Scenario	Near Net Zero Scenario	Total Savings over OBC (%)
EUI [kWh/m²]	195	119	73	62%
GHGI [$kgCO_2e/m^2$]	25	10	2	91%

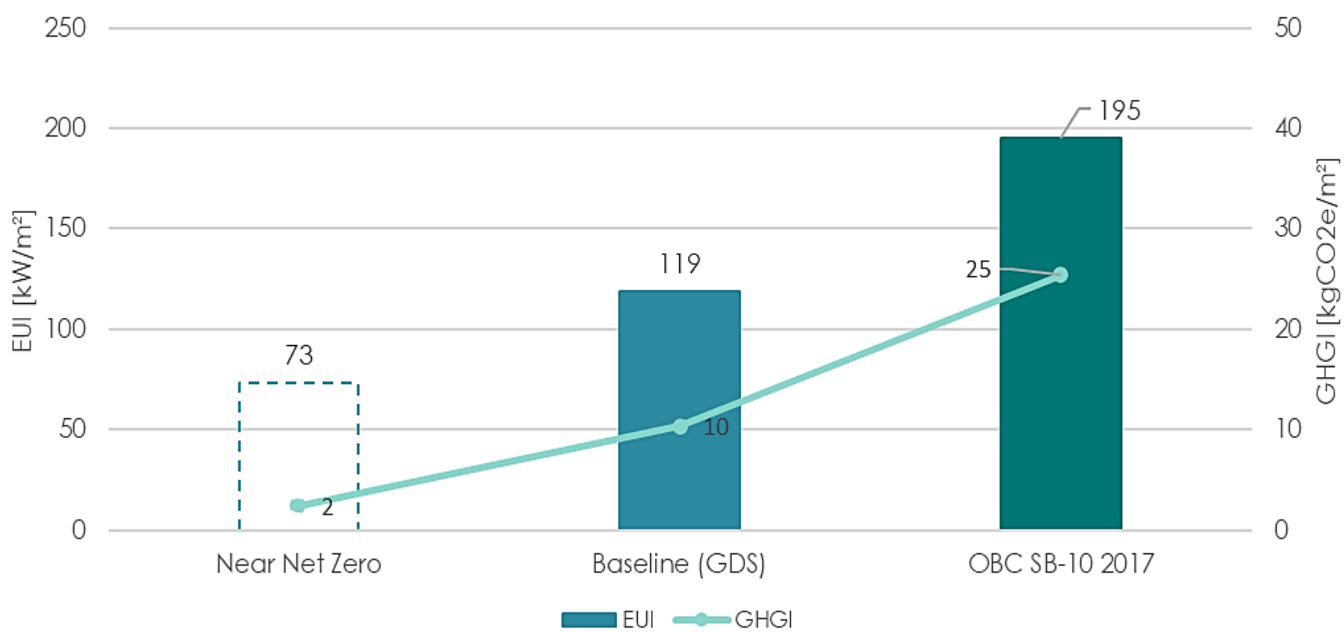

Figure 13: Estimated EUI and GHGI Reduction Potential Comparison to OBC and Baseline Scenario

4. Transportation Systems

The GDS requires that at minimum all single-family residential dwellings, 50% of multi-unit residential buildings (MURBs) and 20% of all non-residential spaces are equipped with the required infrastructure to be EV charger ready, as shown in **Table 5** in **Section 2.4**. To estimate the number of EV charger parking spaces within the Bolton North Hill Secondary Plan Development, population and employment projections for each type of dwelling were used. **Table 11** summarizes the number of parking spaces required to be EV charger ready for the Bolton North Hill Secondary Plan Area.

Table 11: Number of Parking Spaces Required to be EV Charger Ready

Building Type		Caledon GDS EV Charger-Ready Requirement	# of Level 2 Parking Spaces	Total Parking Spaces (Assumed)
Residential	Low Rise Residential (<3 storeys)	Minimum one charging space per dwelling unit	2,097	3,429
	Multi-unit Residential (>6 storeys)	Minimum 50% of parking spaces are EV-Ready.	1332	
Non-Residential	Commercial Retail	20% of parking spaces are EV-ready	12	13
	Schools		1	

To understand the electrical demand the Secondary Plan Area can experience associated with transportation upgrades, the following cases were considered to describe the potential energy demand associated with various scenarios in which EV chargers are installed and utilized within the Secondary Plan area:

- **Transportation Case 1** – 25% of residential dwellings install and utilize EV chargers, along with the minimum required 20% of all other spaces
- **Transportation Case 2** – 50% of residential dwellings install and utilize EV chargers, along with the minimum required 20% of all other spaces
- **Transportation Case 3** – 100% of residential dwellings install and utilize EV chargers, along with the minimum required 20% of all other spaces
- **Transportation Case 4** – Assumes that all parking spaces will include EV Chargers

Transportation Case 1 is used as a baseline in this analysis to compare other scenarios against. **Transportation Case 3** represents a conservative scenario in which the GDS's minimum required chargers are all installed and utilized, showing a peak demand for the Secondary Plan Area.

Crozier Consulting Engineers completed a Transportation Study for the proposed Bolton North Hill Secondary Plan Area, entitled *Transportation Assessment Update – Bolton North Hill Option 1 & Option 2 Lands* dated February 2025 (Crozier Consulting Engineers, 2025). The purpose of the transportation study was to assess the impact of the proposed community on the existing road network in Caledon, Ontario near the existing community and the forecasted vehicle traffic that is expected within the development area based on the proposed urban form.

Crozier Consulting Engineers' transportation study forecasted personal vehicle daily trips taken within the community, based on the proposed site layout. These values were used as a basis to inform the baseline estimate of the transportation GHG emissions from personal vehicles within the Bolton North Hill Secondary Plan Area. These values will be used as a basis to inform Scope 3 emissions from personal vehicles that have the potential to be reduced using forms of active transportation and implementation of the EV chargers. A discussion on tailpipe Scope 3 emissions is reported in **Appendix E**.

4.1. Transportation Systems Results

4.1.1. Estimated Electrical Demand

To estimate the electrical demand from Level 2 chargers for the Bolton North Hill Secondary Plan Development, population and employment projections for each type of dwelling were used. Level 2 chargers are assumed to have an electrical demand of 6.6 kW per charging station for single family homes. All other dwellings (MURBs, commercial and school buildings) require an energy management system to be installed which limits the peak demand. Level 2 chargers in these spaces were assumed to have an average electrical demand of 2 kW.

To understand the potential electrical demand the Secondary Plan Area can experience associated with transportation upgrades, the transportation cases shown in **Table 12** were used to describe the potential energy demand associated with various scenarios in which EV chargers are installed and utilized within the Secondary Plan area. **Transportation Case 1** is used as a baseline in this analysis to compare other scenarios against.

Table 12: Transportation Scenarios Assessed

Category	Baseline Design Scenario	Net Zero Design Scenarios
Transportation	***Transportation Case 1*** *25% of residential and 20% of non-residential spaces utilize EV chargers*	***Transportation Case 2*** 50% of residential and 20% of non-residential spaces utilize EV chargers
		Transportation Case 3 100% of residential and 20% of non-residential spaces utilize EV chargers
		Transportation Case 4 100% of residential and 100% of non-residential spaces utilize EV chargers

The results of the analyses conducted demonstrate that if adopted at high rates, EVs and their associated infrastructure requirements are expected to significantly increase electricity demand. The estimated overall energy demand associated with the scenarios modelled is summarized in **Table 13**.

Table 13: Estimated EV Charger Demand

Scenarios Assessed	Level 2 EV Chargers		Level 2 EV Chargers Demand [kW]	Total Carbon Emissions [$kgCO_2e$]	Increase in Energy Consumption
	Residential	Non-Residential			
Transportation Case 1	857	3	4,227	211	-
Transportation Case 2	1,715	3	8,449	422	2x
Transportation Case 3	3,429	3	16,892	845	4x
Transportation Case 4	3,429	13	16,914	846	5x

It is not feasible to offset the expected electrical demand on-site through active or passive measures, and therefore electric vehicle charging demand was considered separately from the **Near Net Zero Scenario.**

Costing for the EV charging stations was based on average costs of $1,200 per charger for Level 2 chargers. These costs include charging station equipment, conduits, electrical cable runs and installation. These average costs were obtained from major supplies in Canada (ChargePoint, Switch Energy, & Flo). Approximately 65% and 85% of this cost is associated with the conduits, and electrical cables for residential and non-residential buildings, respectively. The remainder of the costs associated with charging station equipment and installation are to be borne by individual owners.

This equates to $780 for level 2 residential chargers, $1,020 for level 2 non-residential chargers, that can be installed at the time of development to make the buildings EV charger ready. Based on the GDS requirements to make buildings EV charger ready, this results in a total of **$2,677,431**. Major suppliers have suggested that there is a factor of economies of scale that exists when chargers are installed in larger quantities. This value varies between suppliers and would be determined at the time of procurement as it is based on market demand. Networking opportunities also exist in which chargers are connected to a central management system to reduce the energy required to operate the individual chargers.

While service upgrades are not required to make single-family homes EV charger ready, medium and medium/high density residential and non-residential spaces will likely require higher capacity transformers and sub-stations due to the electrification of building and transportation services. This depends on the anticipated usage at the site and can be coordinated with a service provider during the design development stage.

In terms of emissions, **Transportation Case 4** would fully eliminate Scope 3 tailpipe emissions from the proposed community associated with the residents, however, **Transportation Case 4** also increases the energy demand and carbon emissions by 300% or 5x over **Transportation Case 1**.

5. District Energy Systems

5.1. District Energy Anlysis Considerations

District Energy Systems (DES) distribute heating and cooling generated at a centralized plant to provide energy to multiple buildings on a development or neighborhood scale. A DES consists of a heating and/or cooling center, and a thermal network of pipes connecting groups of buildings (City of Toronto, 2023). DES provide access to a low-carbon fuel source, such as electricity generated from renewable sources like solar photovoltaics or wind, with minimal infrastructure required to tie into the piping network. These systems can create economies of scale and energy-sharing opportunities to achieve large-scale, cost-effective GHG reductions.

The feasibility of such systems was explored in this study. Note that systems developed at the district scale may be comparable (in terms of cost) to building level systems. Typically, DES providers aim to achieve payback of 20 years, which is in line with the time frame adopted for the life cycle costing analysis conducted in this study.

District energy systems rely on building density and supporting infrastructure to be viable. Consequently, these systems are best suited to medium to high-density development areas. The density classification of archetypes was completed based on units per hectare provided by the Bolton North Hill planning consultant:

- Low-density residential:
  - Single houses (10 units per hectare)
  - Street townhouses (12 units per hectare)
  - Stacked and back-to-back townhouses (18 units per hectare)
- Medium and higher density residential:
  - Medium density blocks (52 units per hectare)
  - Medium/high density blocks (61 units per hectare)
  - Mixed use (89 units per hectare)

Feedback from district energy developers in the Greater Toronto Area suggests that these systems are viable for medium/high density service areas >1M sq ft. The capital cost of implementing a ground source heat pump-based DES, comprising centralized ground loop fields, energy transfer stations, and a distribution network, can be comparable to the combined cost of installing individual ground or air source heat pumps and mechanical systems in each building. While initial costs may be concentrated in the shared infrastructure, the DES approach can achieve greater efficiency, reduced equipment redundancy, and long-term operational savings through centralized management and energy sharing across buildings.

