Mayfield Tullamore Secondary Plan Area

Community Energy and Emissions Reduction Plan

Town of Caledon, ON

Prepared for: Mayfield Tullamore Landowners Group

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Pratus Group Inc.

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Pratus

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Document Revision History

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A	February 2nd, 2025	Internal Draft	Yasaman Bateni, Simonne Varela	Eric Dunford, Christopher Mohabir	Oleksandra Onisko
B	February 26th, 2025	Second Internal Draft	Yasaman Bateni, Simonne Varela	Eric Dunford, Christopher Mohabir	Oleksandra Onisko
C	March 13th, 2025	Secondary Plan Submission	Yasaman Bateni, Simonne Varela	Eric Dunford, Christopher Mohabir	Oleksandra Onisko

Limitations

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

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Table of Contents

1. Executive Summary

Pratus Group Inc. was retained by the Mayfield Tullamore Landowners Group to develop a Community Energy and Emissions Reduction Plan (CEERP) consistent with Section 5.6.20.14.17(d) of the Region of Peel Official Plan and the Town of Caledon Terms of Reference (TOR) for the Mayfield Tullamore 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 communicated in the Green Development Standard (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 Mayfield Tullamore Secondary Plan Area is expected to consist of 609 hectares of land, with 360 hectares of developable land area. The Plan Area as currently envisioned is expected to be primarily low-rise residential with areas of denser development. The proposed building mix for the planned community includes street townhouses, single and semi-detached homes, medium density stacked townhouses and condos with an estimated total gross floor area of approximately 163.9 hectares.

Energy simulations were conducted to estimate baseline energy use and carbon emissions expected to arise from the Secondary Plan Area based on the building stock meeting the requirements established by the Town of Caledon. From this baseline, additional energy conservation and emissions reduction opportunities were assessed and explored to identify a low-carbon scenario consistent with the Town and Region decarbonization objectives.

Building Energy Systems Assessed

The **Baseline Scenario** establishes the expected energy consumption based on the proposed development meeting the prevailing energy standards in the Town of Caledon. The **Near Net Zero Scenario** was then constructed by evaluating a variety of potential additional 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 GDS, at a minimum, requires that all single-family residential dwellings, 50% of multi-unit residential buildings and 20% of all other types of dwellings are equipped with the required infrastructure to be EV-Charger ready. The requirements of the Town of Caledon's Green Development Standard (GDS) were used to estimate the energy demand associated with implementing electric vehicle (EV) chargers in the Secondary Plan Area for the following scenarios:

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

Transportation Case 1 is used as a baseline in this analysis to compare other scenarios against.

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 Scenario	Net Zero Design Scenario	% Savings over Baseline	
				Energy	Emissions
Residential	Single / Semi Detached Homes & Street 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	36%	74%
	Stacked Townhomes & Apartments	Constant volume corridor make-up air unit (MUA) and constant volume in-suite ventilators served by condensing boilers and chillers		40%	82%
Commercial	Commercial Services + Retail	Fan coil units (FCUs) / Dedicated Outdoor Air Systems (DOAS) served by condensing boilers and chillers		56%	84%

Category	Archetype	Baseline Design Scenario	Net Zero Design Scenario	% Savings over Baseline	
				Energy	Emissions
Educational	Schools	Rooftop Units –Natural gas heating and DX cooling	100% gas and passive measures	44%	84%

Category	Archetype	Baseline Design Scenario	Net Zero Design Scenarios	Increase in Energy Consumption	
Transportation	**EV Chargers**	***Transportation Case 1*** 25% of residential and 20% of non-residential spaces utilize EV chargers	***Transportation Case 2*** 50% of residential and 20% of non-residential spaces utilize EV chargers	94%	1.9x
			Transportation Case 3 100% of residential and 20% of non-residential spaces utilize EV chargers	282%	3.8x
			Transportation Case 4 100% of residential and 100% of non-residential spaces utilize EV chargers	306%	4.1x

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		
114.2	-14.2	-11.7	-16.2	-1.1	-43.3	72.0
% of individual reduction	12%	10%	14%	1%	38%	

Table 3: Estimated GHGI Reduction Potential

Baseline Scenario GHGI [$kgCO_2e$ / m^2]	Reduction Strategies [$kgCO_2e/m^2$]				Total Reduction Potential GHGI [$kgCO_2e$ /m^2]	Near Net Zero Scenario GHGI [$kgCO_2e$ / m^2]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
8.9	-1.7	-0.4	-4.6	0.0	-6.7	2.2
% of individual reduction	19%	4%	51%	0%	75%	

The results of the analyses conducted demonstrates that EVs and their associated infrastructure requirements are expected to impose a significant electricity demand. The estimated overall energy demand associated with the scenarios modelled is summarized in **Table 4**.

