Mount Hope West Secondary Plan Area

Community Energy and Emissions Plan

Town of Caledon, ON

Prepared for: Solmar Development Corporation

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Pratus Group Inc.

Pratus

Issuance Approval

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A	October 31, 2024	Internal Draft	Yasaman Bateni	Eric Dunford, Christopher Mohabir	Oleksandra Onisko
B	January 29, 2025	SPA Submission	Yasaman Bateni	Eric Dunford, Christopher Mohabir	Oleksandra Onisko

Limitations

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1. Executive Summary

Pratus Group Inc. was retained by the Solmar Development Corporation 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 Mount Hope West Secondary Plan Area located in the Town of Caledon, Ontario. The purpose of this study was to:

- Assess the anticipated energy requirements for the Secondary Plan Area based on prevailing development requirements for new building construction in the Town of Caledon (termed the **Baseline Scenario**)
- 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**)
- Assess the viability of community-based energy generation systems for subareas of the proposed Secondary Plan Area
- 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 Mount Hope West Secondary Plan Area is 31.7 hectares, with 11.4 hectares consisting of land that is allotted to be developed as new buildings. The Plan Area as currently envisioned is expected to consist primarily of low-rise residential with some areas of denser development. The proposed building mix for the planned community includes freehold townhouses, detached homes, medium density condos, and a commercial block area with an estimated total gross floor area of approximately 143,285 m^2.

Energy simulations were conducted to estimate baseline energy use and carbon emissions resulting from the energy consumption of buildings proposed for construction within the Secondary Plan Area. Baseline performance was established per the building performance requirements outlined in the Town of Caledon's Green Development Standard. From this baseline, reduction opportunities associated with the proposed community development were assessed and explored to identify a low-carbon scenario consistent with the Town of Caledon and Region of Peel decarbonization objectives.

Building Energy Systems Assessed

The **Baseline Scenario** establishes the minimum energy consumption required for future development. The **Near Net Zero Scenario** was then constructed through evaluation of a variety of low-carbon design strategies and technologies, both at building and district scales. Strategies were selected based on their capacity to achieve energy conservation and emissions reduction strategies, ultimately identifying a prospective pathway to a lower-carbon development approach within the Secondary Plan Area.

Transportation Systems Assessed

The requirements of the Town of Caledon's GDS were used to estimate the energy demand associated with implementing electric vehicle (EV) chargers in the Secondary Plan Area for the following two scenarios:

- **Transportation Case 1** – Based on the Town of Caledon GDS minimum requirements
- **Transportation Case 2** – Assumes that all parking spaces will include EV Chargers

Under **Transportation Case 1,** a minimum number of EV chargers based on dwelling type and population was modeled based on the requirements of the Town of Caledon GDS. For **Transportation Case 2**, it was assumed that 100% of the residential and non-residential parking spaces would be equipped with EV chargers.

Archetype Energy and Carbon Results

Full details of the future development are not available at the Secondary Plan stage. To enable modeling of the required energy for the planned community, archetypes were established based on the expected development patterns identified by the project owner and planning team. The relative energy and carbon emissions performance of the archetypes modeled are illustrated in **Table 1.** In terms of energy performance, like-for-like system efficiencies are comparable whether looking at energy systems on a local or district level as the technologies used for heating, cooling or energy production adhere to the same operating principles. For the purpose of this study, the **Near Net Zero** energy system improvements were modeled to be implemented across all building archetypes.

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

Category	Archetype	Baseline Design	Net Zero Design (Improvements over Baseline)	% Savings over Baseline	
				Energy	Emissions
Residential	Detached Homes & Townhouses	3 season air source heat pump (ASHP) with natural gas backup	Solar PV panels, geothermal heat pump system for HVAC, and upgrade of domestic hot water to ASHPs with natural gas back up from 100% gas and passive measures	32%	73%
	Stacked Townhomes & Apartments	Constant volume corridor make-up air unit (MUA) and constant volume in-suite ventilators served by condensing boilers and chillers		37%	82%
Commercial	Commercial Retail	Fan coil units (FCUs) / Dedicated Outdoor Air Systems (DOAS) served by condensing boilers and chillers		44%	80%

Category	Archetype	Transportation Case 1	Transportation Case 2 (Improvements Over Case 1)	% Savings over Case 1	
				Energy	Emissions
Transportation	EV Chargers	1 EV charger at all residential units 50% of residential parking spaces, 25% of non-residential parking spaces (with 5% Level 3 chargers)	100% of residential and non-residential parking	3%	3%

Near Net Zero Scenario

Geothermal heat pumps, air source heat pump domestic hot water heaters (with a natural gas backup system), and rooftop solar PV systems were evaluated for the **Near Net Zero Scenario**, based on their potential energy and emissions performance. The energy use and greenhouse gas intensity reduction potential between the scenarios is shown in **Table 2** and **Table 3**, respectively.

Table 2 : Estimated EUI Reduction Potential

Baseline Scenario EUI [kWh/m²]	Reduction Strategies [kWh/m²]				Total Reduction Potential EUI [kWh/m²]	Near Net Zero Scenario EUI [kWh/m²]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
116.1	-16	-7	-16	-1	-41	75.6
% of individual reduction	14%	6%	14%	1%	35%	

Table 3: Estimated GHGI Reduction Potential

Baseline Scenario GHGI [$kgCO_2e$ / m²]	Reduction Strategies [$kgCO_2e/m^2$]				Total Reduction Potential GHGI [$kgCO_2e$ /m²]	Near Net Zero Scenario GHGI [$kgCO_2e$ / m²]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
9.6	-2	-0.2	-5	-0.03	-7	2.3
% of reduction	21%	2%	52%	0%	72%	

The results of the analyses conducted demonstrated that adoption of electric vehicles in the Secondary Plan Area will impose a significant increase in electrical demand - approximately 6.7 MW of electricity for **Transportation Case 1** and 6.9 for **Transportation Case 2**, representing additional capital cost requirements of approximately $1.0 million for Transportation Case 1 and $1.1 million for Transportation Case 2 respectively. These costs solely represent the anticipated electrical cost for EV charging stations required and do not include estimated costs for any additional electrical infrastructure such as higher capacity transformers or substations. It is not feasible to offset this increased electrical demand through low-carbon community energy sources within the Secondary Plan Area due to the magnitude of the demand. Therefore, electric vehicle charging demand was considered separately from the **Near Net Zero Scenario**.

While **Transportation Case 1** is required by the GDS, **Transportation Case 2** would provide a full reduction of Scope 3 tailpipe emissions on the site. **Transportation Case 2** increases the energy demand and carbon emissions by an estimated 3% from **Transportation Case 1**.

Table 4, **Figure 1**, and **Figure 2**, 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 Ontario Building Code demonstrates that the energy requirements of the Town of Caledon's GDS exceed the standard used other municipalities in Ontario as a baseline. As shown, the Town of Caledon GDS requirements are significantly more stringent than OBC, meaning that the Baseline Scenario represents significant energy conservation and emissions reduction over the provincial code.

Table 4: Estimated EUI and GHGI Reduction Potential Comparion to OBC and Baseline Scenario

	Ontario Building Energy Code	Baseline Scenario	Near Net Zero Scenario	Total Savings over OBC (%)	Total Savings over Baseline Scenario (%)
EUI [kWh/m2]	196	116	75.6	61%	35%
GHGI [kgCO2e/m2]	25.6	9.6	2.3	91%	76%

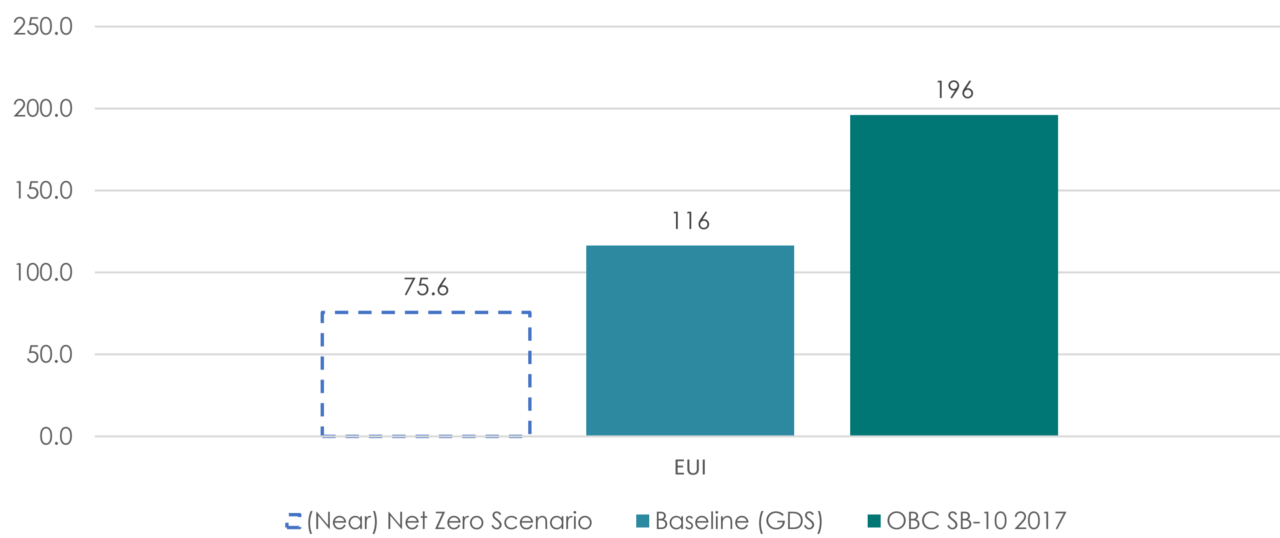

Figure 1: Estimated EUI Reduction Potential Comparion to OBC and Baseline Scenario

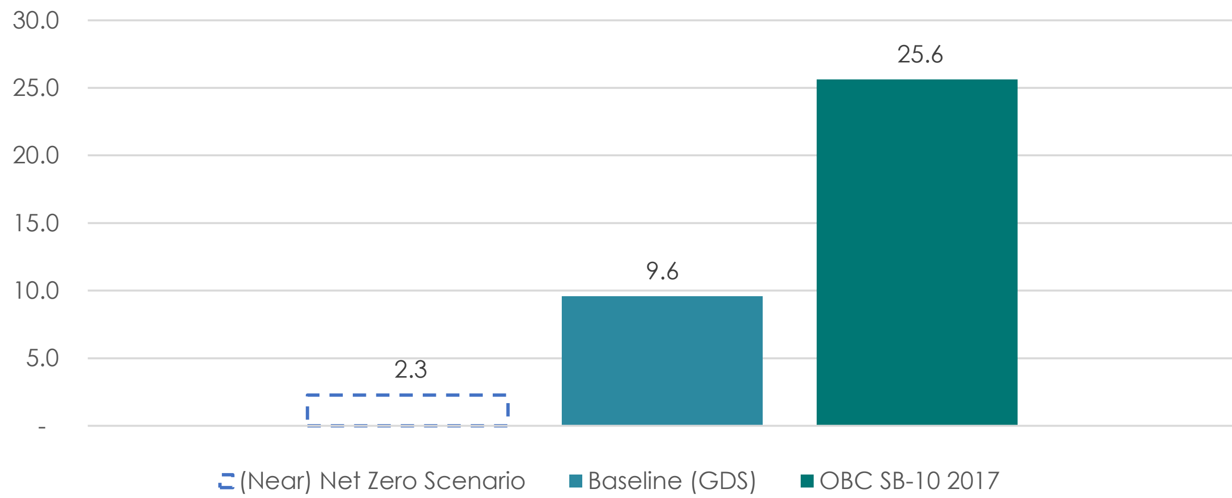

Figure 2: Estimated GHGI Reduction Potential Comparion to OBC and Baseline Scenario

The **Near Net Zero Scenario** provides a potential pathway to achieving a low-carbon development within the Plan Area that nearly achieves net zero carbon emissions for Mount Hope West Secondary Plan Area. This potential roadmap is shown in **Figure 3** and **Figure 4**.

Further energy and emissions conservation within the Secondary Plan Area would only be achievable through deployment of more compact, denser forms of development and through installation of on-site renewable energy that is currently not feasible based on the proposed development.

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

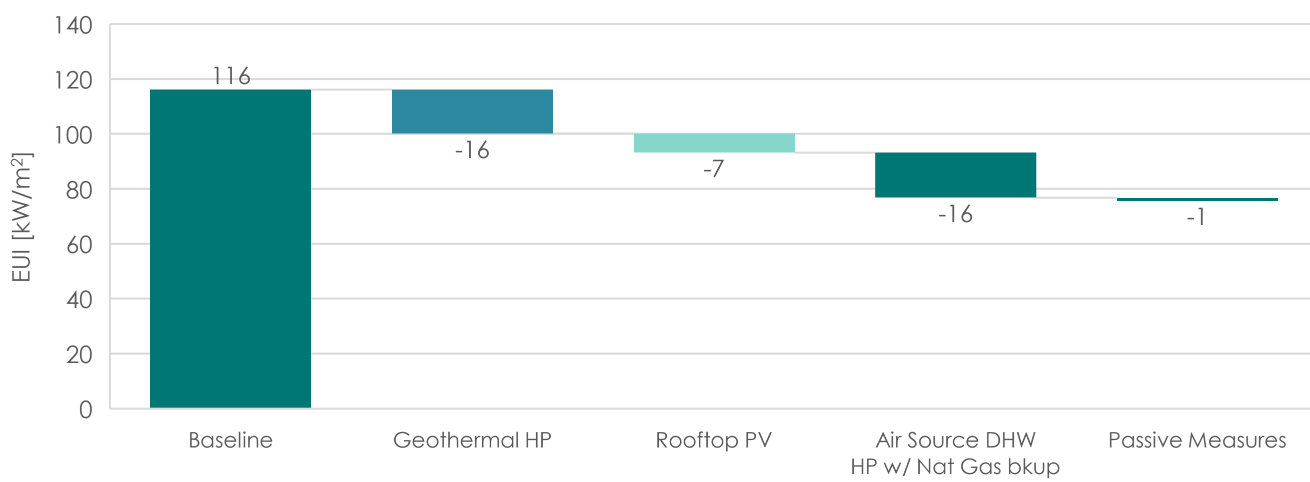

Figure 3: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential

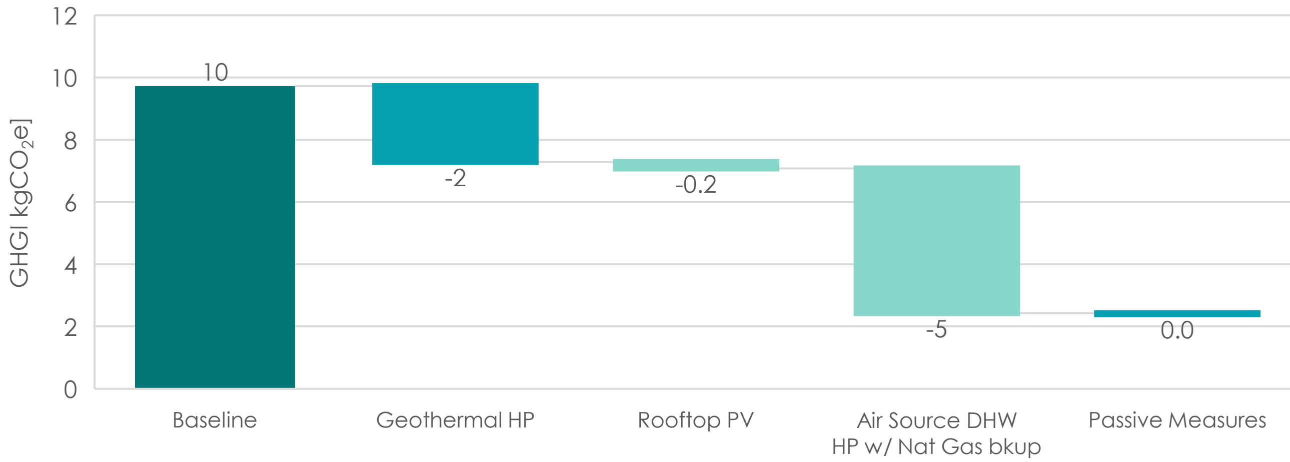

Figure 4: Greenhouse Gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

District Energy System Considerations

District energy systems (DES) rely on building density and supporting infrastructure to be viable community energy systems. These systems are better suited to service medium to high-density developments. Typically, a threshold greater than one million square feet in total serviceable floor area is preferred by developers of these systems.