Potential district energy systems were evaluated for a sub-area of medium and medium/high density subareas indicated in **Figure 3** within the Bolton North Hill Secondary Plan Area. **Table 14** summarizes the systems evaluated.

District energy systems were evaluated based on factors including spatial feasibility and infrastructure constraints as well as site density and serviceable floor area. A quantitative analysis exploring the feasibility of district energy systems can be found in **Appendix F**.

Table 14: Overview of District Energy Systems Evaluated

System Type	Description
Geothermal Pumps System	Uses ground source heat pumps (that rely on electricity) to harness heat from the ground, with the ground acting as both a heat source (in winter) and heat sink (in summer). *Note that no electrical energy is produced from this system. *Note that no electrical energy is produced from this system.
***Cogeneration System**	Electric or thermal energy production using process waste and/or biofuels.
PV Array	Composite panels that convert solar energy into electricity.
****Water Source Exchange System**	Acts as a heating source during the winter season and heat sink during the summer season.
Sewage Waste Heat Recovery	A system of water source heat pumps (that rely on electricity) that harnesses heat from sanitary water flows (i.e., the water body acts as a heat source). *Note that no electrical energy is produced from this system.

**Cogeneration systems require access to co-located industrial processes that can be leveraged to fuel the system. Based on planning documentation provided, it is expected that there will not be any nearby industrial processes or renewable fuel sources that could be accessed to provide a low carbon cogeneration energy source. Therefore, this DES was excluded from consideration.*
***Water source exchange systems require proximity to large water bodies. Based on the planning documentation for the Secondary Plan Area, it was assumed that there are no proximal large water bodies in the Mayfield Tullamore Secondary Plan Area and therefore this DES was excluded from consideration.*

Assumptions regarding pricing and the analysis of these systems are outlined in **Appendix F**.

5.2. District Energy Subarea Analysis

Section 2.1 of the report discusses the land use concept plan for the Bolton North Hill Secondary Plan Area. Subareas selected for district energy analysis within the Secondary Plan Area included the medium and medium/high density areas centered around Emil Kolb Parkway and Regional Road 50 intersection as shown in **Figure 14**. The remainder of the Secondary Plan Area is expected to be predominated by low-rise residential buildings that are poorly suited for district systems. A distribution of these subareas, their dwelling types, and square footage is shown in **Table 15**.

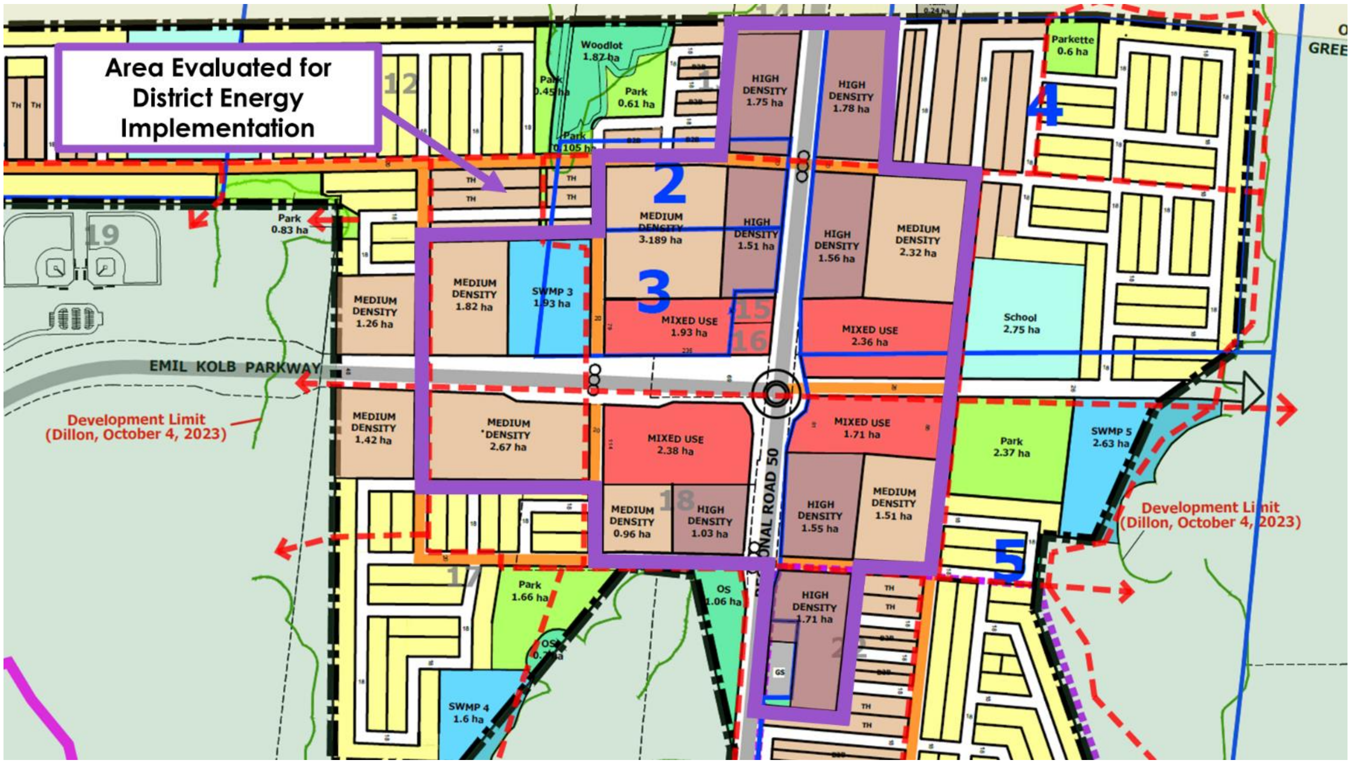

Figure 14: Area of Consideration for DES Feasibility (Bousfields Inc., May 26, 2025)

Table 15: Overview of the Subareas Within the Secondary Plan Area

Sub-Area	Building Archetypes & Square Footage	Total GFA
Low Density Areas	Single Houses – 4,017,997 ft² Street Townhouses – 1,499,030 ft² Stacked and Back-to-Back Townhouses - 421,602 ft²	5,938,630 ft²
Medium and Medium/High Density Areas	Medium Density Blocks – 1,482,728 ft² Medium / High Density Blocks – 1,032,099 ft²	2,514,827 ft²
Mixed Use Areas	Mixed Use buildings with Commercial Services and Retail Spaces at Ground Level	865,104 ft²
Schools	Schools – 132,348 ft²	132,348 ft²

5.3. District Energy Results

5.3.1. Medium and Medium/High Density Areas

Approximately 27% of the Bolton North Hill Secondary Plan's development total gross floor area consists of buildings classified as medium or high density. Combined, these areas are 2,514,827 ft^2 in total. Based on the density, spatial consolidation, and grouping of the more developed areas of the site, along with the proposed square footage of these subareas, a feasibility assessment for district-level energy systems was carried out and the required space for geothermal equipment was estimated to be 126,013 ft^2. This area is equal to 5% of total medium and medium/high density areas. Note that this equipment can be accommodated within the mechanical rooms of the buildings and would require minimal additional dedicated additional space. A summary of these findings is outlined in **Table F-2** of **Appendix F**.

5.3.2. Low Density Areas

District systems are generally poorly suited to low-rise residential development patterns due to extensive infrastructure costs and low population density. One of the alternative compliance pathways under the Town of Caledon's Green Development Standards requires all single-family residential homes to include a three-season air-source heat pump. This highly efficient system reduces the marginal benefit of implementing a district energy system in such developments. These areas of the Secondary Plan Area were therefore excluded from the analysis conducted. This style of development is the majority of the proposed site, at approximately 6 million ft^2.

5.4. Potential Policy Barriers and Planning Considerations

Beyond considerations of density and square footage, there are additional considerations for successful implementation of DES. The following policy barriers will likely need to be addressed between the Landowners, the Town, and other stakeholders to enable DES implementation:

- **Right of Way (ROW) and Utility Design:** The Bolton North Hill Secondary Plan directs that new public utility and telecommunications infrastructure be located underground and grouped within single utility trenches. While this consolidated approach supports coordinated infrastructure delivery and efficient land use, it may constrain the flexibility required for implementing district energy systems (DES), particularly geothermal solutions that require significant subsurface area and custom configurations. Additionally, the Plan emphasizes the integration of multiple systems—such as stormwater management facilities, sidewalks, and cycling infrastructure—within public rights-of-way, which may create spatial competition and complicate the allocation of space for DES infrastructure.
- **Ownership and Maintenance:** The GDS acknowledges that technologies like district heating are optional for builders to consider in meeting performance targets. However, it does not provide explicit guidance on ownership, maintenance, or operational responsibilities for such systems. The Town of Caledon would likely need to review and consider appropriate policy, legal, financial, and operational frameworks before assuming ownership or entering into partnerships with private

developers for DES implementation. (Town of Caledon Green Development Standard - Summary Report, 2024)

- **Timeline:** Implementing DES typically requires extensive planning, including economic and engineering studies, design phases, and stakeholder consultations, which can span three to five years. This requires extensive coordination between the Landowners, developers of individual project sites, the Town, and other stakeholders (e.g., utilities).
- **Cost:** While DES can offer long-term energy efficiency benefits, the initial capital investment is substantial. Although private-public partnership models exist where private entities fund construction in exchange for long-term contracts, the feasibility of such arrangements in Caledon would require further exploration and policy development.

6. Conclusions

The development of the CEERP involved the exploration of various energy efficiency and emission reduction strategies and technologies for both buildings and transportation assets for the proposed Bolton North Hill Secondary Plan Area.

6.1. Near Net Zero Scenario

Preliminary conceptual planning information was used to inform understanding of the likely energy performance within the development. The technical feasibility of several building-scale energy systems was then assessed based on the overall energy demand and the sizing of systems that would be required to meet this demand. Of the potential building-scale energy systems considered, geothermal heat pumps, solar rooftop PV systems, domestic hot water systems with air-source heat pumps (and natural gas backup), and passive measures were considered as the most viable options for deployment in the Bolton North Hill Secondary Plan Area.

The **Near Net Zero Scenario** achieves an EUI of 73 kWh/m^2 and a GHGI of 2 kg CO_2e/m^2. This represents a 38% reduction in EUI and a 78% reduction in GHGI over the **Baseline Scenario**.

The 20 Year NPV total cost of implementing the strategies in this scenario is estimated to be **$6.1B**, based on the Class D cost estimate conducted. The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$4.5B**.

6.2. EV-Ready Infrastructure

The results of the analyses conducted demonstrated EVs and their associated infrastructure requirements are expected to impose a significant electricity demand at their assumed usage. Average installation and material costs suggest that it would cost approximately **$2.7M** to install electrical wiring and infrastructure in buildings to make EV charger ready per the GDS minimum requirements.

A factor of economies of scale exists for this installation, however, this will be determined at the time of procurement. While service upgrades are not required to make single-family homes EV charger ready, higher density residential and non-residential spaces may require higher capacity transformers and sub-stations due to the shift to electrifying the building and transportation services. It is not feasible to offset the expected electrical demand on-site through active or passive measures, and therefore electric vehicle charging demand was considered separately from the **Near Net Zero Scenario**.

6.3. District Energy Systems

District-scale geothermal energy generation was evaluated as potentially feasible within the denser development in Bolton North Hill Secondary Plan. Combined, the medium and medium/high density areas are 2,514,827 ft^2 in total. Further analysis and detailed design would be required to fully vet the suitability of such a system within this subarea of the Secondary Plan Area.