Table 4: Estimated EV Charger Demand

Scenarios Assessed	Level 2 EV Chargers		Level 3 EV Chargers	Level 2 EV Chargers Demand [kW]	Level 3 EV Chargers Demand [kW]	Total Energy Demand [kW]	Total Carbon Emissions [$kgCO_2e$]
	Residential	Non-Residential					
Transportation Case 1	1,727	75	4	11,897	248	12,145	607
Transportation Case 2	3,455	75	4	23,298	248	23,545	1,177
Transportation Case 3	6,909	75	4	46,098	248	46,346	2,317
Transportation Case 4	6,909	377	20	48,087	1,239	49,325	2,466

Average costs for EV charging stations, installation and infrastructure amount to approximately $2,000 per Level 2 charger and $50,000 per Level 3 charger, based on discussions from major supplies in Canada (ChargePoint, Switch Energy, & Flo). Approximately 35% and 15% of these costs are associated with charging station equipment and installation for residential, respectively, which are to be borne by individual owners in Caledon. The remainder (~50%) of these costs are associated with the conduits, and electrical cable installation.

To quantify expected costs for EV charging, $1,300 for Level 2 residential chargers, $1,700 for Level 2 non-residential and $42,500 for Level 3 non-residential chargers was assumed. Based on the GDS requirements to make buildings EV-Charger ready, this results in a total of **$9,278,572**. Suppliers have communicated that there is a factor of economies of scale for installation that is not reflected in this value. The true cost will vary between suppliers and would be determined at the time of procurement.

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 increased electricity demand posed by the proposed electric vehicle charging scenarios cannot feasibly be met through on-site generation within the Secondary Plan Area and was therefore excluded from the Near Net Zero Scenario.

Table 5, **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 energy requirements of the Town of Caledon's GDS exceed the standard used other municipalities in Ontario as a baseline, meaning that the Baseline Scenario already represents energy conservation and emissions reduction that exceeds the provincial Code.

Table 5: Estimated EUI and GHGI Reduction Potential 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]	197.1	114.2	72.0	63%	37%
GHGI [kgCO$_2$e/m²]	25.9	8.9	2.2	92%	76%

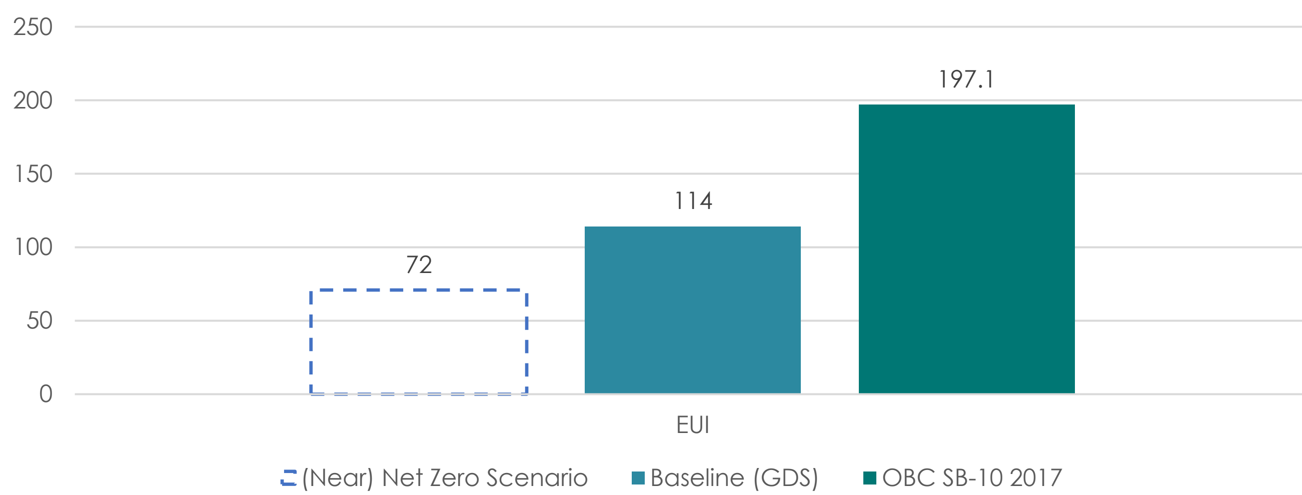


Figure 1: Estimated EUI Reduction Potential Comparison to OBC and Baseline Scenario