DESs are not viable options for low-rise residential buildings due to the extensive infrastructure required to implement DES within such dwellings, leading to additional costs. The Secondary Plan Area includes subareas (the Urban Corridor and Commercial block) that encompasses medium density dwellings, and the feasibility of district systems were explored for these subareas acknowledging that the total site would not support such a system.

It was determined that DES is not feasible for Mount Hope West Secondary Plan. Combined, the Commercial Block and Urban Corridor make up 454,918 ft^2 of land area total. There are no existing energy sources or systems that could be connected to or expanded upon within this Plan Area. Although there are medium density developments within the Bolton North Hill Plan area, located on the southeast side of the Mount Hope Secondary Plan, the combined areas would not meet the desired GFA threshold of one million square feet to potentially share DES.

A geothermal DES is not a viable solution due to the insufficient higher density of the proposed development. Additionally, a district-style solar photovoltaic system was evaluated and found impractical because of the large space requirements, the location of the park relative to denser developments, and its minimal contribution to meeting energy needs.

1.1. Summary of Findings

- The introduction of building-scale geothermal heat pumps, rooftop solar photovoltaic systems, air-source heat pump domestic hot water systems and passive measures offer a pathway to potentially reducing 76% of the GHG emissions associated with the proposed building developments in the Mount Hope West Secondary Plan Area. This exceeds the Town of Caledon's target of 35% GHGI reduction by 2030 for community-wide emissions.
- The incremental capital cost of implementing these technologies over the requirements of the Town of Caledon Green Development Standard is estimated to be approximately $27.4 million 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 $153.7 million based on the Class D cost estimate conducted, which is approximately $ 30.8 million greater than the baseline NPV.
- The increased electricity demand posed by the proposed electric vehicle charging requirements cannot feasibly be met through on-site generation within the Secondary Plan Area and was therefore excluded from the **Near Net Zero Scenario**.
- District-scale energy generation is not feasible from a technical standpoint for several reasons. The medium-density development does not meet the required GFA threshold of one million square feet, and the proposed higher density is insufficient for a geothermal DES. Additionally, a district-style solar photovoltaic system is impractical due to the large space requirements and its limited contribution to meeting energy needs.
- While district energy systems can offer potential improvements in energy efficiency due to more favorable part-load conditions, these improvements are not entirely predictable nor are they necessarily significant (from an energy performance standpoint) when compared to a like-for-like system implemented at the building scale. It should also be noted that a DES provider requires roughly 3-5 years of engineering discussions and economic planning to successfully implement such a system. As a result, all proposed energy conservation and emissions reduction strategies reported here are at the building scale. It will be important to monitor and evaluate requirements for deployment of these strategies during future planning and approvals phases as planning and design of buildings within the Secondary Plan Area advances.

2. Introduction and Study Context

The Mount Hope West 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 (November 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 Mount Hope West 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 Mount Hope West Secondary Plan Area development is planned north of the Town of Bolton, Ontario as shown in **Figure 5**. The site is bound by Columbia Way to the south, and Mount Hope Road North to east, as depicted in **Figure 6**. Areas to the west of the site are part of a separate Secondary Plan Area.

The conceptual plan for the proposed Secondary Plan Area the following land uses:

Residential Area

- Including single detached homes, street semi-detached, laneway semi-detached and street towns, apartments, and stacked townhomes.

Retail Area

- Including commercial retail building archetype. (Located in the Commercial Block)

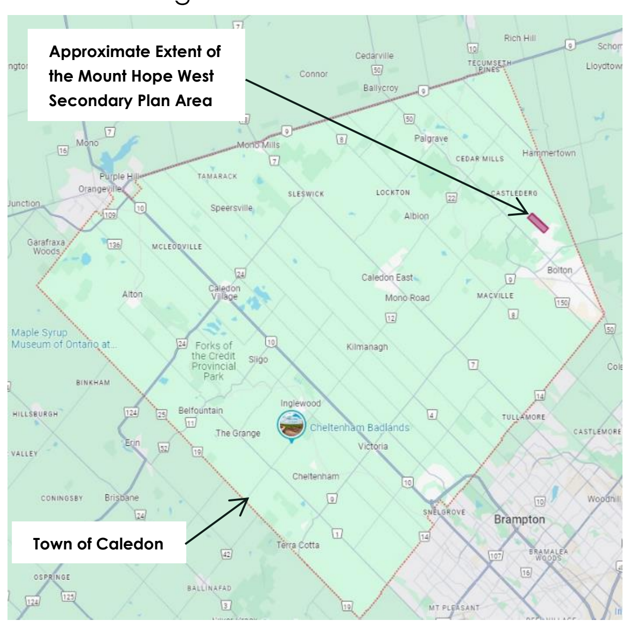

Figure 5: Approximate Extent of the Mount Hope West Secondary Plan Area in the Town of Caledon

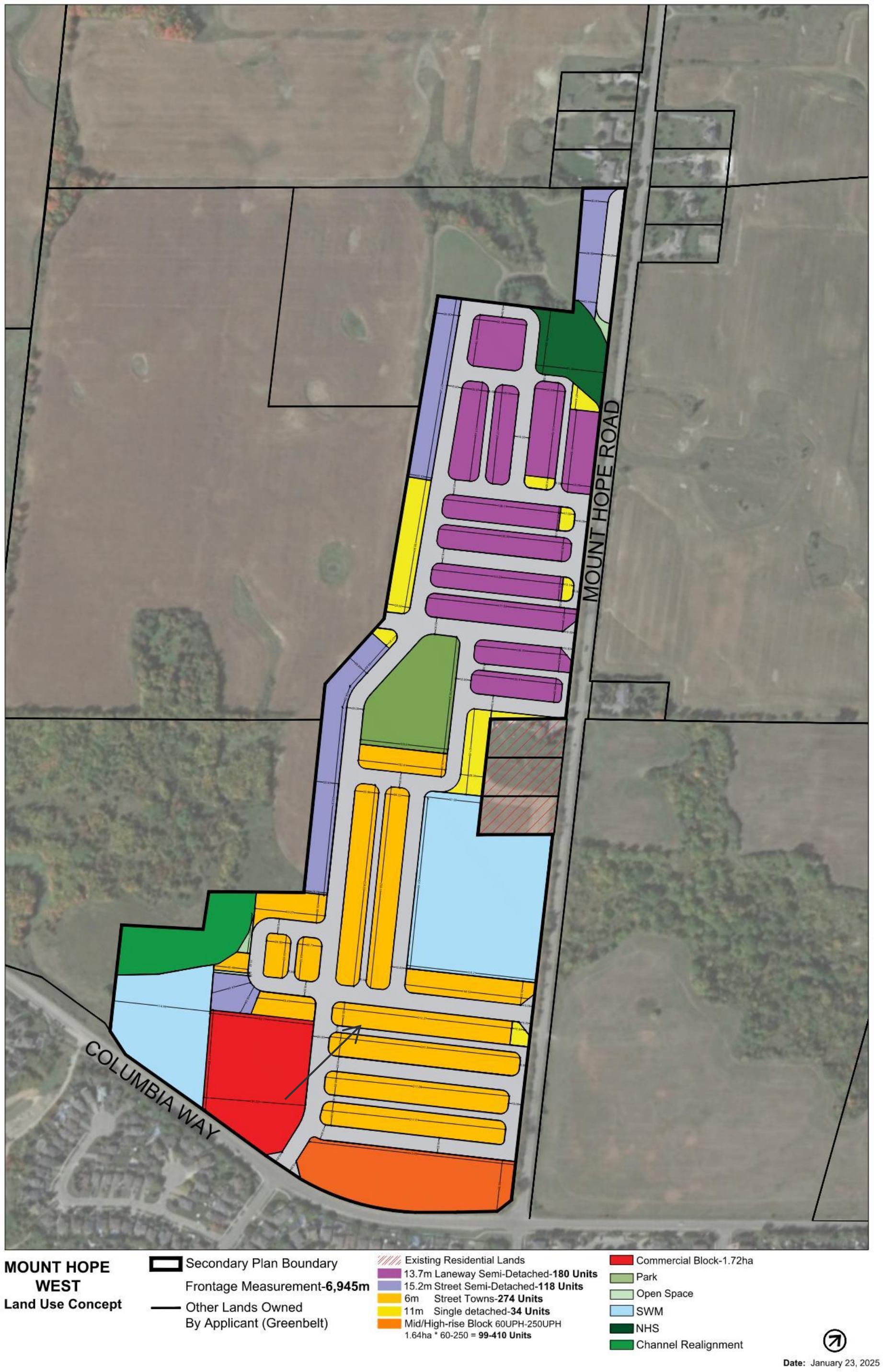

Figure 6: Proposed Conceptual Land Use Plan for the Mount Hope West Secondary Plan (SGL Planning Consultants, January 23, 2025)

2.1.1. Demographics, Site Statistics and Building Types

The Mount Hope West Secondary Plan Area is proposed to include a land area of approximately 31.7 hectares of land with a mix of land uses. 11.4 hectares of the total land area is expected to be developed into new buildings at full build-out of the site.

Of the total 31.7 hectares of land, 15.7 hectares were excluded from community energy analyses conducted. These lands were excluded as they are not expected to support construction of residential and retail buildings. Areas were selected for exclusion based on their classification per the current land use policies and the proposed Land Use Plan.

Excluded areas include the following land use types:

- Stormwater management facilities – 4.6 ha
- Park – 1.16 ha
- Channel Realignment – 0.95 ha
- ROW – 8.21 ha
- NHS – 0.69 ha
- Open Space: 0.06 ha

The proposed development plan for the community includes a variety of building types such as freehold townhouses, detached homes, street towns, medium density stacked townhomes, and commercial areas comprising retail. The total gross floor area of the proposed development is approximately 139,466 m^2.

2.1.1.1. Details per Building Type

The current site consists of several land use profiles as described in the *Block Plan Concept with Ownership Stats* (See **Appendix B** for details). These building types and areas are listed in **Table 5** for reference. **Figure 7** shows a breakdown of the types of building within the Secondary Plan Area development.

Table 5: Mount Hope West Secondary Plan Area Building Type Descriptions

<table>
<tr><th colspan="2">Residential Building Types – Total 10.55 ha / 1012 units</th></tr>
<tr><td>Low Rise (3 stories or less)</td><td>Mid /High-Rise (≤ 6 stories)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Low Density Residential Single Detached: 36 units
Street Semi-Detached:178 units
Laneway Semi-Detached: 178 units
Street towns: 271 units
Total Low-Rise: 9.33 ha / 603 Units</td><td>Medium / Higher Density Stacked Townhomes and Apartments
Total Mid-Rise: 1.21 ha / 409 Units</td></tr>
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Non-Residential Building Types - Total 0.86 ha

Commercial Block

Commercial Services and Retail
0.86 ha

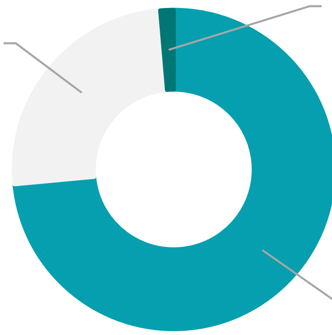

Figure 7: Mount Hope West Secondary Plan Area Building Type Breakdown (by Gross Floor Area)

2.2. CEERP and Net Zero Targets

The Region of Peel Official Plan, approved on November 4th, 2022, introduced new 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), secondary plan areas are required to address:

- The feasibility, planning, and implementation requirements to achieve near Net zero carbon emissions and near net zero annual energy usage.
- The feasibility of implementing alternative and renewable energy systems including district energy systems and outlining policy requirements for their implementation in accordance with objectives to be established for each secondary plan area.
- The legal, financing, technical and regulatory requirements necessary to facilitate the implementation of alternative and renewable energy systems.
- A strategy and policy direction to implement Regional and local sustainable development guidelines in community, neighborhood, site and building designs, including implementation, and phasing in of the current and future energy performance requirements of the Ontario Building Code; and
- A strategy and policy direction to implement electric vehicle charging infrastructure.

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 as well as an interim target of 36% reduction in emissions 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 can be found in Error! Reference source not found..

2.3. 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/m²yr). This is the total annual energy use of the building and site divided by the modeled floor area.
- **TEDI:** Thermal Energy Demand Intensity (kWh/m²yr). 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/m²yr). 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 **Table 6**.

Table 6: Town of Caledon's GDS Absolute Performance Targets (Town of Caledon, 2024a)

Building Type	Energy and Carbon Performance Measures: TEUI [kWh/m²/yr.]	TEDI [kWh/m²/yr.]	GHGI [$kgCO_{2e}$/m²/yr.]	EV Charging Requirements*
Low Rise Residential (<3 stories)	Design and Construct to a minimum: Tier 3 energy performance under NECB or recognized labelling program equivalent to ENERGY STAR for New Homes version 13.1rev02 Reduce operational GHG by 20% OR Design and construct to the current OBC and install hybrid heating systems			Minimum one charging space per dwelling unit.
Multi-unit Residential (>6 stories)	15	135	50	Minimum 50% of parking spaces are EV-Ready.
Multi-unit Residential (≤6 stories)	15	130	40	
Commercial Office	15	130	30	Total of 20% parking spaces are EV-Ready. Minimum 5% of spaces to be equipped with EV Supply Equipment (EVSE).
Commercial Retail	10	120	40	
Industrial	15	130	60	

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

2.4. District Energy Systems

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). DESs are capable of providing access to a low-carbon fuel source with minimal infrastructure required to tie into the piping network and can create economies of scale and energy-sharing opportunities to achieve large-scale, cost-effective GHG reductions. The feasibility of such systems is explored within this study. An example schematic of a typical DES is shown in **Figure 8**.