6.4. Future Actions

Implementation of the strategies associated with the **Near Net Zero Scenario** would enable the Bolton North Hill Secondary Plan Area to achieve GHGI performance well beyond the Town of Caledon's interim emission reduction target of 36% by 2030. Individual strategies described under this scenario pursued in isolation would also have a meaningful impact on energy efficiency and emissions avoidance. Beyond the technical feasibility of these strategies described within this Community Energy and Emissions Reduction Plan, however, successful implementation of the systems identified will require effective consideration of ownership and management factors, and resulting operating costs would need to be evaluated at a more comprehensive level to define the business case.

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7. Implementation

Implementation of the proposed energy conservation and emissions reduction strategies within the Bolton North Hill Secondary Plan Area will require a range of actions at key milestones in the planning and development process. These are outlined in **Table 16**.

Table 16: Items For Implementation of the Near Net Zero Scenario

Actions	Reference Document	Timeline	Dependency
Policy			
The Landowners Group shall engage with the Town of Caledon to confirm elements of the Town of Caledon pilot Green Development Standard that the Landowners Group will agree to integrate into policy requirements for the Secondary Plan Area.	Secondary Plan	Official Plan Amendment	Town of Caledon
The Landowners Group shall introduce policy statements that confirm that developments within the Secondary Plan Area will comply with elements of the Town of Caledon's GDS as determined through engagement between the Landowners Group and the Town of Caledon.	Secondary Plan	Official Plan Amendment	None
District Energy System Feasibility			
The Landowners Group shall research and engage potential district energy system partners to further assess the feasibility of the district-level systems identified as potentially feasible for sub-areas of the site.	N/A	Draft Plan	Town of Caledon
The Landowners Group shall investigate potential district energy system funding mechanisms and/or incentives available from other levels of government (federal and provincial), and ownership models available through system developers / suppliers. This may include application for grant funding from suitable sources to complete a full business case.	N/A	Draft Plan	None

Actions	Reference Document	Timeline	Dependency
If changes to the concept plan for the Secondary Plan Area are proposed that will increase the expected density, the Landowners Group shall further analyze and define sub-areas that are best suited to district-level energy systems, which is expected to be based on density ratios of planned developments (through a business case).	N/A	Draft Plan	None
Building-Scale Measures			
The Landowners Group shall demonstrate compliance with energy and emissions performance targets for all building typologies defined by the metrics in the Town of Caledon GDS agreed upon between the Town of Caledon and the Landowners Group.	Green Development Standard	Site Plan	Town of Caledon
The Landowners Group shall engage with renewable energy providers and utility companies to confirm design requirements for building-scale systems (e.g., heat pumps and solar photovoltaics).	N/A	Site Plan	None
Electric Vehicle Infrastructure			
The Landowners Group shall engage with the Town of Caledon to discuss and confirm electric vehicle charging capacity and infrastructure requirements (per building type).	Green Development Standard	Official Plan Amendment	Town of Caledon
The Landowners Group shall implement electric vehicle charging capacity and infrastructure requirements (by building type) based on agreed upon metrics with the Town of Caledon.	Green Development Standard Architectural & Urban Design Guideline	Draft Plan	Town of Caledon Hydro One Networks Inc.

Actions	Reference Document	Timeline	Dependency
The Landowners Group shall liaise with utility providers to confirm the total electrical demand requirements for the Secondary Plan Area for electric vehicles based on the standards and requirements agreed upon with the Town of Caledon.	N/A	Official Plan Amendment	Town of Caledon Hydro One Networks Inc.

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Appendix B. Site Plan and Statistics

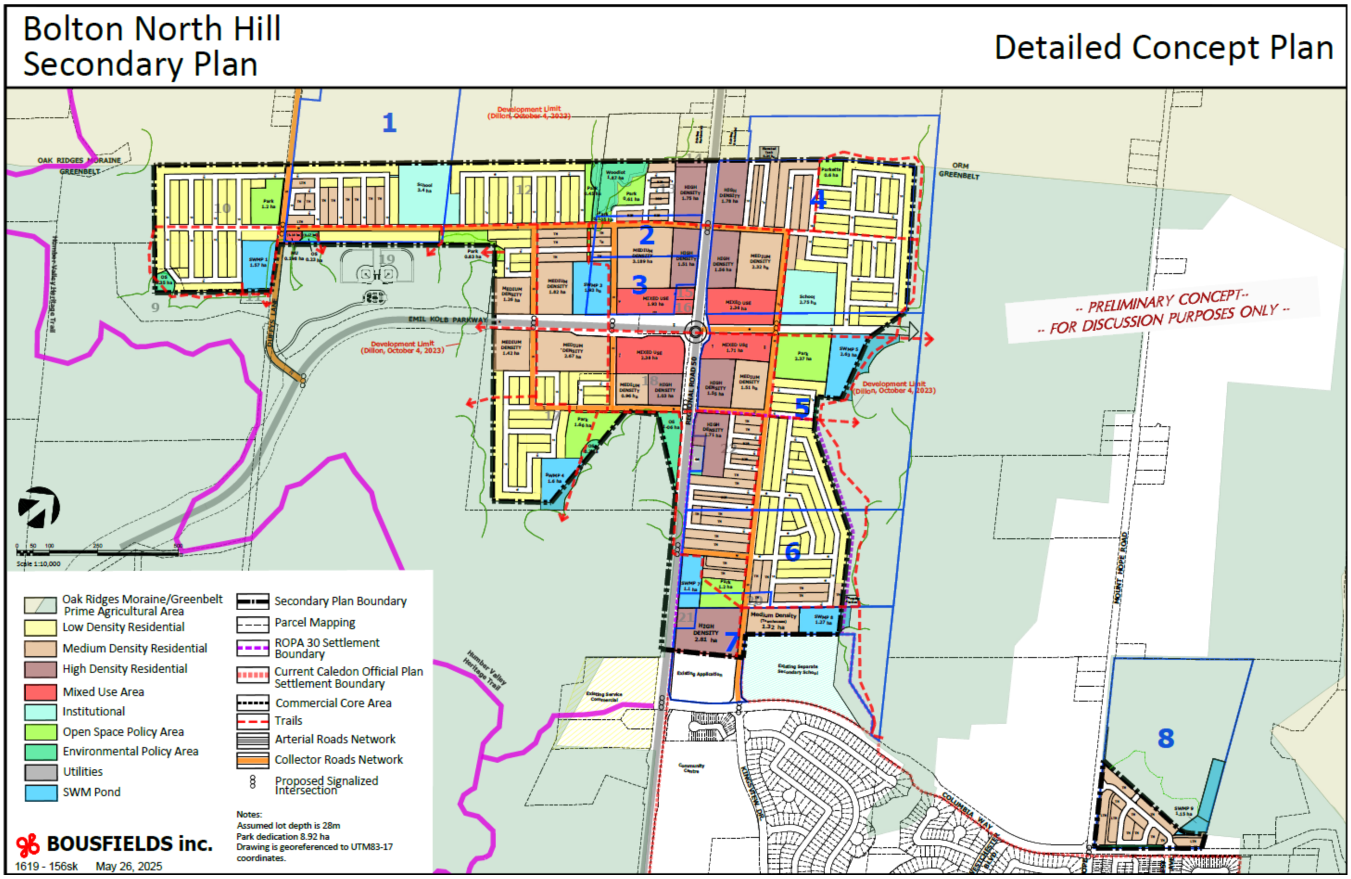

Figure B-1 Preliminary Concept Plan Option for the Bolton North Hill Secondary Area (Bousfields Inc., May 26, 2025)

Appendix C. The Energy and Carbon Environment

Utility Costs

The Secondary Plan Area is currently serviced by Hydro One for electricity, Enbridge for natural gas, and by the Region of Peel for domestic potable water. The prevailing Time-of-Use utility rates are summarized in **Figure C-1**. A blended electricity rate of 14.5 cents/kWh was used for all analyses conducted in the development of this report.

TOU period	Hours	Price
Off-peak	Weekdays from 7 p.m. to 7 a.m. and all day weekends and holidays	7.6¢ per kWh
Mid-peak	Weekdays from 11 a.m. to 5 p.m.	12.2¢ per kWh
On-peak	Weekdays from 7 a.m. to 11 a.m. and 5 p.m. to 7 p.m.	15.8¢ per kWh

Figure C-1: Toronto Hydro Time-of-Use Rates effective November 1, 2024 – April 30, 2025 (Toronto Hydro, 2025)

Prevailing natural gas rates are summarized in **Table C-1**.

Table C-1: Enbridge Gas Rates (January, 2025) (Enbridge, 2025)

Enbridge Gas Rates	
Total	cents/m^3
First 30 m^3	0.32
Next 55 m^3	0.31
Next 85 m^3	0.30
Next 170 m^3	0.30

The Caledon Green Development Standard

The Town of Caledon has developed guidance for low-carbon building construction under its proposed Town of Caledon Green Development Standard (GDS). The Town of Caledon's GDS establishes a suite of long-term, low-carbon goals and strategies governing building design and construction.

The GDS consists of tiers of performance measures with supporting guidelines that promote sustainable site and building designs. Tier 1 requirements of the GDS are defined as the mandatory requirement for the planning approval process. The GDS outlines absolute targets for planned developments and requirements for EV chargers based on building archetype. The GDS utilizes three energy performance metrics as the basis for quantifying and assessing energy and GHG emissions as follows:

- **TEUI:** Total Energy Use Intensity (kWh/m^{2}yr). This is the total annual energy use of the building and site divided by the modeled floor area.
- **TEDI:** Thermal Energy Demand Intensity (kWh/m^{2}yr). The annual heating load that the mechanical systems must provide to the building for space and ventilation heating, divided by the modeled floor area. Note that this is heat that the systems must provide at the terminals, not energy consumed by mechanical equipment to supply the required heating.
- **GHGI:** Greenhouse Gas Intensity (kg/m^{2}yr). The annual CO_2 equivalent emissions per modeled floor area using utility rate emissions factors.

These metrics mirror standards that have been implemented in most of the municipalities in the Greater Toronto Area. Similar metrics have also been used in various building performance standards such as the Canada Green Building Council's (CAGBC) Zero Carbon standard to establish energy and GHG targets. The current targets for Caledon's GDS are outlined in **C-2**.

C-2: Town of Caledon's GDS Absolute Performance Targets (Town of Caledon, 2024a)

Building Type	Energy and Carbon Performance Measures			EV Charger-Ready Requirements*
	TEUI [kWh/m2/yr.]	TEDI [kWh/m^2/yr.]	GHGI [kgCO2e/m2/yr.]	
Low Rise Residential (<3 storeys)	Energy Star or equivalent OR NBC Tier 3 performance and 20% reduction in GHG emissions from OBC		15	Minimum one charging space per dwelling unit
Multi-unit Residential (>6 storeys)	135	50	15	Minimum 50% of parking spaces are EV-ready
Multi-unit Residential (≤6 storeys)	130	40	15	
Commercial Office	130	30	15	Total of 20% parking spaces are EV-ready
Commercial Retail	120	40	10	
Industrial	130	60	15	Minimum 5% of spaces to be equipped with EV Supply Equipment (EVSE)

**For all building sites: Encourage dedicated parking spaces for carshare services or carpooling and charging spaces for e-bike and scooters.*

Appendix D. Energy Modelling Considerations

Energy Modelling Considerations

To reduce variability in the analysis and directly evaluate the energy consumption and carbon emission results for each building archetype, the study focuses on studying active energy conservation measures such as alternate HVAC systems, and then subsequently studied on-site renewable energy opportunities. The analysis compared the various potential energy conservation measures while holding the assumption that enclosure performance and ventilation loads (passive measures) were comparable to that of a Town of Caledon GDS Tier 1 compliant building. As a result, GHG and energy reductions are compared directly to the mandated Town of Caledon GDS Tier 1 energy and carbon emission performance metrics (TEUI and GHGI). Passive measures were then considered as a final proposed measure in the roadmap to achieve near net zero emissions.