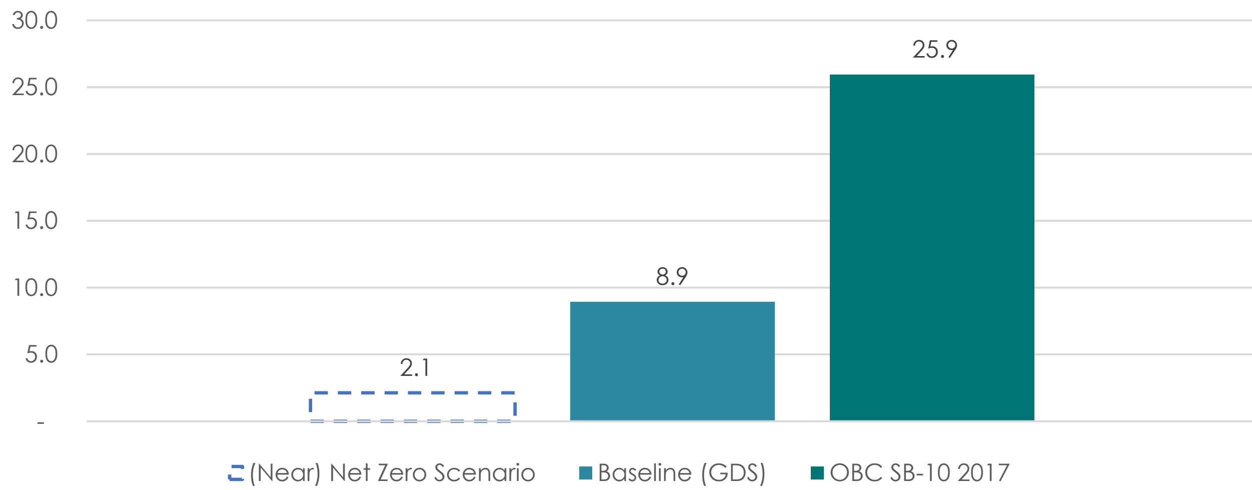


Figure 2: Estimated GHGI Reduction Potential Comparion to OBC and Baseline Scenario

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 Mayfield Tullamore 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.