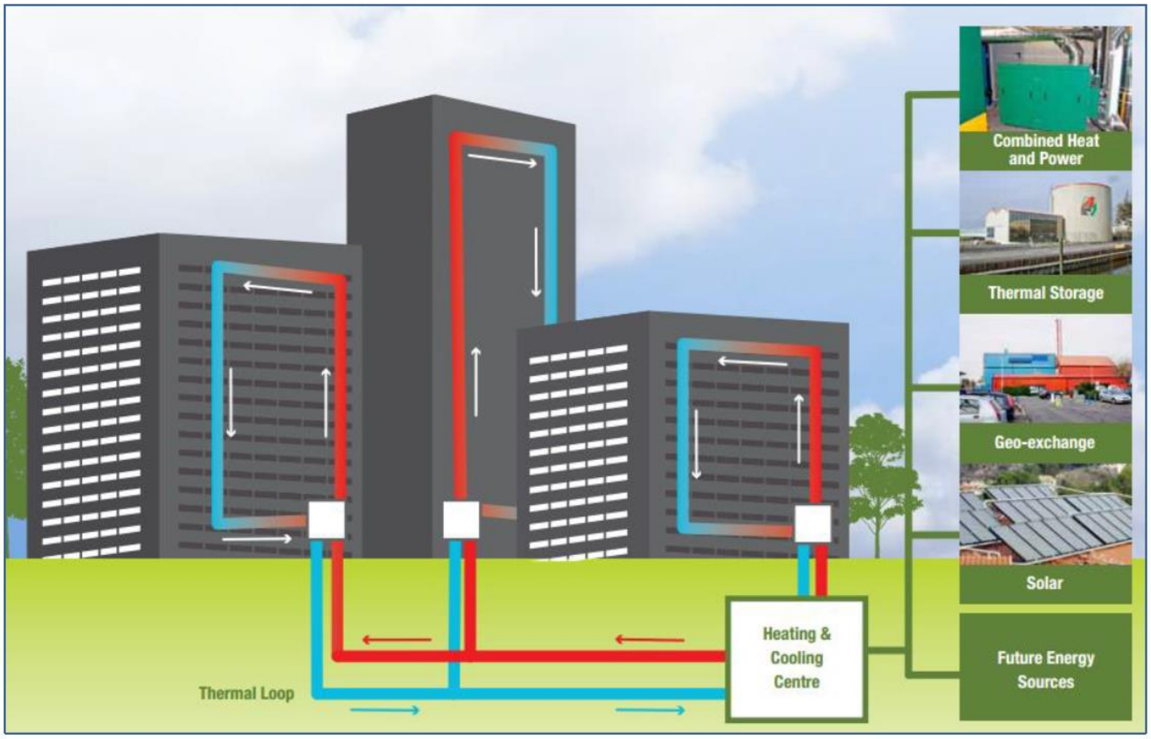

Figure 8 – Illustration of the function of a District Energy System (City of Toronto, 2016a)

3. Methodology and Assumptions

3.1. Building Energy Systems

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

- Establishing baseline energy consumption requirements
- 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.

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 and ventilation considerations). The energy and carbon emission reduction achieved from passive measures are dependent on location and site orientation. These details have not been defined at this stage of planning and are expected to vary across the Secondary Plan Area.

3.2. Measures Considered

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 against 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 achieving 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 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. The software was used to develop multiple scenarios to guide and inform the analysis as follows:

- **Baseline Scenario** – Based on the Town of Caledon GDS (Refer to Table 5 in Section 2.3)
- **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 in the baseline scenarios. This scenario accomplishes additional 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 reduction potential
- Spatial feasibility
- Relative ease / difficulty of implementation
- Operations and maintenance considerations
- Estimated cost

3.2.1. 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, as discussed in **Appendix C.**

Table 7 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 7 - 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 radiation and to heat DHW.
Solar Energy Generation	Solar Photovoltaics (PV)	Rooftop solar photovoltaic panels installed on building roofs convert solar energy into electrical energy.

3.3. Transportation Systems

As per the Town of Caledon TOR, the GDS was used to estimate the energy demand associated with implementing EV Chargers for the following two scenarios:

- **Transportation Case 1** – Based on the Town of Caledon GDS (Table 5 in Section 2.3)
- **Transportation Case 2** – All parking spaces on site provided with EV Chargers

Transportation Case 1 used the Town of Caledon GDS as a baseline which assumes a minimum number of EV chargers required based on dwelling type and population. For **Transportation Case 2**, it was assumed that 100% of the residential and 100% of non-residential parking lots would be equipped with EV chargers.

A transportation study for the proposed Mount Hope West Secondary Plan Area development is concurrently being prepared which will assess the impacts of the proposed community on the existing road network in Caledon and the forecasted vehicle traffic that is expected within the development area based on the proposed urban form. 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.

3.4. District Energy System Considerations

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. For context, the density classification of archetypes was completed based on units per hectare. Based on classification of site statistics provided by the planning consultant for the Secondary Plan Area, the following classifications were made for the proposed developments:

- Low-Density Residential:
  - Single Detached: 33 units per hectare
  - Street Semi-Detached: 46 units per hectare
  - Laneway Semi-Detached: 46 units per hectare
  - Street Towns: 52 units per hectare
- Medium-Density Residential: 60-251 units per hectare
- Retail (classified as medium density): 47 jobs/m^2

Feedback from district energy developers in the Greater Toronto Area suggests that these systems are only viable for medium/high density service areas that are greater than one million square feet. The cost of the mechanical infrastructure to implement DES is on par with that of the mechanical systems required for a building scale system. The primary financial benefit to developers lies in the opportunity to avoid upfront building level costs and instead defer the costs to tenants. District energy developers typically target a payback of 20 years, which aligns with the timeframe used for the NPV analysis for the various HVAC and other systems evaluated in this report. Assumptions regarding pricing and the analysis of these systems have been outlined in **Appendix D**. A summary of this analysis is provided in **Section 4.3.**

If implemented, district systems offer benefits including the reduced need for space for heating and cooling equipment and reduced upfront capital costs for individual buildings. Some systems may also be able to leverage economies of scale to provide lower long-term utility costs than market rates.

For some types of low-carbon energy, building-level systems are not technically or financially feasible. Centralized systems also offer opportunities for individual buildings to readily connect to a low carbon energy source. With centralized systems, mechanical room or penthouses for multistorey buildings can be reduced in size, and separate equipment is not required for low-rise buildings connected to the district network.

Potential district energy systems were evaluated for higher density subareas within the Mount Hope West Secondary Plan Area are outlined in **Table 8.** These systems were evaluated based on factors including spatial feasibility and infrastructure constraints as well as site density and serviceable GFA floor area.

Table 8 - 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.*
***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 to the Mount Hope West Secondary Plan Area and therefore this DES was excluded from consideration.*

3.3.1.Subarea Analysis

Section 2.1 of the report shows the land use concept plan of the Mount Hope West Secondary Plan Area. Subareas of the Secondary Plan Area consist of higher-density development patterns. Subareas selected for consideration include the Commercial Block located at the southwest corner of the site, an Urban Corridor zone located at the southeast and southwest corner of the site. The majority of the remainder of the Plan Area is expected to consist of Neighbourhood Areas which are envisioned to be predominated by low-rise residential buildings. A breakdown of these subareas, their dwelling types and square footage is shown in **Table 9**.

Table 9 - Overview of the subareas within the Secondary Plan Area

Sub-Area	Building Archetypes & Square Footage	Total Dense Areas
Commercial Block	Retail – 20,358 ft^2	20,358 ft^2
Urban Corridor	Medium Density Stacked Townhomes – 82,594 ft^2 Medium Density Apartments – 294,416 ft^2	377,011 ft^2
Neighbourhood Areas	Low-Rise: Single Detached + Laneway Semi-Detached – 481,230 ft^2 Street Detached + Street Semi-Detached – 622,051 ft^2	-

3.3.1.1. Commercial Block and Urban Corridor

Less than 27% of the Mount Hope West Secondary Plan's development total gross floor area consists of buildings that would be classed as medium or high density. Combined, the Commercial Block and Urban Corridor are 397,369 ft^2 in total. Based on the density and square footage of these proposed subareas, they were evaluated for feasibility of district-level energy systems.

Additionally, with current community developments planned in adjacent Secondary Plan Areas, there is an opportunity to share DES systems with adjacent high-density neighborhoods. However, this option is not feasible for the Mount Hope Secondary Plan Area based on a review of the publicly available information for the adjacent Bolton North Hill Secondary Plan Area conceptual plan.

Figure 9 shows the land use concept of the Bolton North Hill Secondary Plan area, primarily located on the west side of the Mount Hope West Secondary Plan, with an additional area to the southeast side. Although there are medium density development areas proposed within the Bolton North Hill Plan area, and to the east of the Mount Hope Secondary Plan, the entirety of the combined medium density areas is less than 600,000 square feet and likely remains insufficient to support a DES.

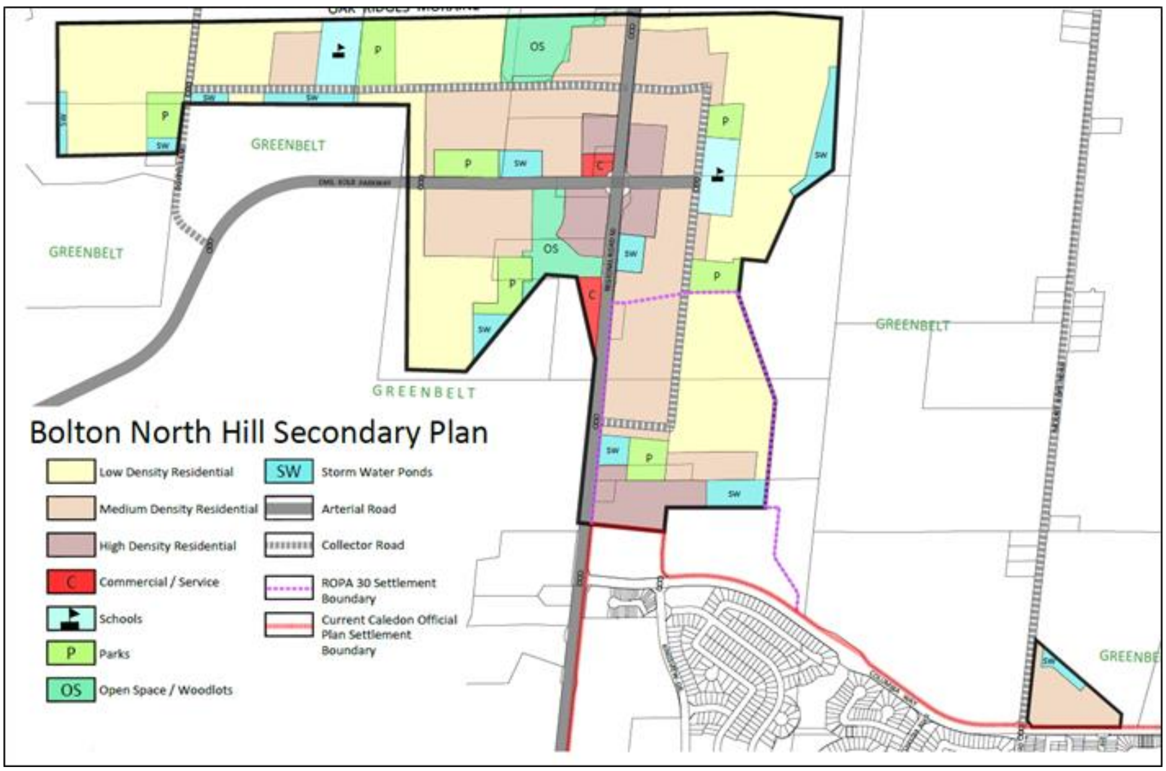

Figure 9 – Proposed Conceptual Land Use Plan for the Bolton North Hill Secondary Plan, (Bousfields Inc., December 20, 2021)

3.3.1.2. Neighbourhood Areas

District systems are not viable for low-rise residential buildings due to extensive infrastructure costs and low population density. The Town of Caledon GDS mandates all single-family residential homes to include a 3-season air-source heat pump, which is already highly efficient and limits the additional value of a prospective district system. These areas of the Secondary Plan Area were therefore excluded from the analyses conducted. This style of development is a significant majority of the proposed site, at approximately 1.08 million square feet.

3.3.2 Potential Policy Barriers and Planning Considerations

Beyond considerations of density and square footage, the Mount Hope West Secondary Plan Area presents other potential logistical challenges for implementation of district systems. The following policy barriers exist that may negatively impact the feasibility of deployment:

- Right of Way (ROW) and Utility Design: The implementation of potential district energy solutions such as geothermal systems will require the Town of Caledon to consider alternative approaches to its existing ROW and utility design standards and directives to create an enabling environment for such technologies to be successfully deployed. New infrastructure requirements may also present competing demands for space with other infrastructure such as stormwater systems.

- Ownership and Maintenance: The ownership, maintenance and operations, and management of potential systems modeled was outside the scope of this study. It is expected that the Town of Caledon will need to assess policy, legal, financial, and operational considerations prior to assuming ownership over any district-level energy utility or prior to entering financial and legal partnerships with third parties to operate and maintain such facilities.

- Timeline: District energy systems typically require advanced planning with as much as three to five years of economic and engineering, planning, and design to explore various energy sources and options as well as evaluate the financial feasibility of potential systems.

- Cost: District systems can be comparable in cost to comparable building-scale systems, however building owners are able to take advantage of financial options to shift capital costs over a much longer period of time. There are options for district-level systems to reduce upfront capital cost requirements, including models where private suppliers cover the capital cost of construction in exchange for long-term contracts.

4. Results

The relative energy and carbon emissions performance of the archetypes modeled for this CEERP are illustrated in **Table 10.** The medium density development (Urban Corridor and Commercial Block) of the Secondary Plan Area discussed in **Section 3.3.1** of the report was evaluated for feasibility of district-level energy systems. In terms of energy performance, like-for-like system efficiencies are comparable whether looking at energy systems on a local or district level as the technologies used for heating, cooling or energy production adhere to the same operating principles. For the purpose of this study, the **Near Net Zero Scenario** energy system improvements were implemented across all building archetypes.

Table 10 - : Energy and Carbon Emission Reduction Savings from Near Net Zero Designs

Category	Archetype	Baseline Design	Net Zero Design (Improvements over Baseline)	% Savings over Baseline	
				Energy	Emissions
Residential	Detached Homes & Townhouses	Three-season ASHP with natural gas backup	Solar PV panels, geothermal heat pump system for HVAC, and upgradation of domestic hot water to ASHPs with natural gas back up from 100% gas and passive measures	32%	73%
	Stacked Townhomes & Apartments	Constant volume corridor MUA and constant volume in suite ventilators served by condensing boiler and chiller		37%	82%
Commercial	Commercial - Retail	Fan coil units (FCUs) / Dedicated Outdoor Air Systems (DOAS) system served by condensing boiler and chiller		44%	80%

Category	Archetype	Transportation Case 1	Transportation Case 2 (Improvements Over Case 1)	% Savings over Case 1	
				Energy	Emissions
Transportation	EV Chargers	1 EV charger at all residential units 50% of residential parking spaces, 25% of non-residential parking spaces (with 5% Level 3 chargers)	100% of residential and non-residential parking	3%	3%

4.1. Secondary Plan Area Results

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, air source (ASHP), and hybrid heat pumps were all categorized as low-carbon heat pump 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. These were evaluated against each other, as well as against the other HVAC systems. A summary of the results of the analysis conducted is outlined in the following sections.