Passive measures (primarily building enclosure upgrades) offer wide ranging performance gains. Thermal bridging (linear and point thermal transmittance) through elements such as parapets, slab-by-passes, window perimeters, corners, and the slab at grade plays a crucial role in determining how effective heat moves through the enclosure. An exterior wall assembly with a nominally rated insulation layer of R-20 will achieve various levels of performance depending on how heat loss through the thermal bridging elements is managed. Due to the considerable level of ambiguity associated with passive measures, a modest thermal demand intensity reduction was applied in the improved design to demonstrate the impacts of a reasonable improvement in enclosure performance.

Energy Modelling Software

Energy usage was informed by simulations completed using the IES-Virtual Environment 2023 (IES-VE) building performance simulation software. IES-VE is a sophisticated building energy simulation software that enables simulation of complex building systems including solar shading, daylighting, natural ventilation, and highly customizable HVAC systems.

Building Strategies and Technologies Assessed

The Town of Caledon is located in a heating-dominated climate, and this will continue to be the case into the future based on climate modeling conducted for the local region (Amec Foster Wheeler, 2018) In a heating-dominated climate, the largest contributors to GHG emissions from buildings are heating demands experienced during winter months which is typically met by on-site combustion of fossil fuels. Many of the building energy and emission strategies explored in this analysis prioritize reducing the heating load and fuel switching from natural gas to electricity. These strategies will achieve GHG emissions reductions by using less emissions-intensive fuel.

Table D-1 summarizes the technologies that were assessed as part of the development of this study. The technologies include various heat pump system options, where heat pumps are systems that extract or reject heat from one source (air, water, geothermal, etc.) and transfer it to building spaces that require it in the heating or cooling seasons, respectively. This technology saves energy as heat is transferred rather than generated in conventional heating systems. Other technologies that were studied included domestic hot water (DHW) source options in which efficient and low-carbon HVAC options were suggested to serve DHW loads from buildings; a change from traditional natural-gas sources.

Table D-1 - Low-Carbon Building Technologies Assessed

Building Strategies and Technologies Assessed		Description
Heat Pumps Options	Geothermal Heat Pumps	Ground source heat exchange or ground source heat pumps use the ground as a heat source in the heating season and a heat sink during the cooling season to extract and reject heat from the building spaces, respectively.
	Air-Source Heat Pumps (ASHP)	Air source heat pumps extract heat energy from the outside air (and use some energy to re-heat it) in the winter to provide heat to interior spaces and reject heat from the interior spaces to the outside during the summer months.
	Hybrid Heat Pumps	Hybrid heat pump systems incorporate both electric and natural gas sources to take advantage of the efficiency gains associated with electrification while retaining some of the more practical elements associated with traditional natural gas systems.
Domestic Hot Water (DHW) Options	Wastewater Heat Recovery	Wastewater heat recovery systems extract heat from sanitary water going down drains to preheat incoming water used for DHW loads in the building.
	ASHP with Electric Backup & Natural Gas Backup	ASHPs (as mentioned above) were considered to service the DHW loads of the buildings with both electric and natural gas backup, if required.
	Solar Water Heaters	Solar water heaters harness solar energy to heat domestic hot water (DHW)
Solar Energy Generation	Solar Photovoltaics (PV)	Rooftop solar photovoltaic panels installed on building roofs convert solar energy into electrical energy.

Appendix E. Transportation Scope 3 Emissions

Personal Vehicle GHG Reductions (Scope 3 Emissions)

Crozier Consulting Engineers' transportation study proposes a road network design for Bolton North Hill Secondary Plan that promotes active transportation. To estimate the amount of GHG reduction potential this could have for the Bolton North Hill Secondary Plan Area, a **Business-As-Usual Scenario** was assumed in which personal vehicles are used by community members for all transportation needs for the entire Secondary Plan Area (i.e., at 100% use of fossil fuel-powered vehicles).

For the purpose of this analysis, an average trip distance of 1.5 km was assumed. This is the approximate north-south distance of the site. It was also assumed that 1 gallon of gasoline provides a personal vehicle with approximately 25 miles, or 40.2 km of travel. Additionally, a tailpipe CO2 emission factor of 8.887 kg / gallon of gasoline is used, where tailpipe emissions are the product of fuel combustion from a tailpipe of a vehicle (EPA, 2023). Transportation or tailpipe emissions are a Scope 3 GHG emission, which are emissions that result from the activities of the community during operation (National Grid, 2023).

BA Consulting Group provided a forecasted trip generation within their transportation study, as shown in **Table E-1**. Based on forecasted trip values and the assumptions and GHG emission factor above, approximately 6,817 kg of daily CO2e were estimated for the Business-As-Usual Scenario.

Table E-1: Estimated Future GHG Emissions from Personal Vehicles for the Secondary Plan Area (Business-As-Usual Scenario)

Types of Trips	AM Trips	kg of CO_2e
Residential Trips	2,930	971
Types of Trips	**PM Trips**	**kg of CO2e**
Residential Trips	3,573	1,184
Total kg of Daily CO_2e		2,155

A study on active transportation conducted by the Victoria Transport Policy Institute in British Columbia suggests that active transportation can reduce automobile trips by 5% to 14% (Litman, 2023). This could provide a daily GHG reduction of between 108 kg to 302 kg of CO_2e.

The largest reduction in transportation GHG emissions can be achieved via the use of electric vehicles as they do not have any tailpipe CO_2 emissions (EPA, 2023). **Transportation Case 3** represents a case in which all residential dwellings install and use EV chargers, which amounts to approximately 99% of the development having chargers. Provided that electric vehicle uptake corresponds with charger availability, this can be extrapolated to a 99% reduction in daily GHG emissions of 2,134 kg of CO_2e.

The implementation of EV charging infrastructure and maintenance comes at a high cost and electrical demand and should be considered when determining whether this strategy should be included within the Mayfield Tullamore Secondary Plan Area.

It should be noted that Scope 3 emissions are not within the scope of the study and were excluded from the total GHGI reduction for the Bolton North Hill Secondary Plan Area.

Appendix F. Evaluation of District Energy Systems

Geothermal Analysis

The medium and higher density archetypes' peak heating and cooling load for the medium and medium/high density areas are estimated to be 3,703 kBTU/hr and 2,633 kBTU/hr, respectively, making the site dominated by heating loads.

The peak heating and cooling demand rate were obtained from the modelling analysis. A total of 450 boreholes were calculated based on peak heating demand. The boreholes were assumed to be 850 ft deep with 15 ft spacing, which enabled the calculation of the total area required for the infrastructure. This results in a field with a total area of approximately 126,013 ft^2. This equates to approximately 5% of the medium and higher density development, indicating that there would be limited space restrictions, and that the deployment of the system could be technically viable.

The cost per borehole was assumed to be $20,000 per borehole which enabled calculation of the total geothermal field cost. The cost of the geothermal heat pump was based on $ 36.3 /ft^2 of conditioned area. These costs were based on market research and consultation with Quasar Consulting Group. Hence, the overall cost of geothermal system was estimated to be around $1,040/kw of peak load demand.

The approximate NPV cost of implementing this system would be $1,706,133,419.

Solar Photovoltaics Analysis

Solar PV is traditionally mounted on building roofs. Considering the size of the proposed development in the Secondary Plan Area, several opportunities to maximize PV deployment may exist.

PV is extremely flexible in the context of spatial feasibility. The ideal location for a District style PV array would be near electrical substations and on/near public property/buildings with adequate space to accommodate a sizable array. Using PV panels as potential shading devices would allow for additional panel area. Based on the site statistics provided by the planning consultant (refer to section 2.1.1.), 5% of the parks, and 1% of the Public Elementary Schools lands, comprising a land area of 42,765 square feet, has been allocated for photovoltaic (PV) installation. The estimated annual energy production of approximately 309,894 kWh is calculated based on the solar radiation for the city of Caledon for each month of the year.

A district style solar PV system installed in Public Parks and Elementary Schools would allow for approximately 42,765 square feet of panel area, which is equivalent to mounting panels on roughly 1% of all available area across all medium and medium/high density archetypes within the entire Secondary Plan Area. However, even with the additional space allocations towards Solar PV, the energy generation potential from the system only amounts to an EUI reduction of less than 1%. In addition, based on the location of the parks and schools relative to the denser development, a solar PV system is not well suited for the Secondary Plan area. This style of system was therefore evaluated to be infeasible due to the large space demands and the small contribution to meeting energy needs.

Town of Caledon parkland property and Peel District School Board properties may have restrictions on PV arrays. This also makes it difficult to delineate a ROW for creating infrastructure and the proposed locations highlighted above were selected based on the assumption that the Town has the capability of enacting policy change that would permit some space from publicly owned lands to be used to house infrastructure.

The approximate NPV cost of implementing this system would be $548,373,757.

Wastewater DES Analysis

Sewage waste could be collected for one or several building blocks to be stored in cisterns, where heat exchange can occur as outlined in **Figure F-1** below.

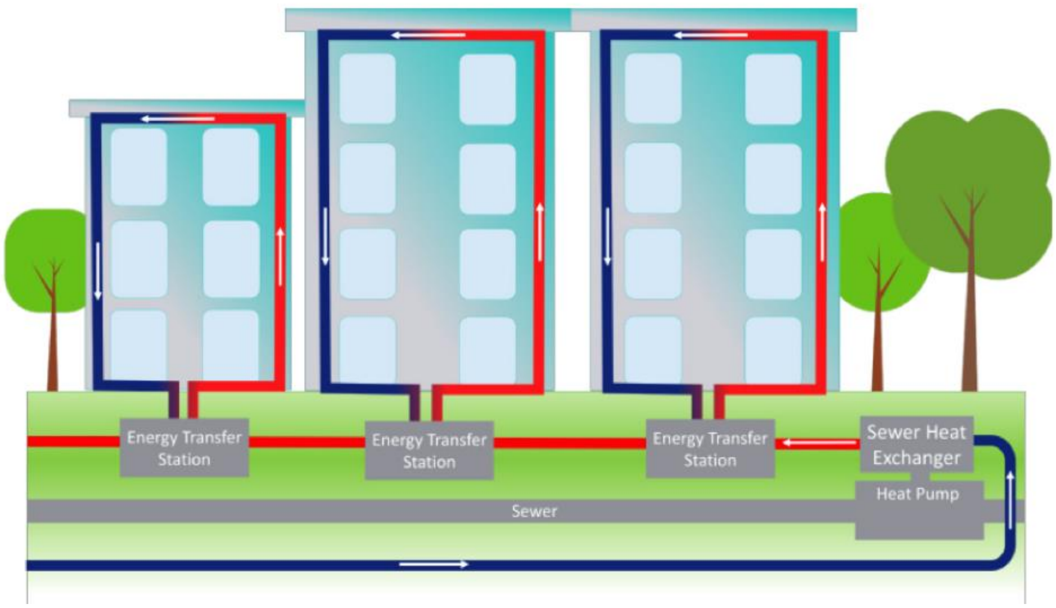

Figure F-1: DES Schematic of Wastewater Heat Recovery (City of Toronto, 2017)

Typically, this system has capacity solely to serve building DHW loads and would need to be used in conjunction with other energy-efficient mechanical systems.