Each ECM was also evaluated for individual building archetypes and as a blended scenario to investigate the energy savings impact potential. The blended scenario results are presented in the following report sections. All analysis results can be found in **Appendix D.**

The analysis of individual performance for each energy and carbon emission reduction measure on the entire proposed site identifies the most effective strategies to implement in the **Near Net Zero Scenario**. These measures were bundled together to create a comprehensive plan forward to achieving the net zero targets set out by the Town of Caledon. The most efficient active measures were evaluated to be:

- Geothermal heat pumps
- Solar PV panels
- Domestic hot water heat pump with natural gas backup

4.1.1. Energy

Figure 10 below illustrates the energy use intensities (EUI) of the **Baseline Scenario** and various other energy conservation and greenhouse gas reduction measures. 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 feasible strategies for reducing emissions and energy use.

Since the majority of the site consists of low-rise residential buildings, the Thermal Energy Demand Index (TEDI) for the entire site is lower than the overall demand for DHW. As a result, measures aimed at improving DHW efficiency are more effective than those focused on heat pumps. Among these measures, wastewater heat recovery stands out as the most efficient, achieving approximately 17% energy savings compared to the baseline.

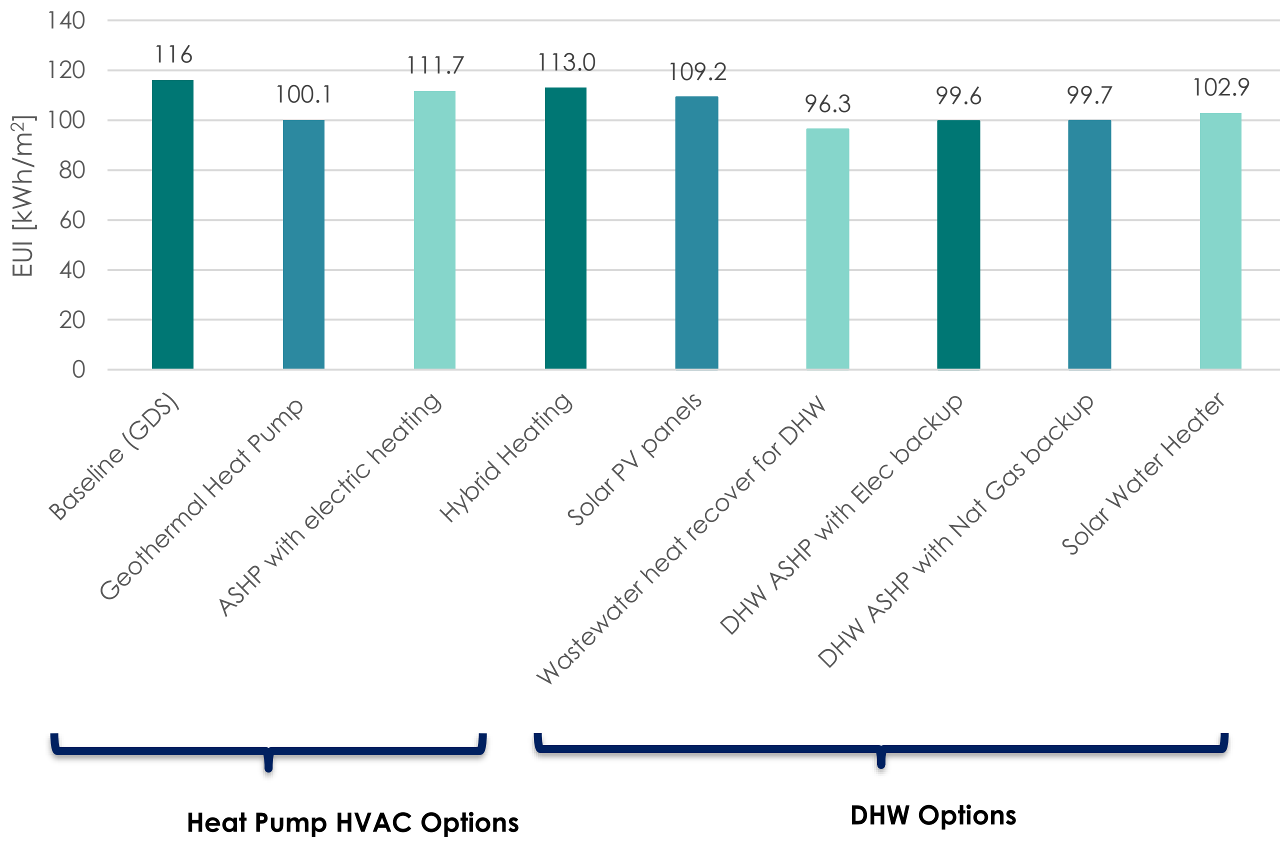

Figure 10 - Energy Use Intensity Results for Each HVAC System Assessed

4.1.2. Carbon

Figure 11 below illustrates the greenhouse gas intensities (GHGI) of the **Baseline Scenario** design and various other energy conservation and greenhouse gas reduction measures. Similar to the energy results, space heating and DHW are the primary contributors to greenhouse gas emissions of the proposed community development. Therefore, energy conservation measures targeting heating and DHW were applied to determine the most feasible strategies for reducing emissions and energy use.

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 because the baseline scenario relies entirely on natural gas for DHW, which accounts for approximately 77% of the GHG emissions in the **Baseline Scenario**. This reliance highlights significant potential for reducing GHG emissions through DHW measures. It's important to note that hybrid heating systems, while they do offer some energy savings, can result in negative overall savings. This is because hybrid heating systems use a larger proportion of natural gas, which increases GHG intensity.

In contrast, measures focused on heating have a lesser impact on the GHGI intensity compared to DHW measures. This is because a significant portion of the heating in the **Baseline Scenario** was assumed to already be electric, due to the GDS requirement for three-season air heat pumps in low-rise residential areas. As low-rise residential buildings constitute approximately 71% of the site floor area, low-carbon space heating was assumed for the majority of the Plan Area based on the heat pump requirement of the GDS, reducing the impact of low-carbon strategies for reducing emissions in these areas. Consequently, there is less room for improvement in GHGI beyond the baseline through heating measures for this development style.

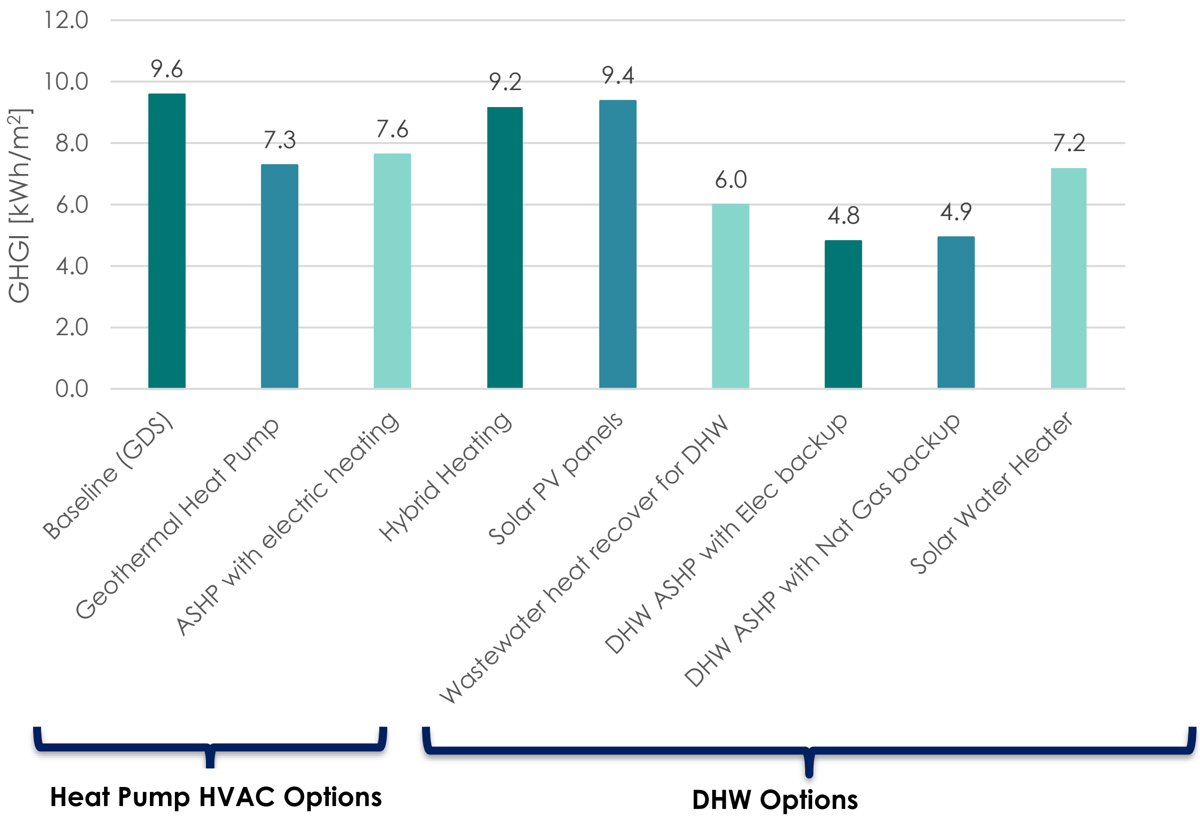

Figure 11 - Greenhouse Gas Use Intensity Results for Each HVAC System Assessed

4.1.3. Cost

Cost estimates (in net present value) over a 20-year period were evaluated for each of proposed HVAC options using

Equation 1, as outlined in **Figure 12** below. Total costs were used to evaluate relative costs between alternate system types over an extended period. Costs are broken down for each system as outlined in **Table 11** below.

Equation 1 - Total Cost

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

Total costs consist of several components as highlighted below:

Total Cost (30-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*

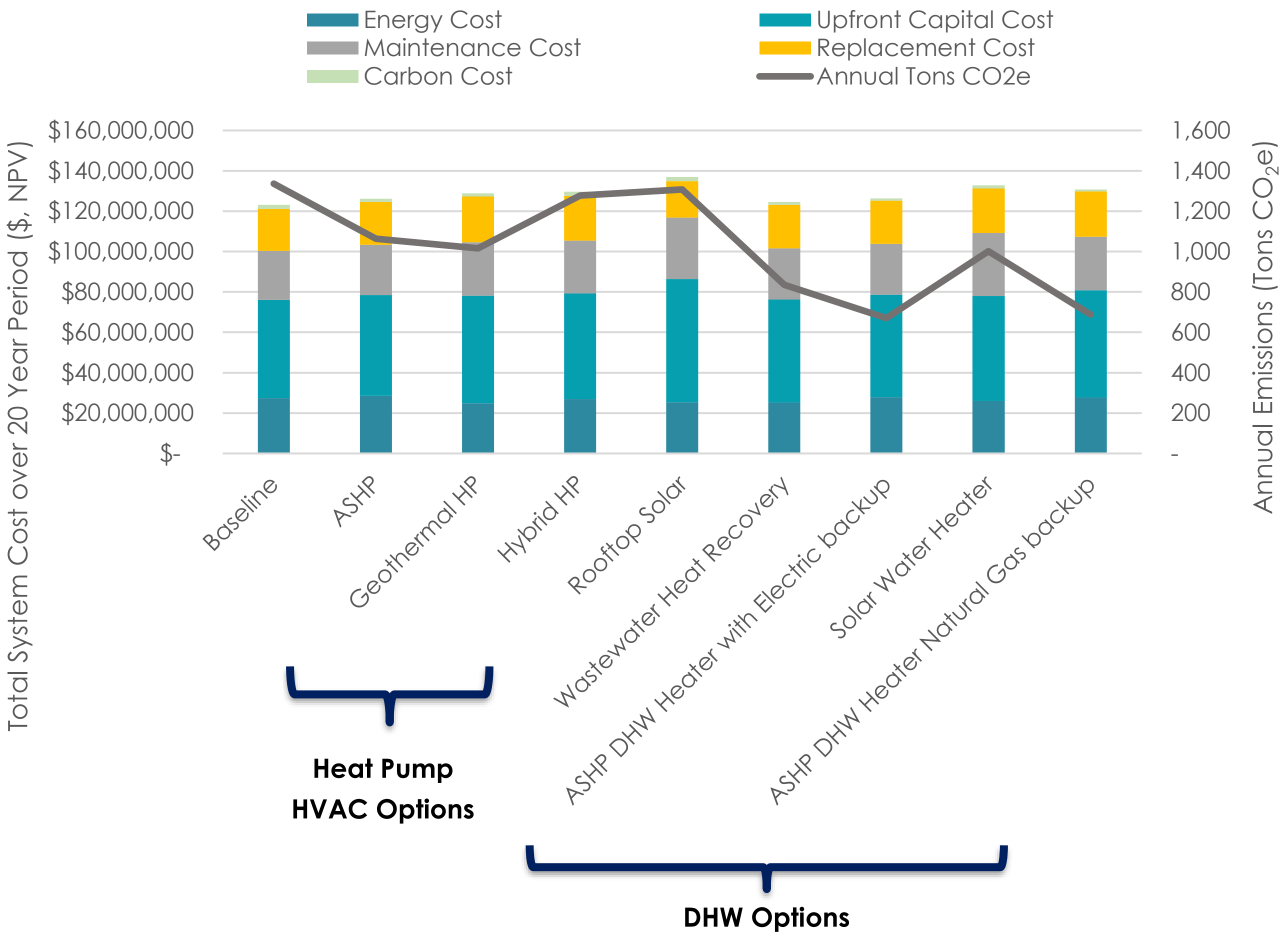

Figure 12: Total System Cost over 20 Year Period (NPV) of Each System Assessed Along with Annual CO_2e Associated with Each Measure

20-year costs are broken down by their respective cost components. Note that systems developed at the district scale were evaluated to be comparable (in terms of cost) to building level systems. Typically, DES providers aim to achieve a payback of 20 years, which is in line with the time frame adopted for the life cycle costing analysis conducted. The costs presented within the report are an estimated value and reflects 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 options and systems were assessed based on GHG impact as well as cost performance. Note that for the **Baseline Scenario**, it was assumed that there would be no solar energy installation, 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 11** (See **Appendix E** for details).

Table 11: 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	Traditional Natural gas Heating System	Relies on natural gas as a primary heating source resulting in elevated emissions. Lower in cost relative to heat pumps.	$123,096,000	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.	$126,176,000	$3,080,000
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.	$128,811,000	$5,715,000
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.	$129,617,000	$6,521,000

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.	$ 137,026,000	$13,930,000

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.	$124,520,000	$1,424,000
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	$126,280,000	$3,184,000
Solar Water Heater	DHW Heating	Reduced GHG benefits as other DHW upgrades at costs relatively comparable to an ASHP Heater.	$132,824,000	$9,728,000
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.	$130,812,000	$7,716,000

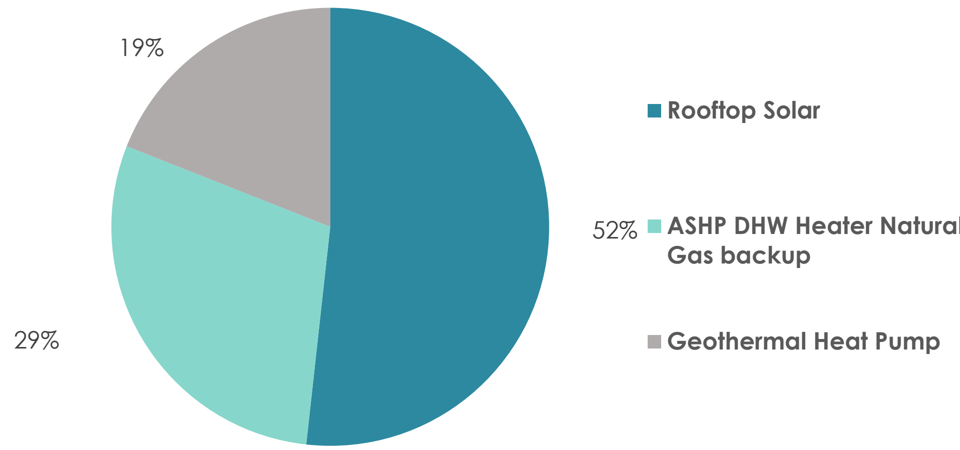

Figure 13: Total Incremental Upfront Capital Cost Distribution of Each Proposed Measure

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 natural gas backup across the site. This would lead to a substantial increase in capital costs as compared to the baseline scenario. **Figure 13** illustrates the incremental upfront capital cost distribution for each measure in the net zero scenario. This shows that the geothermal heat pump systems and solar rooftop PVs are the highest contributor to the incremental upfront costs. The expected increase in the upfront capital cost for the **Near Net Zero Scenario** is approximately $23.9M, or 67% more (refer to **Figure 14**).