To evaluate and demonstrate the feasibility of utilizing a wastewater heat recovery DES for the medium and medium/high density areas detailed calculations and post-processing of the modeling results were performed. This involved comparing the projected annual wastewater generation at the site with the minimum amount of wastewater required to meet the DHW load demand. This comparison was conducted to evaluate whether there would be sufficient wastewater produced to meet the energy needs of DHW.

Actual expected wastewater generation

To calculate the expected wastewater generation, LEED v4 WE indoor water use calculator worksheet was used. The summary of the assumptions used for this calculation is described below-

- Population – 14,780 (as per land use statistics provided by Bolton North Hill Landowners Group)
- Jobs - 410 (as per land use statistics provided by Bolton North Hill Landowners Group)
- Annual days of operation – 365 days
- Washroom flush rate- 1.6 GPF*
- Urinal flush rate-1 GPF*
- Public lavatory flow rate- 0.5 GPM*
- Lavatory faucet flow rate- 2.2 GPM*
- Kitchen faucet flow rate-2.2 GPM*
- Showerhead flow rate-2.5 GPM*

*The flow rates have been assumed based on LEED requirements.

Required wastewater generation to meet DHW Load Demand

The required wastewater generation was estimated based on formulae of thermal energy

$$Thermal\ Energy\ (kWth)\ =\ Flow\ (m3/h)\ x\ Specific\ Thermal\ Capacity\ (kWh/m3\ x\ °C)\ x\ Temperature\ rise$$

- Specific Thermal Capacity Wastewater = 1.16 (kWh/m^3 x °C)
- Temperature difference = 13°C -8°C = 5 °C (KEB Engineering & Project Management, 2021)

Thermal energy, which is essentially the heat extracted from the wastewater, is transferred to the evaporator side of the heat pump loop. Here, the heat is absorbed by the refrigerant. After the refrigerant is compressed, it transfers the absorbed energy to the condenser side of the system. This energy is then used to heat the domestic hot water.

From the energy modelling results the condenser energy (Qh) of this cycle is obtained, and it is estimated to be around 11,587,119 kWh. The COP of the water-to-water heat pumps is estimated at COP 2.5. Hence, based on the available information, the evaporator energy (Qc) was computed using heat pump COP formula which is:

$$\boldsymbol{COP\ =\ Qh/(Qh - Qc)}$$

The Qc value was calculated to be around 6,952,271 kWh. This value represents the thermal energy value to be used in the formula discussed above.

The cost of overall wastewater recovery system (field + heat pumps) was estimated based on $42,000/kW of peak load of area served, based on consultation with SHARC Energy, a vendor of these systems.

The required wastewater generation to meet the medium density development's DHW load demand was estimated to be approximately 319 million gallons/ year. The overall analysis summary is summarized in **Table F-1** below.

Table F-1: Estimated wastewater generation vs estimated wastewater required for Neighbourhood Centre subarea

Wastewater Factor	Projected Flow Rates
Total wastewater generated	279,445,460 gallons/year
Total wastewater required	319,199,930 gallons/year

The wastewater that is expected to be generated in this subarea therefore is projected to exceed the volume required to meet the DHW demand. Cisterns would be needed to handle the flow and house heat exchangers, which would be required to capture the available waste heat from the water.

The approximate NPV cost of implementing this system in the medium and medium/high density areas would be $1,786,004,871

Wastewater recovery solutions are considered technically feasible. They would be, however, incompatible with geothermal solutions, and it should be noted that policy and ownership and management restrictions may still limit the viability of this approach.

DES Result Summary

Table F- 2 summarizes the evaluation of DES Results for the study.

Table F-2: DES Anlaysis Results

System	Infrastructure Required (Enbridge, 2025)	Considerations	Estimated Cost (Subareas)
Geothermal Pumps System	450 boreholes and 126,013 ft^2 land area for medium and medium/high density areas	• Typically sized to serve heating and cooling loads and optionally for DHW • Space constraints must be studied (i.e., borehole field sizes/locations) • Soil conditions • Metering/financing considerations for owners/operators	TBD

System	Infrastructure Required (Enbridge, 2025)	Considerations	Estimated Cost (Subareas)
PV Array (District Level)	41,441 ft^2 of Public Parks and 1,324 ft^2 of Elementary Schools (42,765 ft^2 in total)	• Low energy generation potential • Location of PV arrays and racks are limited to publicly owned property • Metering/financing considerations for owners/operators	TBD
Sewage Waste Heat Recovery	Not feasible	• Can only serve DHW loads • Access to available sanitary waste matter streams • Metering/financing considerations for owners/operators	TBD

Appendix G. Energy and Carbon Analysis Results

Energy

Low-Rise Residential

Figure G-1 below illustrates the Energy Use Intensity (EUI) of the baseline design, as well as the updated baseline incorporating various energy conservation and emission reduction measures for low rise residential archetype buildings which includes single houses, street townhomes and stacked and back-to-back townhouses.

As discussed in the Carbon section, low rise residential is already served by heat pump-based HVAC system, which results in lesser scope of energy savings for space heating. Solar PV panels tend to give more energy savings, since the electric EUI is offset up to a considerable extent by electricity generation through solar PV. Other than that, wastewater heat recovery DHW measure gives the best performing results with around 17% energy savings.

One thing to note is higher DHW savings for this archetype, which is quite opposite to other archetypes. As discussed in the below sections, EUI savings are dominated by space heating focused heat pump measures. Hence, this contradiction in savings profile among low rise residential and other archetypes leads to a more balanced savings trend for the overall entire site. Low rise residential's DHW measure performance is able to compensate other archetypes space heating measure's performance due to its larger share of the overall building site area (approximately 87%).

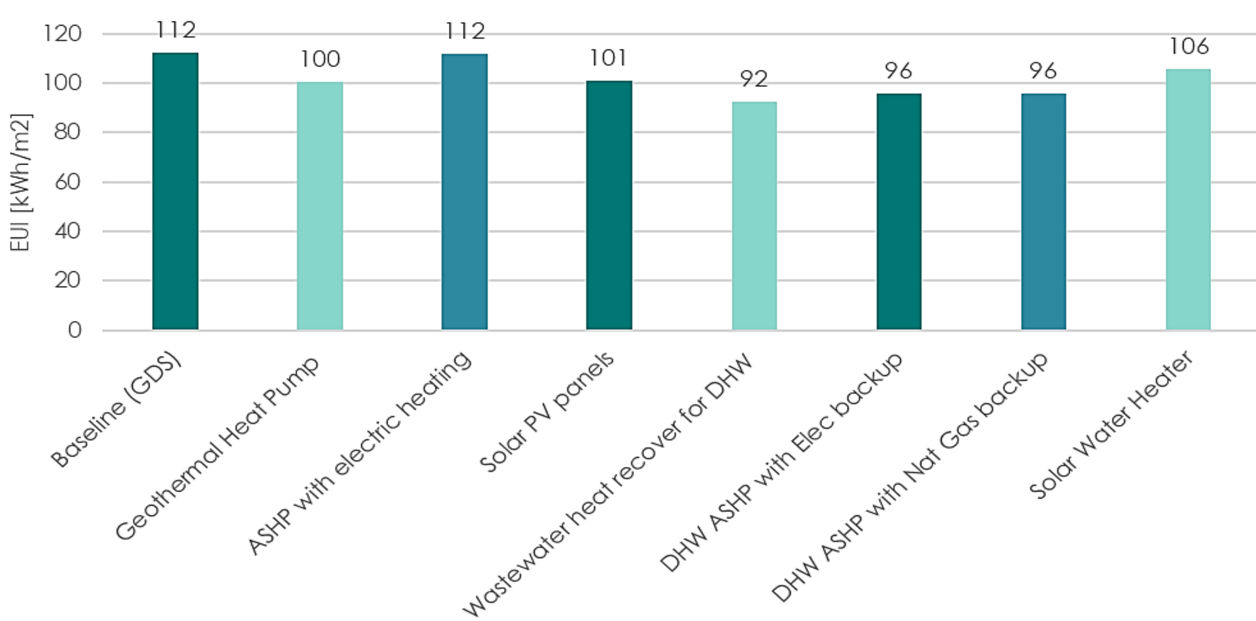

Figure G-1 – EUI Results for Low-Rise Residential

Multi-Unit Residential Building (MURBs) (≤ 6 storeys)

Medium and higher density stacked townhomes and apartments fall under this archetype. Heating measures are as effective as domestic hot water measures for this archetype, the reason being gas based traditional HVAC system in baseline. Note that solar has less impact on EUI as compared to other archetypes for MURBs, because of less roof area available for energy generation and hence less electricity offset. Geothermal heat pumps were the best performing measure with approximately 21% in energy savings as observed in **Figure G-2.**

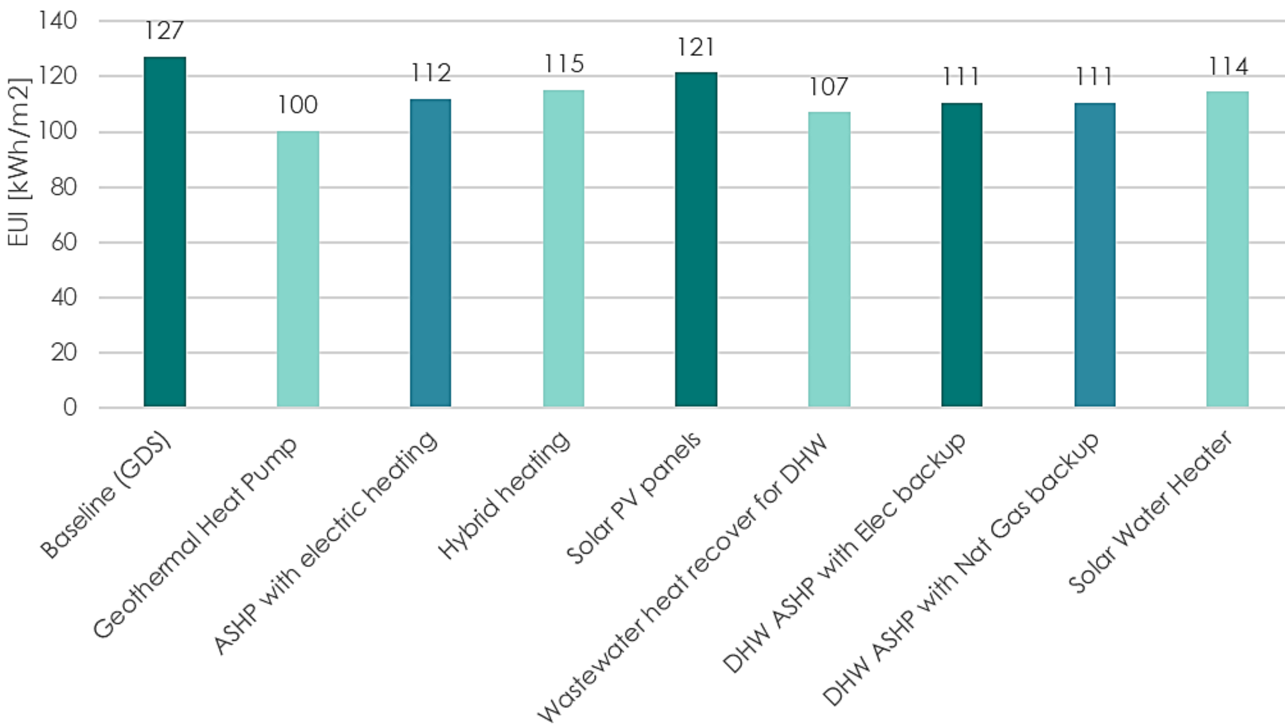

Figure G-2 – EUI Results for MURBs (≤6 storeys)

Mixed Use

The commercial services and retail fall under this archetype category. Geothermal was the best performing measure with an estimated 27% energy savings as observed in **Figure G-3** below. Note that Solar PVs are particularly attractive for this archetype due to the large roof area available for PV panels, leading to increased electricity generation.