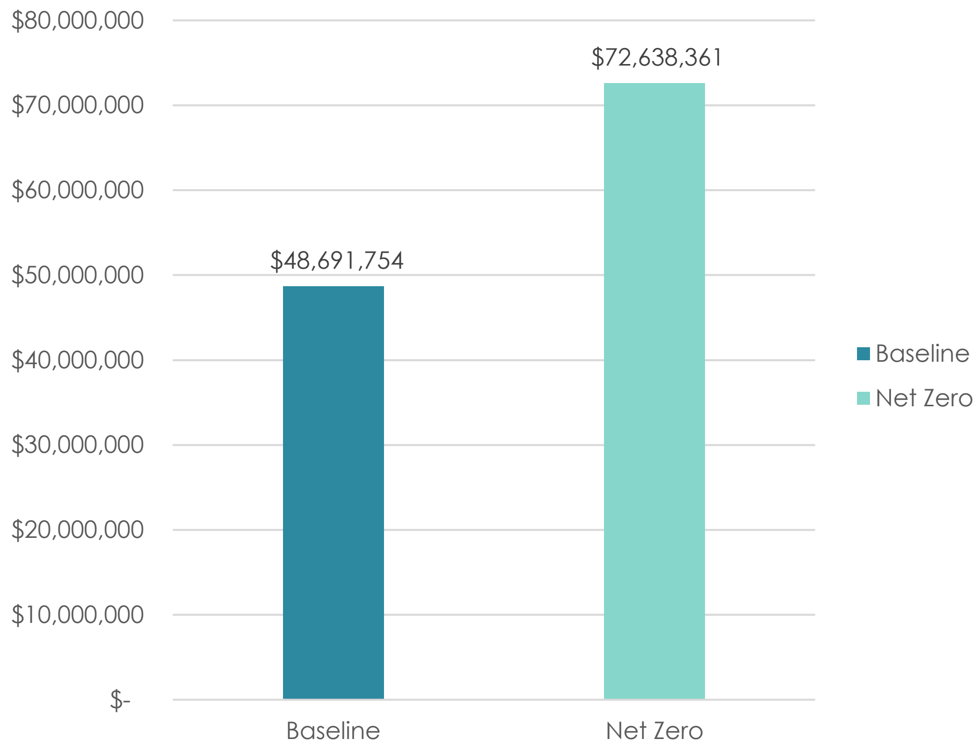

Figure 14: Total Incremental Upfront Capital Cost vs. Baseline Scenario

4.2. Traffic Vehicles & EV Charging

To estimate the electrical demand from EV chargers for the Mount Hope West Secondary Plan Development, population and employment projections for each type of dwelling were used. The number of EV chargers per space was then further separated into Level 2 and Level 3 chargers as per the GDS requirements. Level 2 chargers are assumed to require 6.6 kW per charging station. Level 3 chargers for non-residential spaces require 62.5 kW.

The overall energy demand estimated to provide EV chargers within the Mount Hope West Secondary Plan Area is summarized in **Table 12**.

Table 12: Estimated EV Charger Demand

	Level 2 EV Chargers	Level 2 EV Chargers Demand [kW]	Level 3 EV Chargers	Level 3 EV Chargers Demand [kW]	Total [kW]	Total Carbon Emission [$kgCO_{2e}$]	Estimated Cost of EV Charging Stations* (Present $CAD)
Case 1 – GDS	1,016	6,706	0	0	6,706	335	**$1,016,085**
Case 2 – 100% EV Chargers	1,032	6,814	1	67	6,881	344	**$ 1,086,175**

**Costing for the EV charging stations were based on average costs of $1,000 per charger for Level 2 chargers and an average cost of $50,000 per charger for Level 3 chargers. These costs include charging station equipment and installation. These average values were obtained from major supplies in Canada (ChargePoint, Switch Energy, & Flo).*

Costs for electrical infrastructure upgrades (such as higher capacity transformers and sub-stations) were excluded from these calculations as further analysis will need to be conducted on anticipated usage of the EV chargers and transportation uses which is beyond the scope of this study.

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 Mount Hope West Secondary Plan Area. While **Transportation Case 1** is required by the GDS, **Transportation Case 2** would fully eliminate Scope 3 tailpipe emissions from the proposed community. **Transportation Case 2** increases the energy demand and carbon emissions by **3%** over **Transportation Case 1**. This is due to the small difference in non-residential chargers required as per the transportation cases explored.

4.3. District Energy

4.3.1. Site Summary

As discussed in **Section 3.3.1.1**, less than 27% of the Mount Hope West Secondary Plan's development total gross floor area consists of higher density buildings. Combined, the Commercial Block and Urban Corridor are 397,369 ft^2 in total. Although there are medium density developments within the Bolton North Hill Plan area, located on the southeast side of the Mount Hope Secondary Plan, the entire area does not meet the required GFA threshold of one million square feet. As currently planned, there are insufficient higher density buildings within the Mount Hope Secondary Plan to implement a DES to be technically feasible in comparison to building-scale systems for this Secondary Plan Area. A further evaluation of District Energy Systems for this site can be found in **Appendix F**.

Technical Feasibility: DES is likely not feasible.

4.4. Roadmap to Near Net Zero Discussion

Table 13 and **Table 14** present the systems **Near Net Zero Scenario as** a potential solution results based on relative energy and carbon emission reduction potentials in comparison to **Baseline Scenario** studied, respectively. The percentage of individual reduction is calculated by using the individual measure reduction potential over the total reduction potential value.

Table 13 : Estimated EUI Reduction Potential

Baseline Scenario EUI [kWh/m²]	Reduction Strategies [kWh/m²]				Total Reduction Potential EUI [kWh/m²]	Near Net Zero Scenario EUI [kWh/m²]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
116.1	-16	-7	-16	-1	-41	75.6
% of individual reduction	14%	6%	14%	1%	35%	

Table 14: Estimated GHGI Reduction Potential

Baseline Scenario GHGI [$kgCO_2e$ /m²]	Reduction Strategies [$kgCO_2e/m^2$]				Total Reduction Potential GHGI [$kgCO_2e/m^2$]	Near Net Zero Scenario GHGI [$kgCO_2e$ /m²]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
9.6	-2	-0.2	-5	-0.03	-7	2.3
% of individual reduction	21%	2%	52%	0%	72%	

Table 15, **Figure 15**, and **Figure 16** 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.

Table 15: Estimated GHGI Reduction Potential Comparion to OBC and Baseline Scenario

	Ontario Building Energy Code	Baseline Scenario	Near Net Zero Scenario	Total Savings over OBC (%)	Total Savings over Baseline Scenario (%)
EUI [kWh/m²]	196	116	75.6	61%	35%
GHGI [kgCO2e/m²]	25.6	9.6	2.3	91%	76%

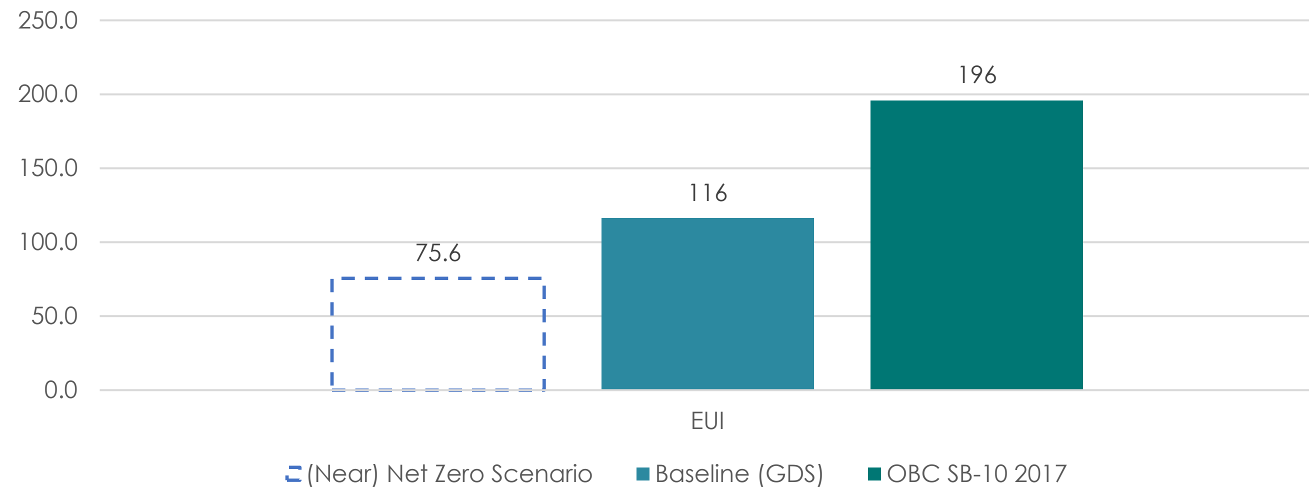

Figure 15: Estimated EUI Reduction Potential Comparion to OBC and Baseline Scenario

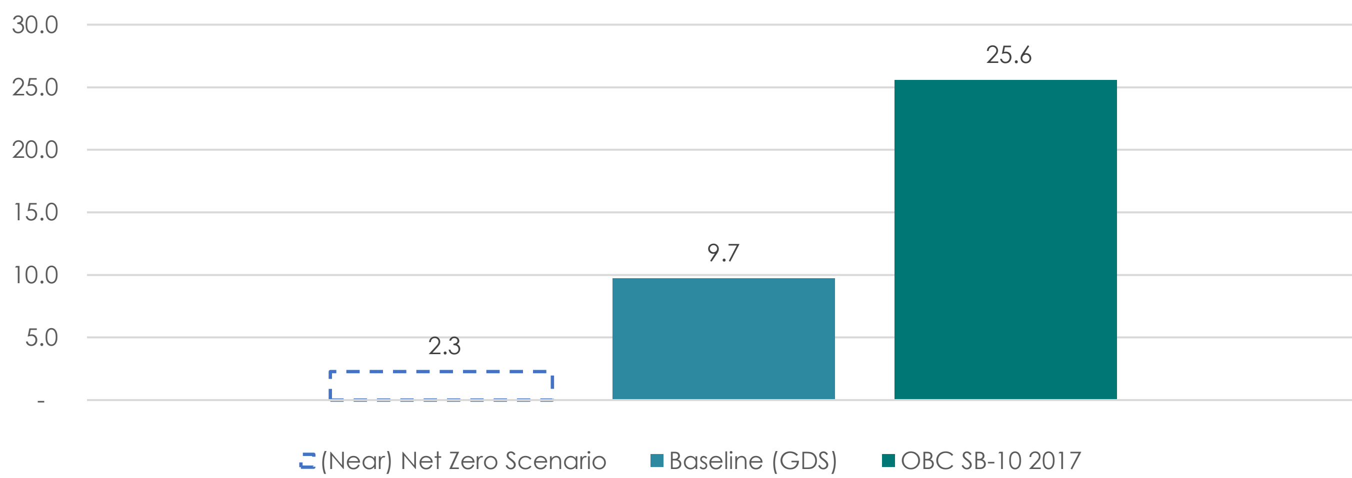

Figure 16: Estimated GHGI Reduction Potential Comparion to OBC and Baseline Scenario

The **Near Net Zero Scenario** is meant to provide a potential pathway to near net zero carbon emissions for the Mount Hope West Secondary Plan Area, which is visually presented in **Figure 17** and **Figure 18** showing how each considered viable strategy reduces the energy and carbon emission demand.

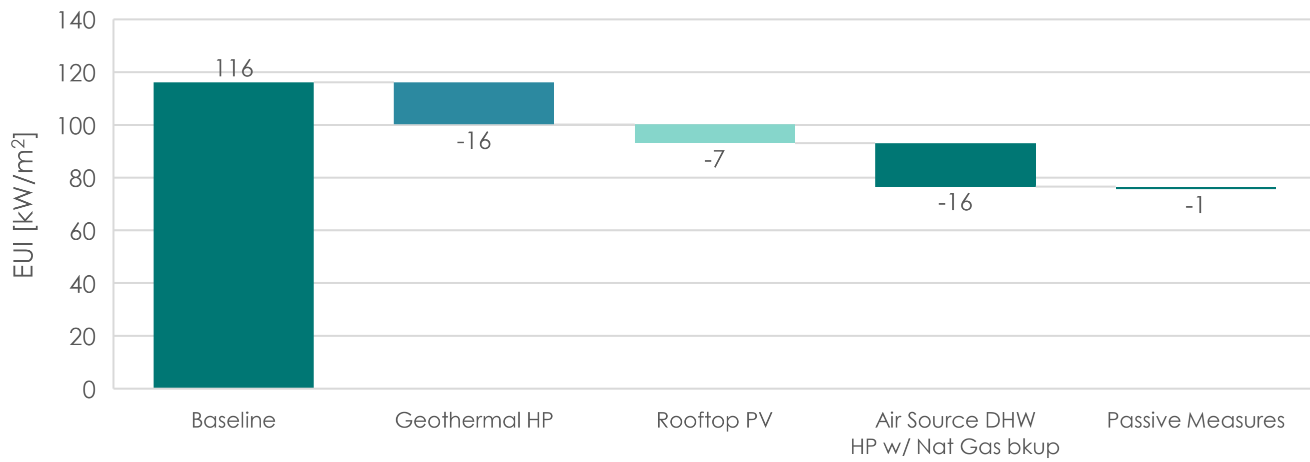

Figure 17: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential

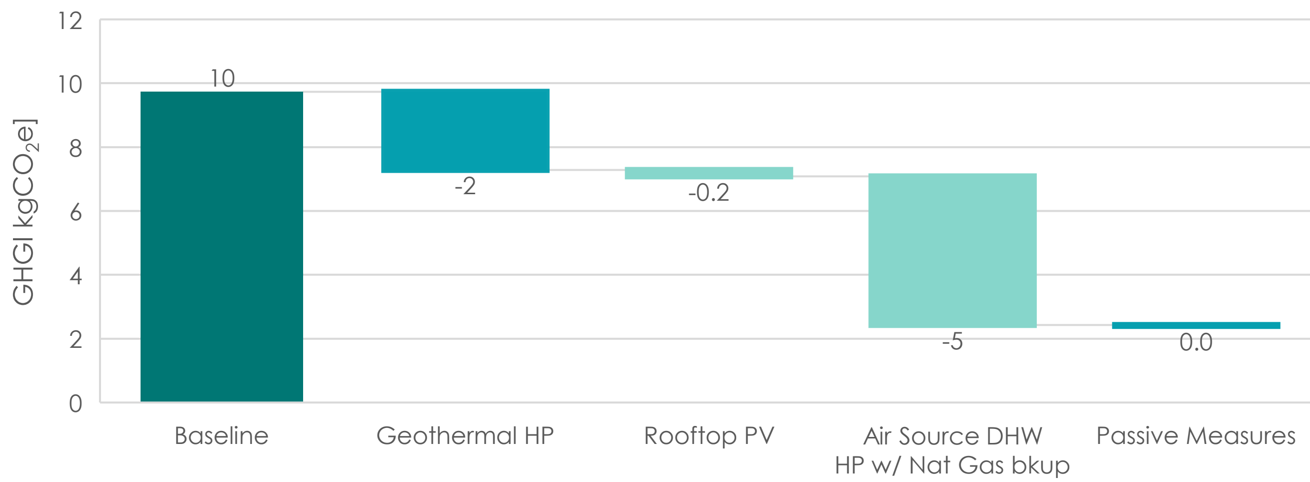

Figure 18: Greenhouse Gas Intensity Reduction Roadmap Demonstrating GHGI Reduction Potential

Therefore, the **Near Net Zero Scenario** as modeled achieves an EUI of 75.6 kWh/m² and a GHGI of 2.3 kg CO2e/m². This represents a 35% reduction in EUI and 76% reduction in GHGI over the baseline scenario.