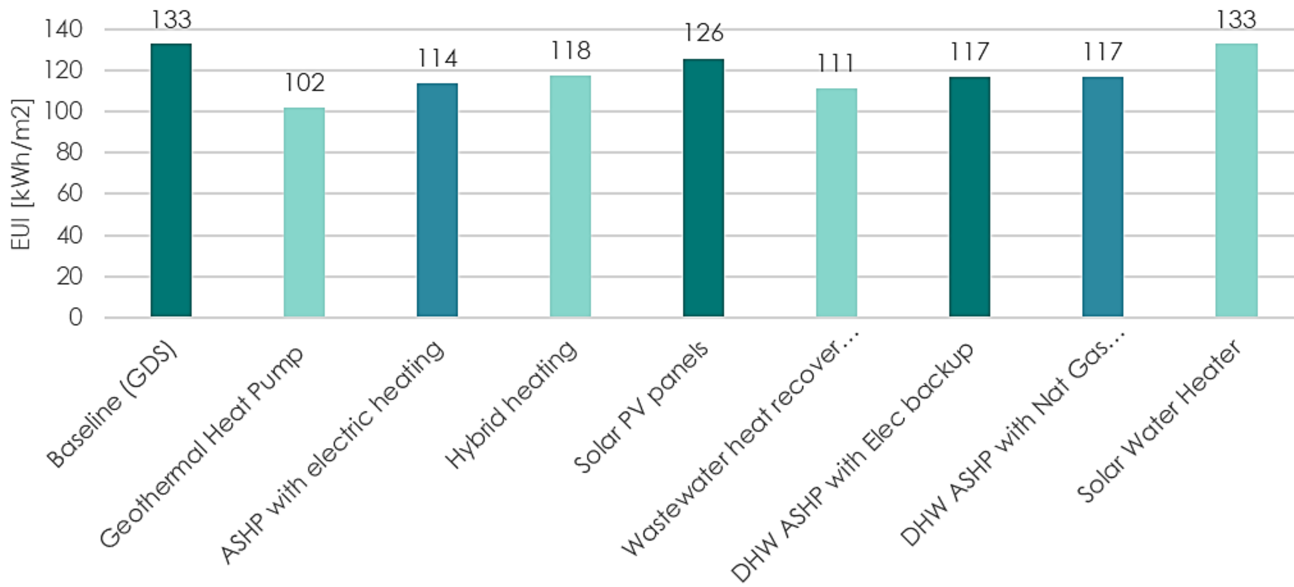

Figure G-3 – EUI Results for Mixed Use

Schools

The prospective performance of new schools in the Secondary Plan Area follows the same pattern as Commercial buildings, hence geothermal heat pump and Solar PVs were the best performing measure with an estimated 29% and 39% energy savings potential as observed in **Figure G-4** below.

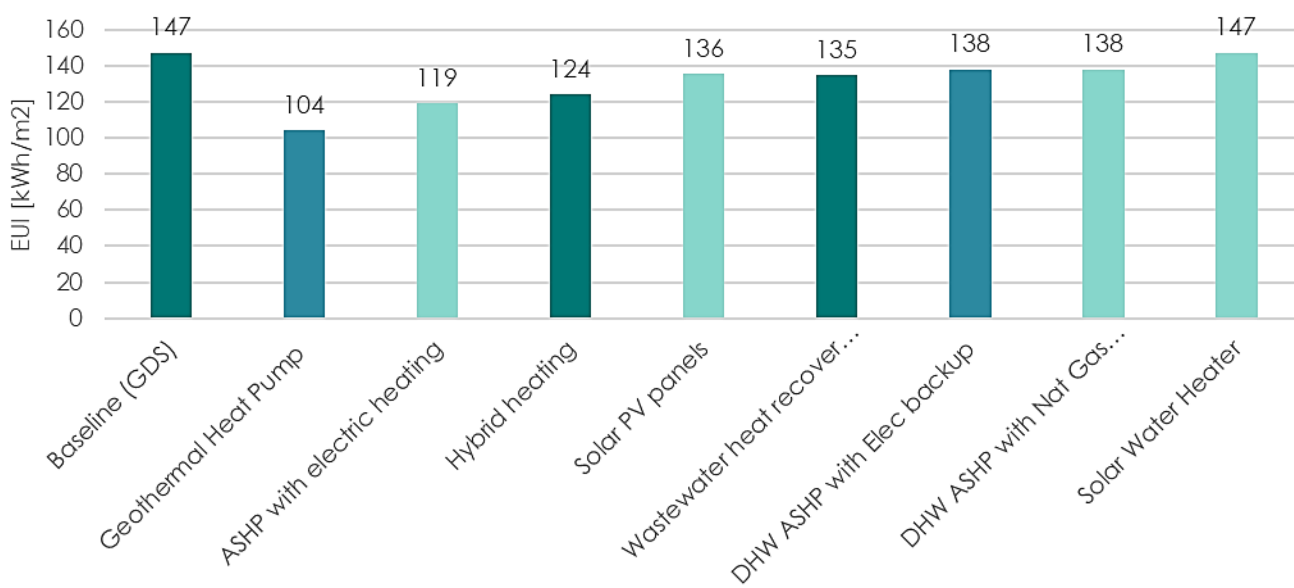

Figure G-4 – EUI Results for Schools

Carbon

The emissions factor used to calculate GHGI emissions were as follows:

- Electricity- 0.03 kgCO_2e/kwh
- Natural Gas- 1.899 kgCO_2e/m^3

Low-Rise Residential

Figure G-5 below illustrates the Greenhouse gas Intensity (GHGI) of the baseline design, as well as the updated baseline incorporating various energy conservation and emission reduction measures for low rise residential archetype buildings which include detached homes and street townhomes.

The GHGI performance with measures follows a similar trend as when considering the entire site. Measures focused on Domestic Hot Water (DHW) provide a greater scope for GHG reduction, as DHW in the baseline scenario relies 100% on natural gas and contributes approximately 58% of the emissions. Consequently, Energy Conservation Measures (ECMs) that focus on DHW tend to have a higher impact on reducing GHGI. DHW with Electric backup offer most GHGI reduction potential with around 57% expected GHGI reduction.

Note that the hybrid heating measure (natural gas and heat pump) was not modeled for this archetype. According to the Caledon GDS, low-rise residential buildings (less than 3 storeys) are required to use a three-season air source heat pump with natural gas backup. As a result, implementing a hybrid heating measure would likely have a negative impact on both energy use and emissions performance and was therefore excluded.

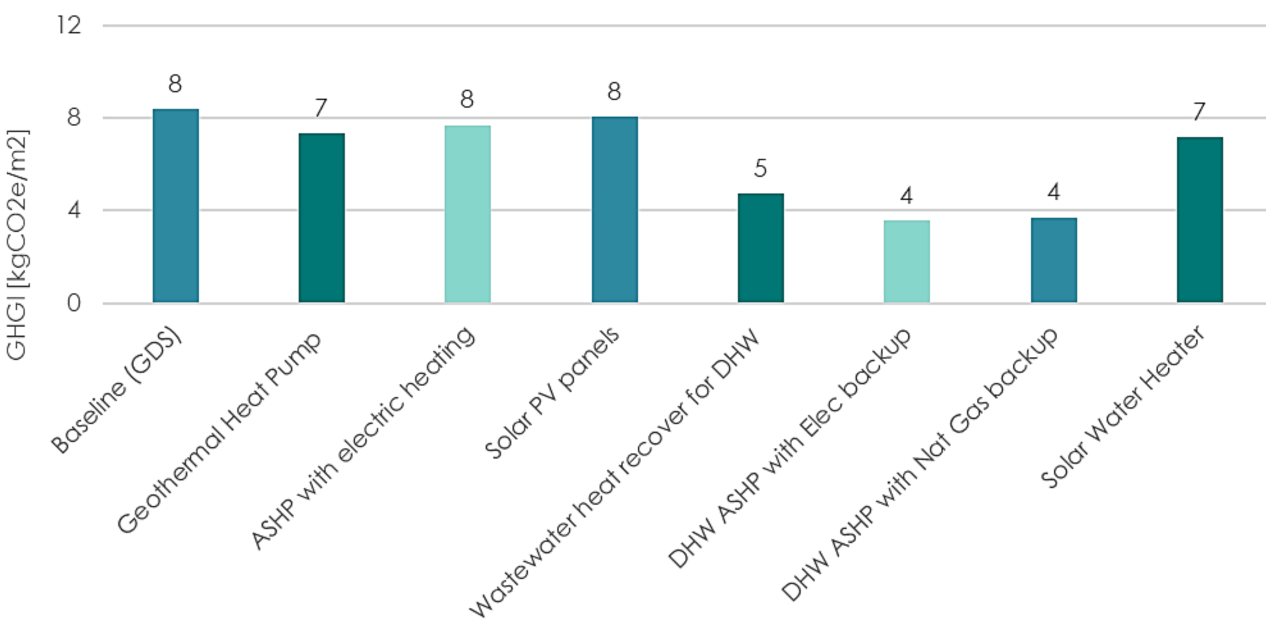

Figure G-5 – GHGI Results for Low Rise Residential

Multi-Unit Residential Building (MURBs) (≤6 stories)

Unlike low-rise residential buildings, MURBs are served by mid-efficiency boiler plant-based HVAC systems. As a result, space heating constitutes around 44% of GHGI emissions in the baseline, which is less compared to the 39% contribution by DHW. Therefore, measures focused on heat pumps and geothermal systems tend to reduce emissions more effectively compared to DHW measures. Geothermal heat pumps were assessed as the most effective GHGI reducing measure for this archetype with an estimated 46% GHGI reduction potential, as illustrated in **Figure G-6** below.

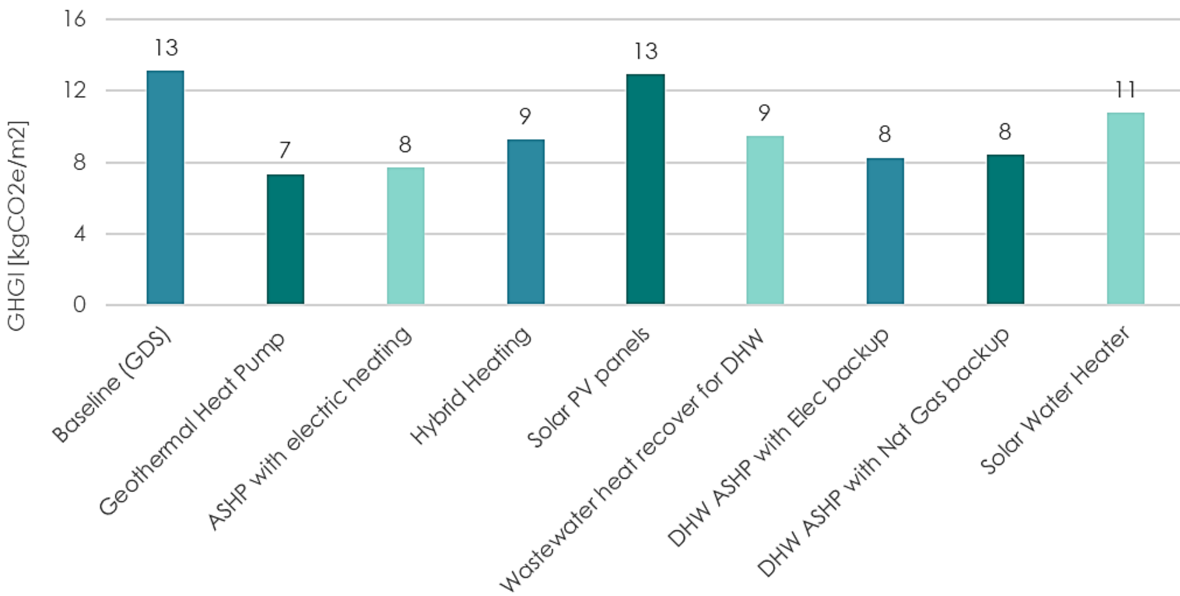

Figure G-6 – GHGI Results for MURBs (≤6 storeys)

Mixed Use

In this archetype, geothermal heat pumps and air source heat pumps offered the greatest reduction potential, with an expected reduction of approximately 47%, as illustrated in **Figure G-7** below.

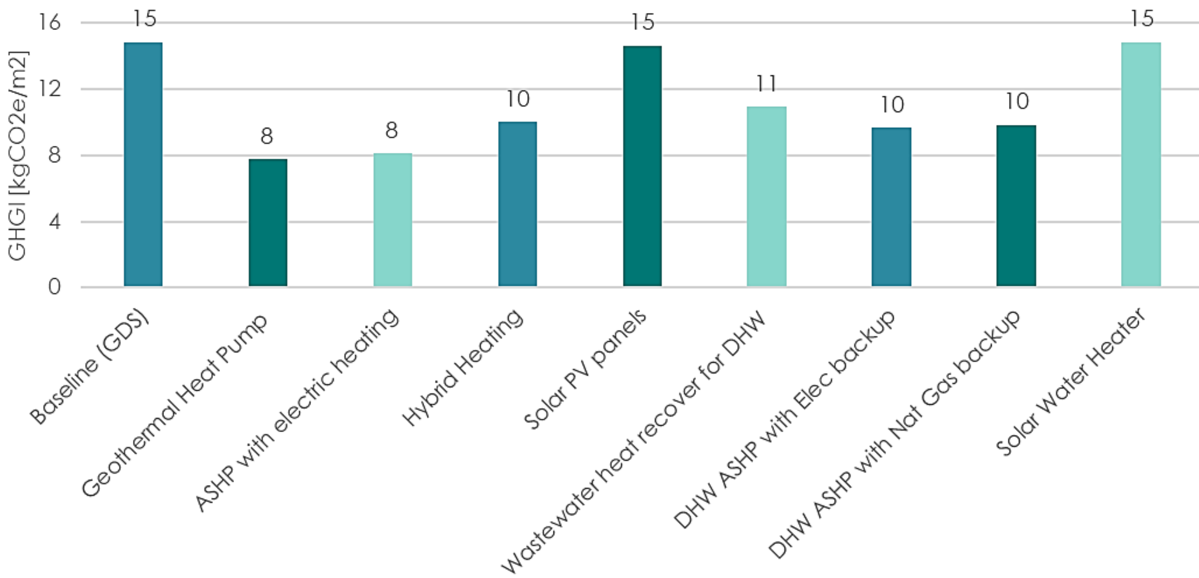

Figure G-7 – GHGI Results for Mixed Use

Schools

For reasons similar to the mixed-use archetype, the school archetype offers greater scope for improvement through heat pump-based measures. Consequently, geothermal heat pumps and air source heat pumps could achieve an estimated 63% reduction in GHGI each, as observed in **Figure G-8**.

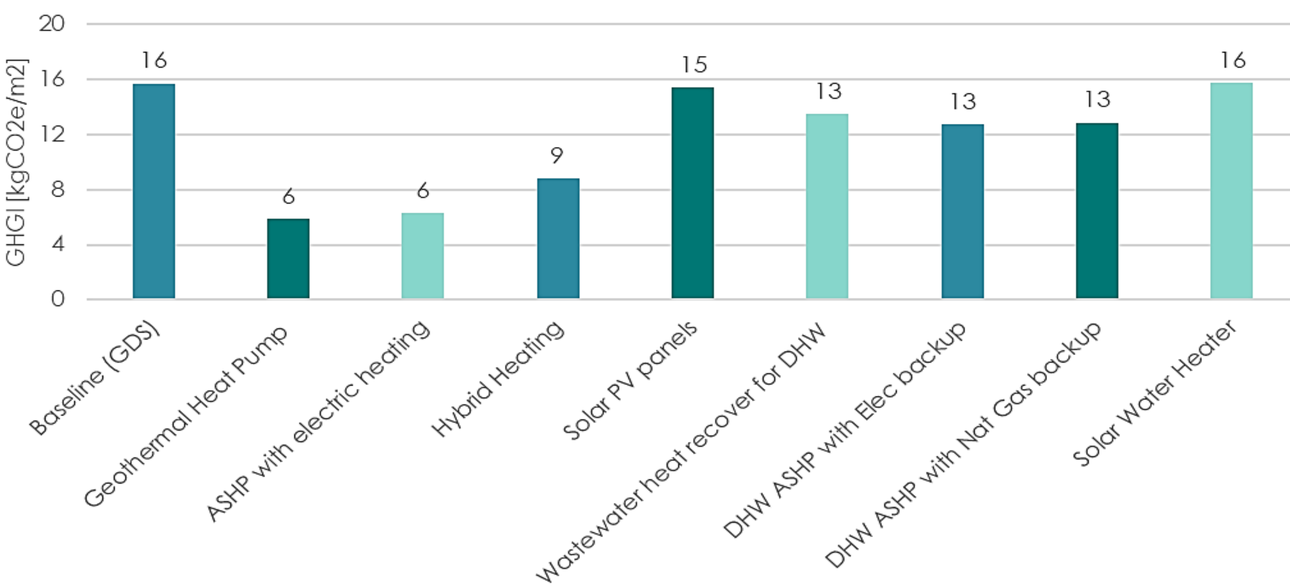

Figure G-8 – GHGI Results for Schools

Appendix H. Costing Analysis

Baseline HVAC

The Baseline HVAC system's total capital cost is calculated based on the total residential GFA multiplied by the total HVAC cost per square foot for each building type. 82% of the total cost per square foot is estimated as the HVAC cost for each unit. These costs were based on market research and consultation with Quasar Consulting Group. **Figure H-1** outlines the total cost for each building type.

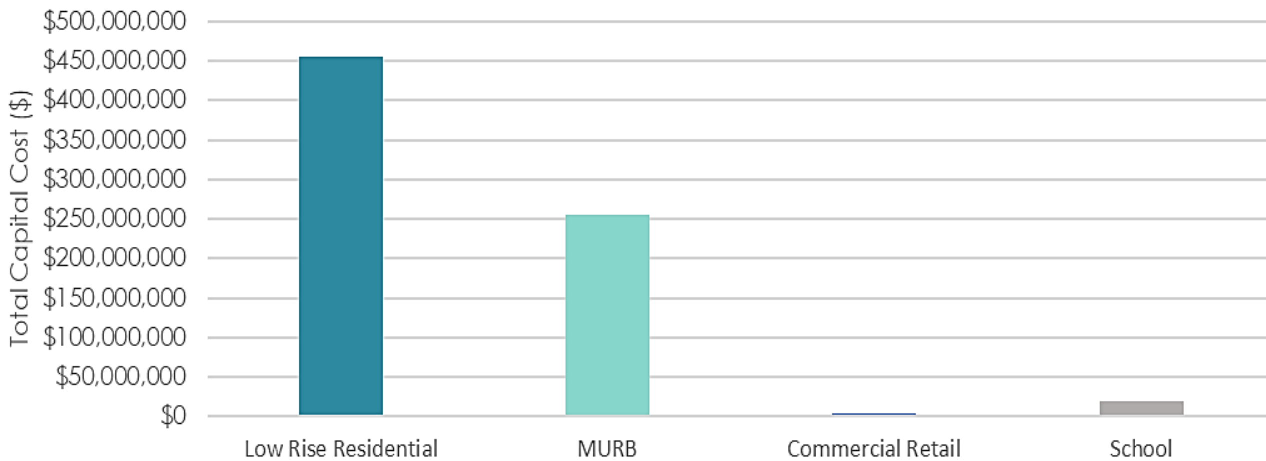

Figure H-1: Total Baseline Capital Cost Per Building Type

Air Source Heat Pump

The ASHP system total capital cost is calculated based on the peak heating (67,226 kW) and peak cooling load (47,805 kW) obtained from the modelling analysis. **Figure H-2** outlines the estimated price for the heating and cooling systems.

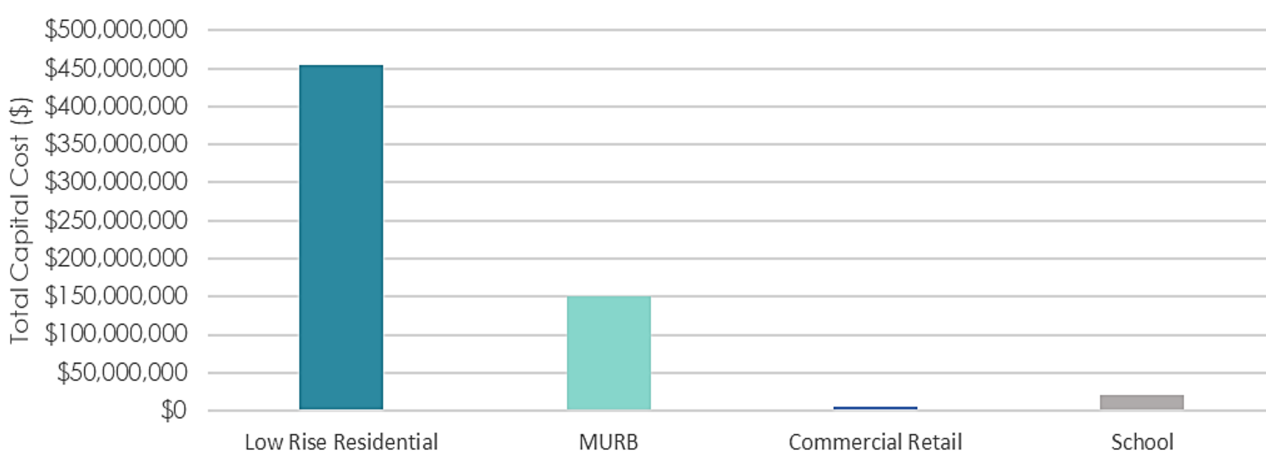

Figure H-2: Total ASHP Capital Cost Per Building Type

Geothermal Heat Pumps

The peak heating and peak cooling load are estimated to be 10,306 kBTU/hr and 7,328 kBTU/hr, respectively, making the site dominated by heating loads. To meet this demand, approximately 3,123 boreholes drilled to a depth of 850 feet would be required to meet the expected demand of the site. The boreholes were assumed to be 850 ft deep with 15 ft spacing. The cost per borehole was assumed to be ~$20,000 per borehole. The cost of the geothermal heat pump was based on $ 36.3 /ft^2 of the conditioned area. These costs were based on market research and consultation with Quasar Consulting Group.