The 20 Year NPV total cost of implementing the strategies in this scenario is expected to be **$153.8 million**, based on the Class D cost estimate conducted, in **Section 4.1.3.** The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$27.4 million**. Passive measures are not reflected in this cost estimate as they are site dependent and will vary throughout the implementation process.

Table 16 provides a comparison of the NPV Total Cost and Incremental capital cost of the systems analyzed. As described, the geothermal heat pumps and air source DHW heat pumps drive the emissions reduction and perform well relative to energy performance, though there are significant costs associated with them.

Table 16: 20 Year NPV and Incremental Capital Cost of the Near Net Zero Scenario

System (Building-Scale)	20-Year NPV Total Cost ($CAD)	Incremental Capital Cost vs. Baseline
Geothermal Heat Pump	$128,811,000	$5,715,000
Solar Rooftop PV	$137,026,000	$13,930,000
Air Source DHW HP w/gas backup	$130,812,000	$7,716,000
Near Net Zero Scenario Total Cost	**$153,847,480**	**$27,361,000**

5. Implementation

Implementation of the proposed energy conservation and emissions reduction strategies within the Mount Hope West Secondary Plan Area will require a range of actions at key milestones in the planning and development process. These are outlined in **Table 17**.

Table 17: Items For Implementation of the Near Net Zero Scenario

Actions	Reference Document	Timeline	Dependency
1: Policy			
Introduce policy statement that directs all developments within the Secondary Plan Area shall discourage the use of fossil fuels for building heating systems as an addition to 7.16.16.16.1.3 which encourages the use of low-carbon technologies including heat pumps.	Secondary Plan	Official Plan Amendment	None
2: District Energy System Feasibility			
The Landowners Group shall research and engage potential district energy system partners to further assess feasibility of district-level systems in the Secondary Plan Areas.	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).	N/A	Draft Plan	None
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.	N/A	Draft Plan	None
3: Building-Scale Measures			
The Landowners Group shall demonstrate compliance with energy and emissions performance targets for all building typologies defined by the Tier 1 requirements of the final published Town of Caledon Green Development Standard.	Green Development Standard	Site Plan	Town of Caledon

Actions	Reference Document	Timeline	Dependency
The Landowners Group shall engage with renewable energy providers and utility companies to confirm design requirements for building-scale systems.	N/A	Site Plan	None
4: Electric Vehicle Infrastructure			
The Landowners Group shall identify electric vehicle charging capacity and infrastructure requirements by building type based on the final requirements of the Town of Caledon Green Development Standard once published and integrate infrastructure requirements outlined within the Standard.	Green Development Standard Architectural & Urban Design Guideline	Site Plan	Town of Caledon Hydro One Networks Inc.
The Landowners Group shall consult with utility providers to confirm the total electrical demand requirements for the Secondary Plan Area for electric vehicles based on the standards and requirements communicated by the Town of Caledon.	N/A	Official Plan Amendment	Town of Caledon Hydro One Networks Inc.

6. Conclusion

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 Mount Hope West Secondary Plan Area. This 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. Other factors including spatial, and financial considerations were considered to define a potential low-carbon community development design, termed the **Near Net Zero Scenario**. 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 Mount Hope West Secondary Plan Area.

In terms of transportation systems, EVs and their associated infrastructure requirements are expected to impose a significant electricity demand - approximately 6.7 MW for **Transportation Case 1** and 6.9 MW for **Transportation Case 2,** representing additional capital cost requirements of approximately $1.0 million for **Transportation Case 1** and $1.1 million for **Transportation Case 2**. While **Transportation Case 1** is mandatory as per the GDS, it is not feasible to offset the expected electrical demand with active or passive measures, and therefore electric vehicle charging demand was considered separately from the **Near Net Zero Scenario**.

District-scale energy generation is not feasible from a technical standpoint for several reasons. The medium-density development does not meet the required GFA threshold of one million square feet, and the proposed higher density is insufficient for a geothermal DES. Additionally, a district-style solar photovoltaic system is impractical due to its limited contribution to meeting energy needs.

The **Near Net Zero Scenario** achieves an EUI of 75.6 kWh/m^2 and a GHGI of 2.3 kg $CO2e/m^2$. This represents a 35% reduction in EUI and 76% reduction in GHGI over the baseline scenario.

The 20 Year NPV total cost of implementing the strategies in this scenario is expected to be **$153.8 million**, based on the Class D cost estimate conducted. The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$27.4 million**.

Implementation of the strategies associated with the **Near Net Zero Scenario** would enable the Mount Hope West 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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Appendix A. References

Amec Foster Wheeler. (2018). *Future Climate Projections for the Town of Caledon.* St. John's, NL: Amec Foster Wheeler Environment & Infrastructure.

Bousfields Inc. (December 20, 2021). *Proposed Conceptual Land Use Plan for the Bolton North Hill Secondary Plan.*

City of Toronto. (2016a, October). *Design Guideline for District Energy-Ready Buildings.* Toronto: City of Toronto. Retrieved from City of Toronto: https://www.toronto.ca/wp-content/uploads/2018/01/96ab-District-Energy-Ready-Guideline_October-2016.pdf

City of Toronto. (2016b). *Minimum Backup Power Guidelines for MURBs.* Toronto: City of Toronto.

City of Toronto. (2017). *City of Toronto - Zero Emissions Buildings Framework.* Toronto, ON: City of Toronto.

City of Toronto. (2023). *District Energy*. Retrieved from City of Toronto: https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/district-energy/

ECCC. (2022, July 12). *2030 Emissions Reduction Plan: Clean Air, Strong Economy- Environment and Climate Change Canada (ECCC)*. Retrieved from Government of Canada: https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030.html

ECCC. (2023a, July 05). *Carbon pollution pricing systems across Canada*. Retrieved from Government of Canada - Environment and Climate Change (ECCC): https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work.html

ECCC. (2023b, 06 14). *Emission Factors and Reference Values*. Retrieved from Government of Canada - Environment and Climate Change Canada (ECCC): https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system/emission-factors-reference-values.html

Enbridge. (2023). *Federal Carbon Charge*. Retrieved from Enbridge Gas: https://www.enbridgegas.com/residential/my-account/rates/federal-carbon-charge

Enbridge. (2024, May 1). *Natural Gas Rates have changed - For Residential Customers.* Retrieved from Enbridge Gas: https://www.enbridgegas.com/-/media/Extranet-Pages/residential/myaccount/rates/EGD---Rate-1---System-Notice.ashx?la=en&rev=5468c83f67974aa592828652b3d6c1fc

Energy Saving Trust. (2021, October 4). *An introduction to the sustainable travel hierarchy*. Retrieved from Energy Saving Trust: https://energysavingtrust.org.uk/an-introduction-to-the-sustainable-travel-hierarchy/

EPA. (2023, May 30). *Tailpipe Greenhouse Gas Emissions from a Typical Passenger Vehicle*. Retrieved from United States Environmental Protection Agency: https://www.epa.gov/greenvehicles/tailpipe-greenhouse-gas-emissions-typical-passenger-vehicle

Glen Schnarr & Associates Inc. (2024a). *Alloa Secondary Plan: Lane Use Plan.* Glen Schnarr & Associates Inc.

Glen Schnarr & Associates Inc. (2024b). *Alloa Secondary Plan Development Statistics.* Glen Schnarr & Associates Inc.

Government of Ontario. (2021, August 16). *Climate Change*. Retrieved from Government of Ontario: https://www.ontario.ca/page/climate-change

Hydro One. (2023). *Electricity Prices and Costs*. Retrieved from Hydro On: https://www.hydroone.com/rates-and-billing/rates-and-charges/electricity-pricing-and-costs

ICLEI Canada. (2018). *Risk and Vulnerability Assessment Project: Final Report.* Caledon, ON: ICLEI Canada.

KEB Engineering & Project Management. (2021, June). Retrieved from WR Community Energy: https://wrcommunityenergy.ca/wp-content/uploads/2021/11/Waste-Water-Heat-Recovery-Report-FINAL.pdf

Litman, T. (2023). *Evaluating Active Transport Benefits and Costs.* Victoria: Victoria Transport Policy Institute.

Public Services and Procurement Canada. (2020, September 14). *Cost Estimate Definitions.* Retrieved from Public Services and Procurement Canada: https://buyandsell.gc.ca/cds/public/2020/01/28/1309436c314b43a9317acb80ee8fb9b4/ABES.PROD.PW_PWZ.B050.E10977.ATTA001.PDF

Region of Peel. (2022, April). *Download the Peel Regional Official Plan.* Retrieved from Peel Region: https://www.peelregion.ca/officialplan/download/_media/region-of-peel-official-plan-april2022.pdf

RSMeans Data Online - Gordian. (2024). *Air source Heat Pump cost calculation*. Retrieved from RSMeans Data Onlin: www.rsmeans.com

RSMeans Data Online - Gordian. (2024). *Rooftop Solar Cost Calculation*. Retrieved from RSMeans Data Online: www.rsmeans.com

SGL Planning Consultants. (January 2025). *Mount Hope - Land Use Schedule.* Toronto: SGL Planning & Design Inc.

SGL Planning Consultants. (January 23, 2025). *Proposed Conceptual Land Use Plan for the Mount Hope West Secondary Plan.*

Town of Caledon. (2021). *Climate Change.* Retrieved from Town of Caledon: https://www.caledon.ca/en/news/resources/Community-Climate-Change-Action-Plan_2021.pdf

Town of Caledon. (2022). *Climate Change.* Retrieved from Town of Caledon: https://www.caledon.ca/en/town-services/climate-change.aspx#Resilient-Caledon-Plan-Materials

Town of Caledon. (2024a). *Caledon Green Development Standard: Metrics Overview.* Caledon, Ontario: Town of Caledon.

Appendix B. Site Plan and Statistics

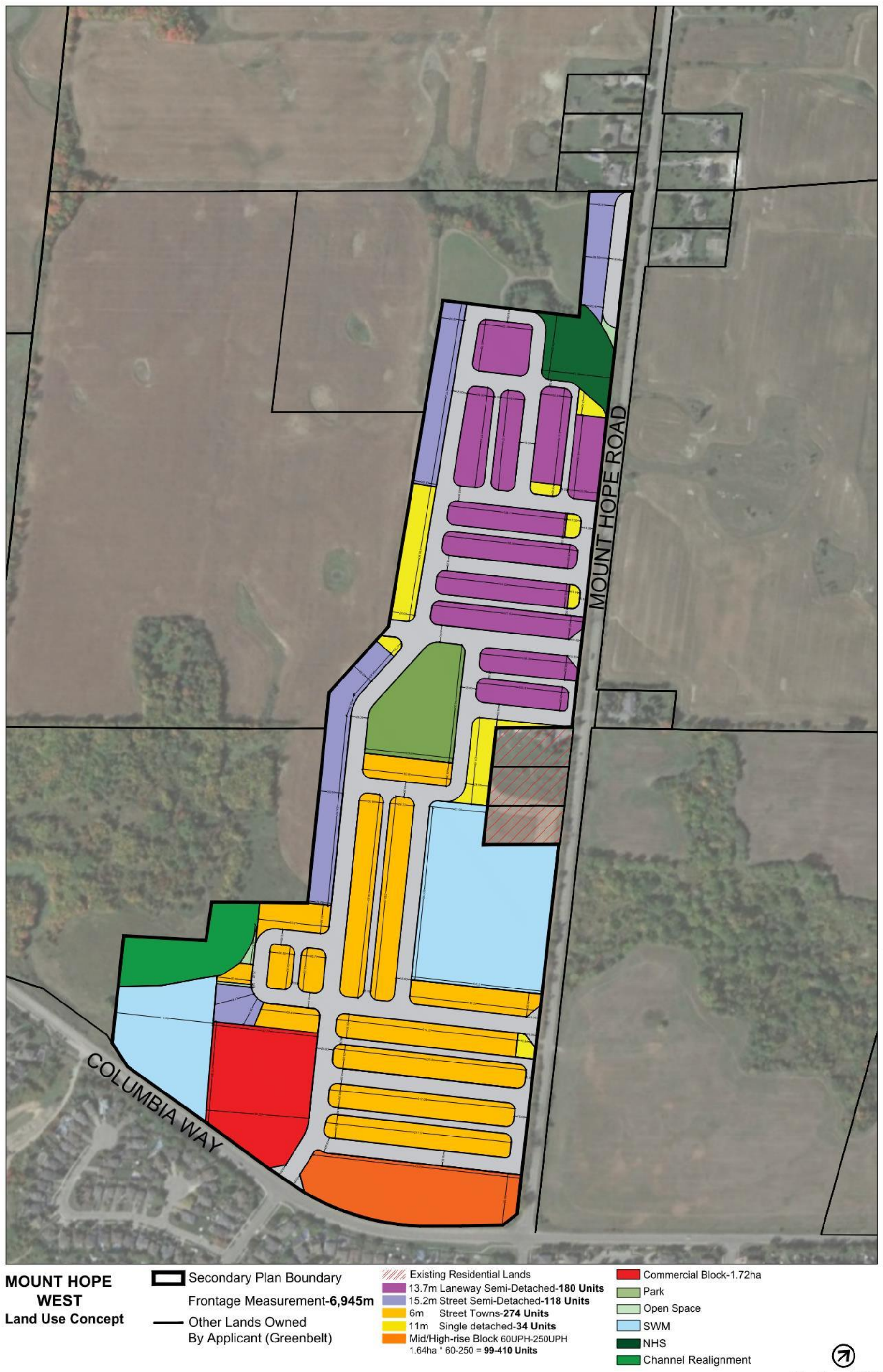

Figure B-1 – Proposed Conceptual Land Use Plan for the Mount Hope West Secondary Plan (SGL Planning Consultants, January 23, 2025)

LAND USE SCHEDULE				
LAND USE	**LOT / BLOCK #**	**AREA (ha)**	**AREA (ac)**	**UNITS**
6.75m Street Semi-Detached	1-16, 36-43, 152-174, 180-181, 250-259	2.53	6.25	118
8m Single Detached	17-35, 68-69, 87, 110, 137-147, 151, 210	1.07	2.64	36
6.75m Laneway Semi-Detached	44-67, 70-86, 88-109, 111-136	3.80	9.39	178
6m Street Towns	148-179, 175-180, 182-209, 211-231	5.21	12.87	271
Mid/High-Rise Block (60-250 UPH)	232	1.64	4.05	99-413
Commercial Block	233	1.72	4.25	
1' Reserves	234-237, 239-242	0.0085	0.02	
Future Residential	238	0.04	0.10	
Stormwater Pond	243,247	4.60	11.37	
Walkway /Overland Flow	244	0.01	0.02	
Open Space	246, 260	0.06	0.15	
Channel Realignment	245	0.95	2.35	
Park	248	1.16	2.87	
NHS	249	0.69	1.71	
ROW		8.21	20.29	
TOTAL		**31.70**	**78.33**	702-1,016

Figure B-2 – Proposed Land Use Schedule (SGL Planning Consultants, January 2025)

Appendix C. Energy and Carbon Cost Assumptions

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.