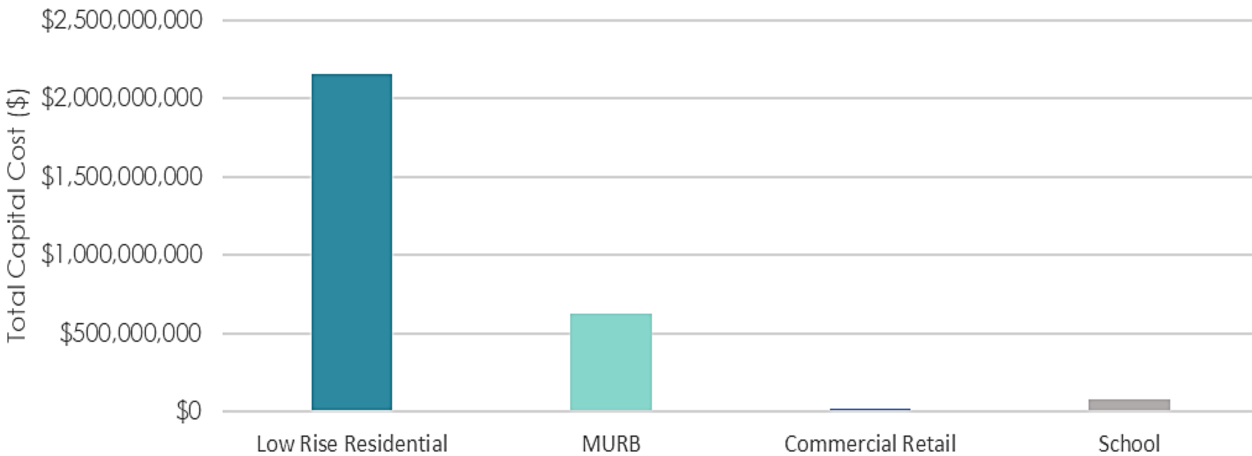

Figure H-3: Total Geothermal Heat Pump Capital Cost Per Building Type

Hybrid Heat Pumps

Same as ASHP, the Hybrid ASHP system total capital cost is calculated based on the peak heating and peak cooling load obtained from the modelling analysis. The system's total capital cost exceeds the ASHP total capital cost by 19%.

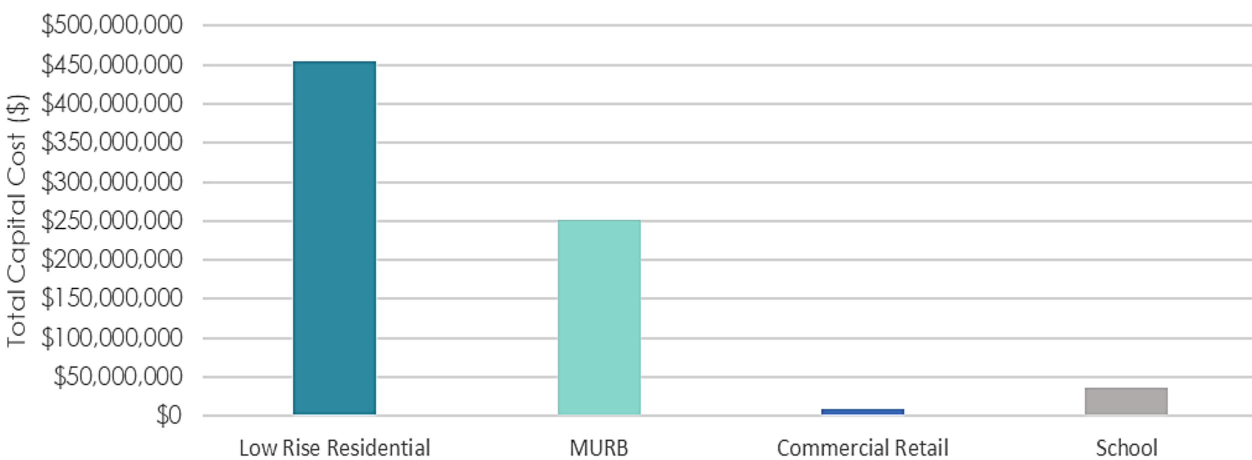

Figure H-4: Total Hybrid Heat Pump Capital Cost Per Building Type

ASHP DHW Heater

The ASHP DHW Heater system's total capital cost is calculated based on **Figure H-5**. These costs were based on market research and consultation with Quasar Consulting Group.

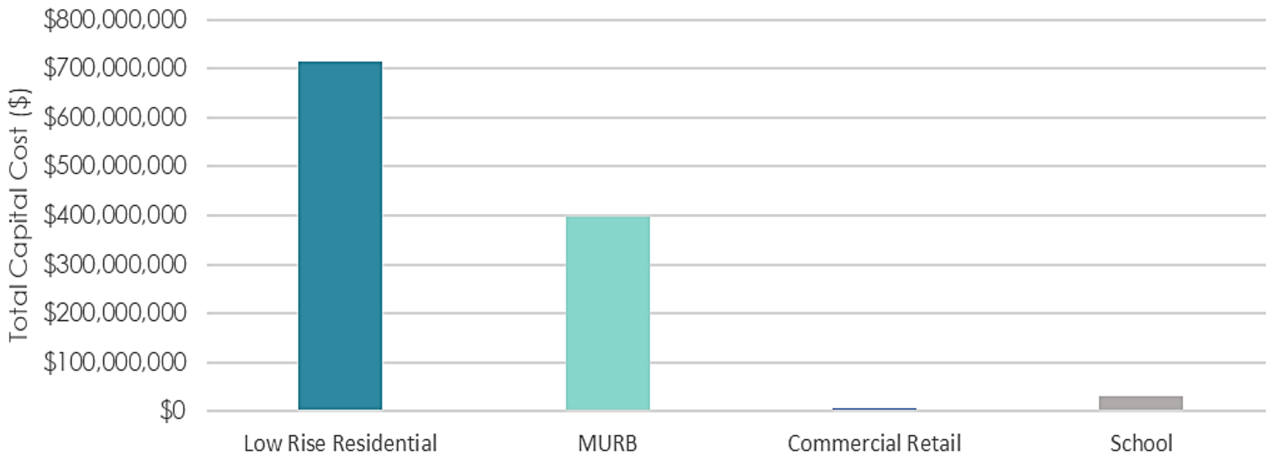

Figure H-5: Total ASHP DHW Heater Capital Cost Per Building Type

Appendix I. Resiliency

The Town of Caledon has identified resiliency as an area of focus as it strives to improve its response to the physical, social, and economic challenges of the future. Examples of external threats that could create vulnerabilities to the built environment may include:

- Overland flooding
- Extreme heat
- Blizzards or cold snaps
- Freeze-thaw events.
- Interruptions to energy supply
- Infrastructure failure
- Public health emergencies
- Cyberattacks

Events such as heat waves, ice storms, rain events and resulting power disruptions may force future residents of the community to rely on the passive and adaptive features of their residences for prolonged periods of time until service can be restored, or repairs can be made.

Resiliency as it relates to the proposed HVAC alternatives is primarily focused on flooding events and extreme weather conditions, and infrastructure failure.

Extreme Weather Conditions

Adapting to severe weather conditions is generally improved by having surplus heating or cooling capacity to service additional loads. This requires building in additional capacity at both the secondary/terminal level and/or plant level.

Per the Risk and Vulnerability Assessment prepared by ICLEI Canada (dated December 5, 2018) for the Town of Caledon, Caledon has previously experience extreme rain events, wind storms, ice storms during the winter months, and in more recent years, events of warmer temperatures during the winter months (February 2018) (ICLEI Canada, 2018).

Although numerous existing extreme weather conditions plans are in place to assist the Town of Caledon prepare for an emergency, the report identifies the gaps in these plans, such as the need for more robust condition assessment of infrastructure, and improvement and maintenance of stormwater management facilities (ICLEI Canada, 2018). The report also further emphasizes the need for municipality specific risk management plans in place to be prepared for such extreme weather conditions (ICLEI Canada, 2018).

Infrastructure Failure

As HVAC systems are converted to electric systems to reduce GHG emissions, additional load is placed on electrical infrastructure straining substations and increasing the risk of a potential power failure. Estimated baseline demand for the site is roughly 6 kW/unit. Fuel switching, via the introduction of air source heat pumps, can result in a 50% electricity demand increase, increasing the estimated peak demand for electricity to roughly 9 kW/unit. Switching again to geothermal reduces this demand back down to roughly 6 kW/unit as the geothermal system demands less peak electrical capacity at lower temperatures as compared to air source heat pumps.

A hybrid approach to energy supply would offer much of the benefit of fuel switching while relying on natural gas heating to service peak load conditions. This would reduce peak electricity demand significantly and would be relatively comparable to the **Baseline Scenario** or the baseline scenario with a geothermal heat pump option for peak demand. **Table I-1** outlines estimated kW demand for the heating and cooling systems under consideration.

Table I-1: Estimated Peak Demand of Alternate Heating/Cooling Systems

Heat Pump Options	Energy Demand (kW)
Baseline	25,000
Geothermal HX	25,000
Air Source HP	37,000
Hybrid HP	25,800

Futureproofing HVAC Systems

If natural gas-based systems or hybrid systems are currently the more viable HVAC option, installing connections for a future district-connected HVAC system presents an opportunity for a planned low-carbon retrofit in the future. Considerations for these systems are listed in the City of Toronto's Minimum Backup Power Guidelines for Multi-Unit Residential Buildings (City of Toronto, 2016b) and include:

- District Energy/Ground-Source Heating: In situations where a district energy system is being planned but will not be constructed in time to connect a building, the building can be future-proofed for connection (i.e. district energy-ready). This approach has the added benefit of also making the building ready for ground-source heating:
    - Install connections on reverse return piping - Arrange the reverse return piping from residential suites so that they have accessible points for future connections (ideally be a pair of riser isolation valves or a pair of Tee connections in communal areas). These connections would also prepare the building for a central heat pump.
    - Provide space for future vertical piping - Allocate vertical space from the parking through to the building level to the reverse return piping connections, in the form of sleeves over which flooring may be installed to avoid future costs. Service vestibules (elevator, garbage, corners of stair landings) may minimize the impact on space planning.
    - Provide space for the energy transfer station or central heat pump - Allocate parking spaces adjacent to the building core to create physical space for a future energy transfer station (ETS) or central heat pump. An ETS requires two (2) spaces, while a central heat pump would require approximately ten (10). MURBs using 4-pipe fan coil units in particular require additional power to be allocated for the future low carbon heating equipment. The estimated cost is $105/kW.
    - Allocate power for the low-carbon heating source - A reasonable estimate is to double the power allocated to the cooling plant to account for the lower efficiency. When a similar technology is producing beneficial heat.

- Lower Heating Water Temperatures: Where a district energy connection is not likely, there are commercially available heat pumps with capacities and temperature ranges to provide low carbon heating and cooling on-site. Mechanical systems must be designed for lower heating water supply temperatures to increase the efficiency and cost effectiveness of heat pumps:
    - Allocated roof space, structural support and power for an air-source heat pump to replace conventional cooling plant – allocate 50% additional peak electrical demand beyond conventional cooling plant for heat pumps.
    - In a heat pump building, plan for water-to-water heat pumps in series with the air-source heat pump.
    - In a fan-coil building, select building heating water distribution with ~50 °C supply water temperature – 50 °C supply water temp in line with commercially available heat pump supply water temp.

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