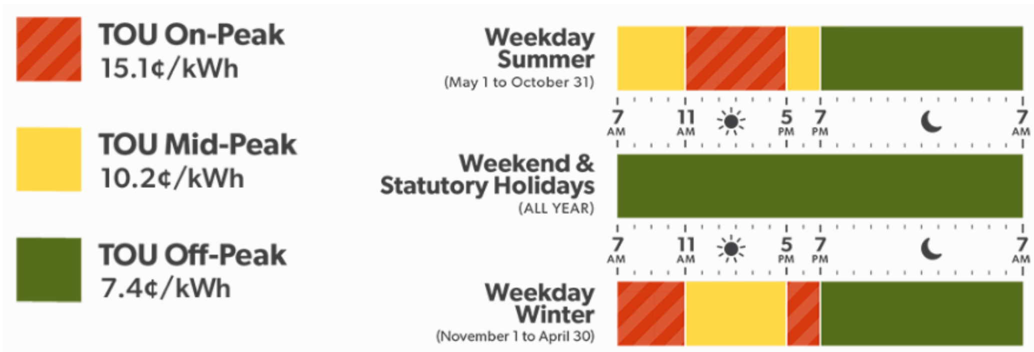

Figure C-1 – Hydro One Time-of-Use Rates Effective until October 31, 2023 (Hydro One, 2023)

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

Table C-1 - Enbridge Gas Rates (as of July 1, 2023) (Enbridge, 2024)

Gas Consumption	Cost (cents/m³)
First 30 m³	60.9364
Next 55 m³	60.2673
Next 85 m³	59.7433
Next 170 m³	59.3527

As part of the Government of Canada's national strategy for decarbonization, provinces and territories are directed to maintain or develop a carbon pollution pricing system. To ensure carbon pollution pricing applies throughout Canada, the federal backstop carbon pollution pricing system applies in whole or in part in any province or territory that requests it or that does not have a pricing system in place that aligns with the federal benchmark stringency requirements (ECCC, 2023a). The federal backstop is currently in place in Ontario.

As part of this program, a carbon charge is applied to fossil fuels sold in Ontario, including natural gas. On April 1, 2020, the federal carbon charge for natural gas was 5.87 cents per cubic meter (m^3) (Enbridge, 2023). This charge is projected to increase annually each April. In April 2024, the charge increased to 15.25 cents per cubic meter (Enbridge, 2023). Expected pricing changes year after year are summarized in **Table C-2**.

Table C-2 - Federal Carbon Charge Rates for Marketable Natural Gas 2024 – 2030 (Enbridge, 2023)

Year	Carbon Charge ($/t$CO_2$e)	Carbon Charge (cents/m^3)
2024	$80	15.25
2025	$95	18.11
2026	$110	20.97
2027	$125	23.83
2028	$140	26.69
2029	$155	29.54
2030	$170	32.40

It is projected that the carbon charge rate will rise to $170 per ton by 2030 (Enbridge, 2023). This will have a significant impact on the cost of using natural gas in buildings that will be constructed in development areas in the future. The current blended gas rate is approximately 50 cents/m^3 with 9.79 cents of that charge being carbon tax. At $170/ton, the carbon tax on a m^3 of gas will increase to 33.3 cents. This will more than double the cost of natural gas by 2030. These costs have been accounted for in the cost feasibility analysis (Section 5.5).

Additionally, the GHG emissions factor of Ontario's electricity grid for 2023 is 30 grams of CO_2 equivalent (CO_{2e}) per kWh produced (ECCC, 2023b). By comparison, the GHG emissions factor of natural gas is 182 grams of CO_2e per kWh of energy produced by natural gas (ECCC, 2023b). Natural gas therefore has a GHG emission factor that is six times greater than that of electricity and therefore has a larger impact on GHG emissions.

Appendix D. Energy and Carbon Analysis Results

Energy

Low-Rise Residential

Figure D-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 detached homes and townhomes.

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 solar water heaters give the best performing results with around 13% 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. The low rise residential's DHW measure performance is able to compensate other archetypes space heating measure's performance due its larger share of the overall building site area (approximately 74%).

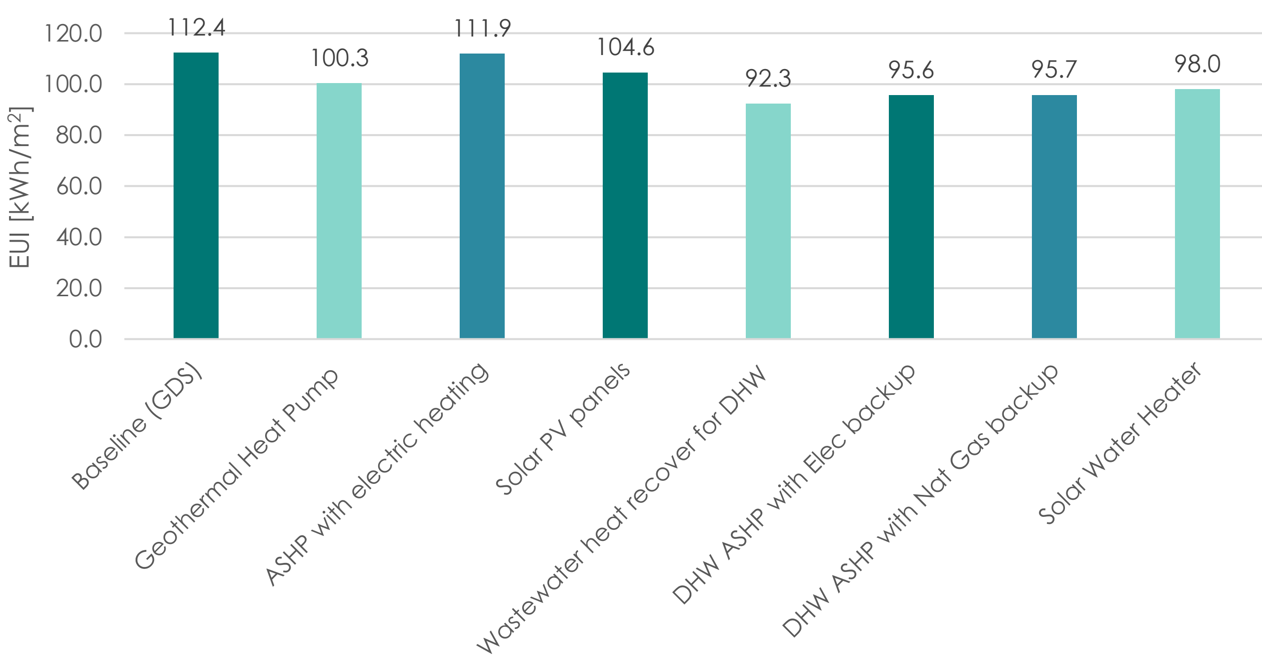

Figure D-1 – EUI Results for Low-Rise Residential

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

Medium density stacked townhomes and apartments falls 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 lesser impact on EUI as compared to other archetypes for MURBs, because of less roof area available for energy generation and hence lesser electricity offset. Other than solar, the geothermal heat pumps were the best performing measure with approximately 21% in energy savings as observed in **Figure D-2.**

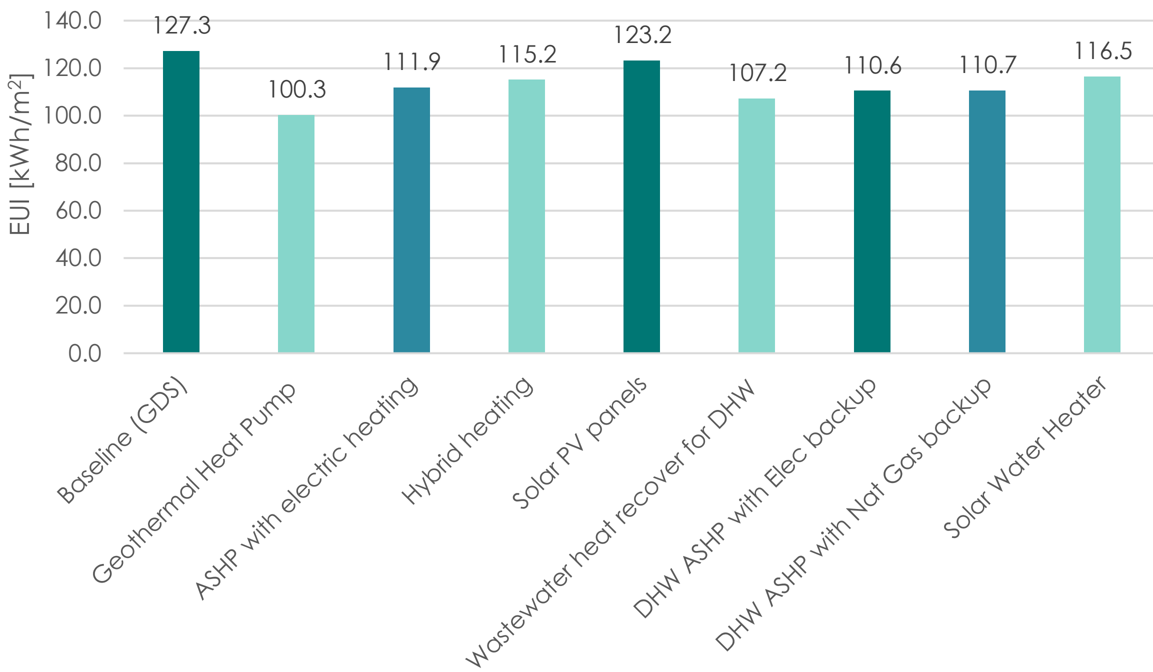

Figure D-2 – EUI Results for MURBs (≤6 storeys)

Commercial Block

The retail buildings in commercial areas fall under this archetype category. Geothermal was the best performing measure with an estimated 27% energy savings as observed in **Figure D-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.

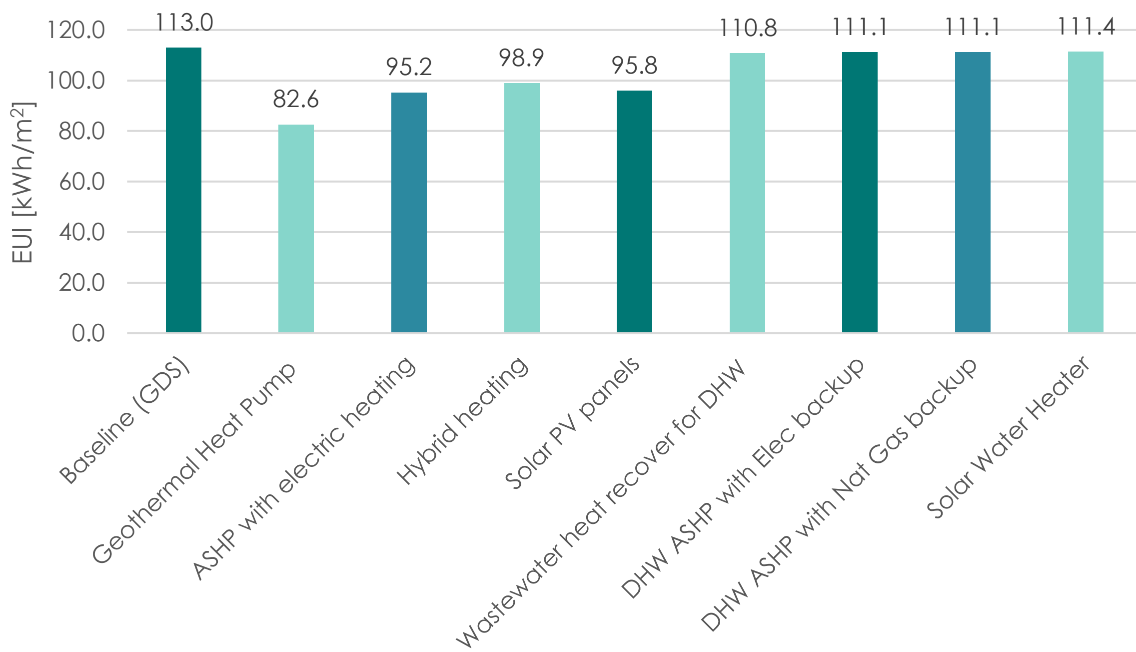

Figure D-3 – EUI Results for Commercial Retail

Carbon

Low-Rise Residential

Figure D-4 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 includes detached homes and 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.

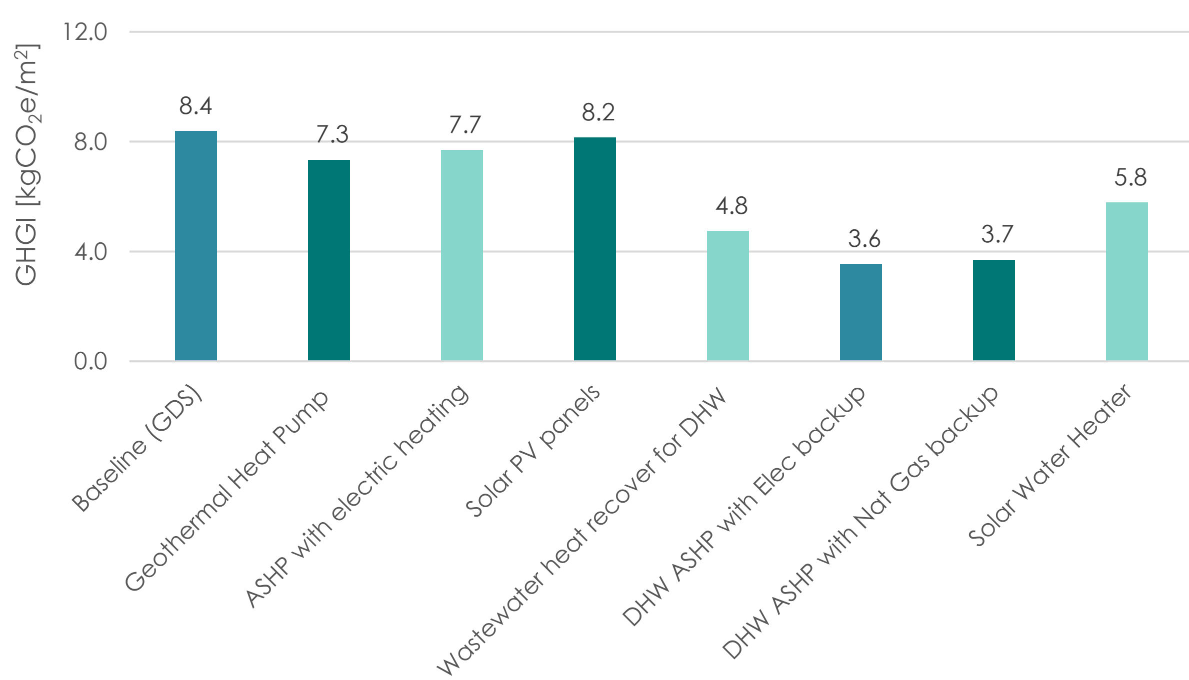

Figure D-4 – GHGI Results for Low Rise Residential

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

In contrast to the low-rise residential archetype, multi-unit residential buildings (MURBs) under or equal to 6 storeys tend to perform better in terms of emissions, as illustrated in **Figure D-5** below. 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 44% GHGI reduction potential.

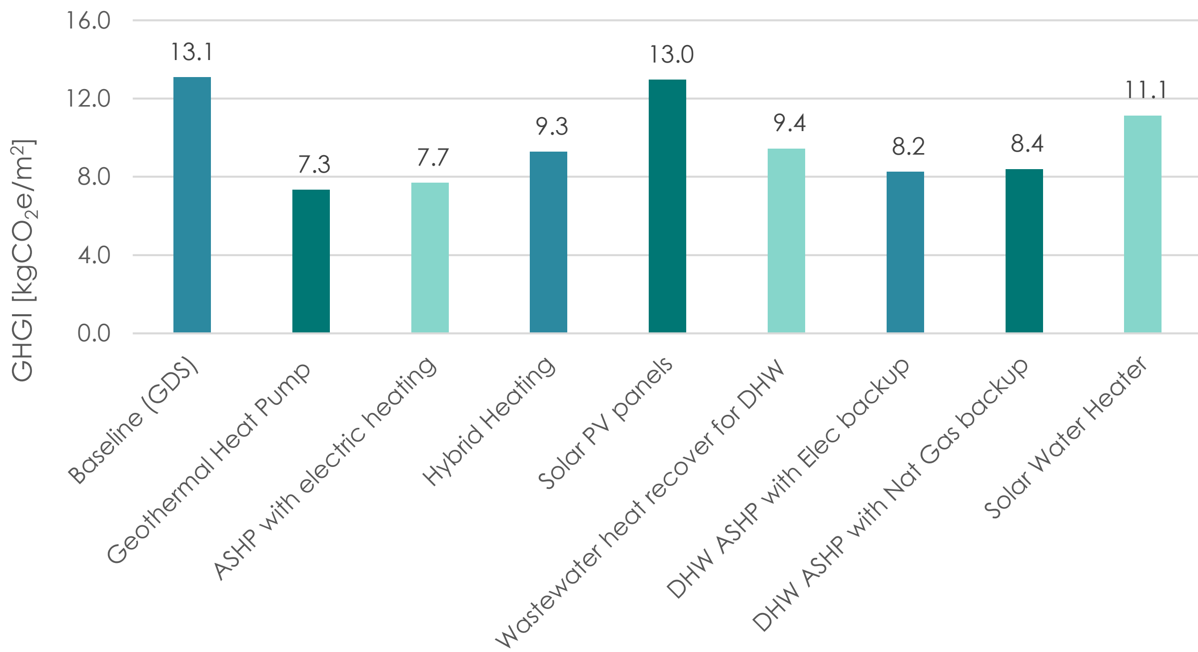

Figure D-5 – GHGI Results for MURBs (≤6 storeys)

Commercial Retail

In this archetype, the contribution of domestic hot water (DHW) to the baseline GHGI is inherently very low, accounting for just 6% compared to the 54% contribution from heating. Consequently, heating measures tend to have a more significant impact on GHGI, as illustrated in **Figure D-6** below. Among these measures, geothermal heat pumps offered the greatest reduction potential, with an expected reduction of approximately 69%.

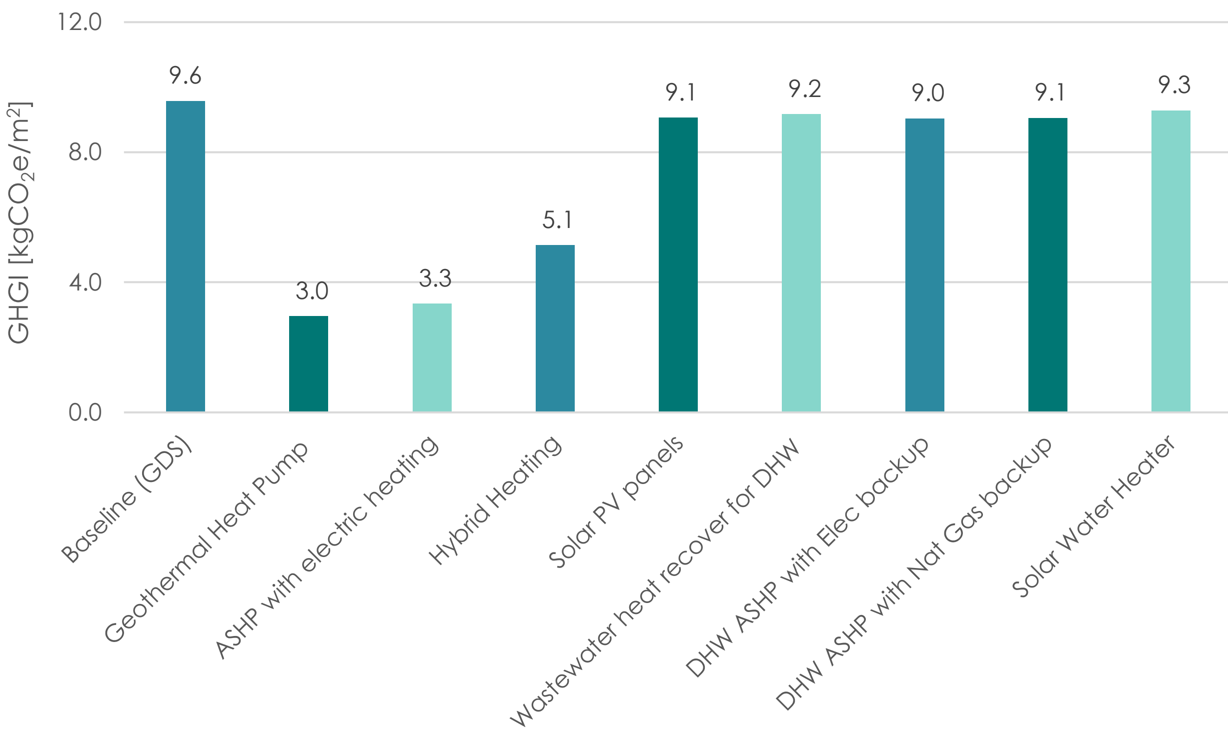

Figure D-6 – GHGI Results for Commerical Retail

Appendix E. Costing Analysis

Baseline HVAC

The Baseline HVAC system total capital cost is calculated based on the total residential GFA multiplied by the total HVAC cost per square foot for each building type. 11% 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. **Table E-1** outlines the total cost/ft^2 for each building type.

Table E-1: Total Capital Cost Per Building Type

Building Type	Low-rise	MURB (≤ 6 stories)	Retail
Total cost/ft^2	288	317	265

Air Source Heat Pump

The ASHP system total capital cost is calculated based on the peak heating (5,799 kW) and peak cooling load (4,124 kW) obtained from the modelling analysis. **Table E-2** outlines the estimated price for the heating and cooling systems.

Table E-2: Total Cost Per Building Type (RSMeans Data Online - Gordian, 2024)

	Heating Capacity (kW)	Cooling Capacity (kW)	O&P Cost/unit
ASHP	50	40	54,800
Heating System	106		9,325
Cooling System		510	85,400

Geothermal HP

The peak heating and peak cooling load are estimated to be 1,649 kBTU/hr and 1,173 kBTU/hr, respectively, making the site dominated by heating loads. To meet this demand, approximately 500 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 which enabled calculation of the total geothermal field cost. The cost of 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 total capital cost of the Geothermal HP was estimated to be around $47,000/kW of peak load demand.

Hybrid HP

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 4%.

Rooftop Solar

The total capital cost of the Rooftop Solar system is calculated based on the total estimated available PV area (50% of the total roof area), the total size of the PV system, and the cost of the panels, racks and DC to AC inverters. See **Table E-3** outlines rooftop solar capital cost calculations.

Table E-3: Rooftop Solar Capital Cost Calculation (RSMeans Data Online - Gordian, 2024)

	Metric	Cost
Panel	150 W	$458
DC to AC inverter	5500 W	$3208
Rack/panel	-	$41
Roof area:	42,166	m^2
PV Area	21,083	m^2
PV W/ m^2	150,300	W/m^2
Total Size of PV system	3,168,778	W
Number of Panels	21,125	
Amount of inverter	577	

Wastewater Heat Recovery

The Wastewater Heat Recovery system total capital cost is calculated based on **Table E-4**. These costs were based on market research and consultation with Quasar Consulting Group.

Table E-4: Total Capital Cost of the system

cost/kW	$3,500
Peak Load	1,706 kW
Total Cost	$ 54,659,000

ASHP DHW Heater

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

Table E-5: Total Capital cost for the system

cost/kW	$1,137
Peak Load	1,706 KW
Total Cost	$50,623,000

Solar Water Heater

The Solar Water heater system cost is calculated based on **Table E-6**. These costs were based on market research and consultation with Quasar Consulting Group.

Table E-6: Total Capital of the system

cost/kW	$1,933
Peak Load	1,706 kW
Total Cost	$51,990,000

Appendix F. Evaluation of District Energy Systems

Should DES be chosen to be implemented within the dense areas of development centered around the Urban Corridor and Commercial block on the south side of the Mount Hope West Secondary Plan, which includes medium density developments, the following analysis was carried out.

Geothermal Analysis

The medium density archetypes' peak heating and cooling load for the Urban Corridor and Commercial Block subareas are estimated to be 431 kBTU/hr and 306 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 131 boreholes were calculated based on peak heating demand. The boreholes were assumed to be 850 ft deep with 15 ft spacing, which enabled to calculate the total area required for the infrastructure. This results in a field with a total area of approximately 14,464 ft^2. This equates to approximately 3.6% of the medium density development, indicating that there would be limited space based on the current development plans.

The cost per borehole was assumed to be $20,000 per borehole which enabled calculation of the total geothermal field cost. The cost of 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 $47,000/kw of peak load demand.

The approximate NPV cost of implementing this system would be $37,866,591.

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.), 10% of the parks, comprising a land area of 12,486 square feet, has been allocated for photovoltaic (PV) installation. The estimated annual energy production of approximately 224,132 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 would allow for approximately 12,486 square feet of panel area, which is equivalent to mounting panels on roughly 3.1% of all available roof area across all medium-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 2%. In addition, based on the location of the park 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.

It is our understanding that the Town of Caledon parkland property and Peel District School Board properties restrict 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 $36,284,160.

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.

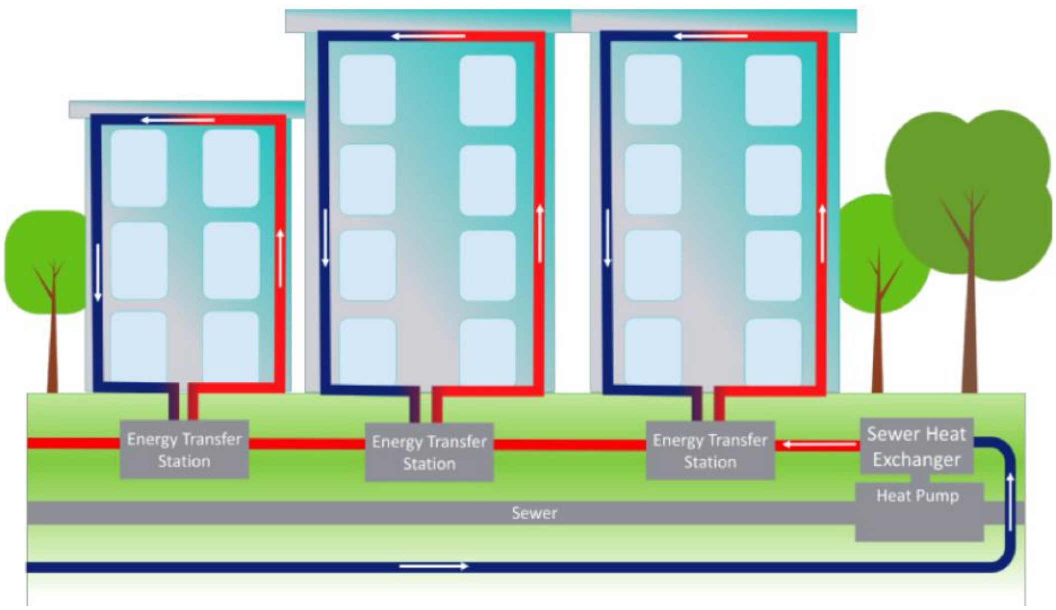

Figure F-1: DES Schematic of Wastewater Heat Recovery (City of Toronto, 2017)

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 density dwellings of the Commercial Block and Urban Corridor, 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 for DHW.

Actual expected wastewater generation

Under the following assumptions, the total expected wastewater generation is estimated at approximately **98.07 million gallons/year.**

- Average Sanitary sewage flow rate- 11.78 L/s (Provided by Schaeffers Consulting Engineers based by a population of 3517)
- Annual days of operation – 365 days

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 **1,348,228.42 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 **808,937.05 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 **37.14 million gallons/ year.** The overall analysis summary is summarized in the **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	98,074,437 gallons/year
Total wastewater required	37,140,762 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.

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.

The approximate NPV cost of implementing this system in the neighborhood Centre would be $34,851,075.

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, 2024)	Considerations	Estimated Cost (Subareas)
Geothermal Pumps System	131 boreholes and 14,464 ft^2 land area for Urban Corridor and Commercial block	○ 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	$37,866,591
PV Array (District Level)	12,486 ft^2 of Urban Corridor and Commercial Block	○ Low energy generation potential ○ Location of PV arrays and racks are limited to publicly owned property ○ Metering/financing considerations for owners/operators	$36,284,160
Sewage Waste Heat Recovery	4,965,002 ft^3 cistern volume for Urban Corridor and Commercial block	○ Can only serve DHW loads ○ Access to available sanitary waste matter streams ○ Metering/financing considerations for owners/operators	$34,851,075

Appendix G. 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 G-1** outlines estimated kW demand for the heating and cooling systems under consideration.

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

Heat Pump Options	Energy Demand (kW)
Baseline	6,072
Geothermal HX	6,072
Air Source HP	9,108
Hybrid HP	6333

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/kVa.
- 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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