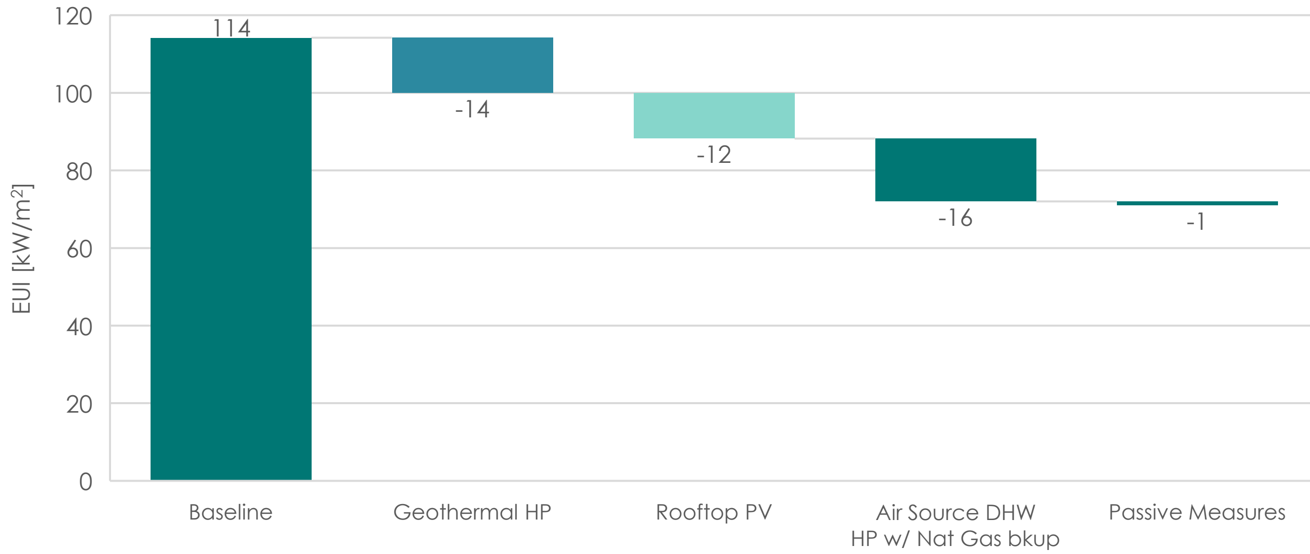


Figure 3: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential

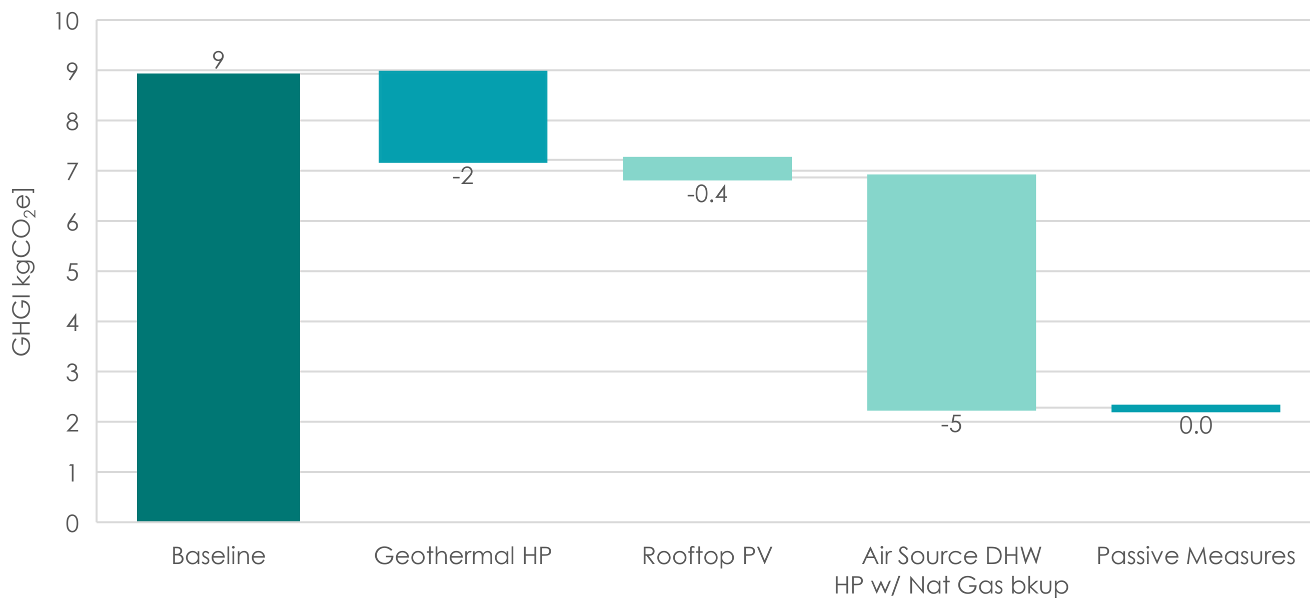


Figure 4: Greenhouse Gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

District Energy System Considerations

The Secondary Plan Area includes subareas (the Neighbourhood Centres and Urban Corridors) that encompass medium and higher density dwellings. The feasibility of district systems was explored for these denser subareas. Solar photovoltaic, sewage wastewater heat exchange and geothermal district energy systems were assessed. This analysis demonstrated that both geothermal and wastewater exchange district energy systems are potentially feasible.

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 in the Mayfield Tullamore Secondary Plan Area.
- The incremental capital cost of implementing these technologies over the requirements of the Town of Caledon Green Development Standard is estimated to be approximately $632.7 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 $2.1 billion based on the Class D cost estimate conducted, which is approximately $ 660.5 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.
- Geothermal and wastewater heat recovery district-scale energy systems are potentially feasible within the denser subareas in the Mayfield Tullamore Secondary Plan. Further analysis and evaluation by a district energy provider is required to confirm whether a system is ultimately viable.
- While district energy systems may offer efficiency gains due to favorable part-load conditions, these benefits can be challenging to predict and may not significantly differ from equivalent building-scale systems. For this analysis, it was assumed that the energy and emissions performance of various system alternatives would be similar at both the building and district scales.

2. Introduction and Context

The Mayfield Tullamore 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 Mayfield Tullamore 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 Mayfield Tullamore Secondary Plan Area development is planned for the southern lands of Town of Caledon, Ontario as shown in **Figure 5**. The site is bound by the planned Old School Road to the north, Torbram Road to the east, and Mayfield Road to the south. Dixie Road is located and to the west, but not immediately adjacent, as depicted in **Figure 6**. The conceptual plan for the proposed Secondary Plan Area includes the following types of neighborhoods:

- Residential Area – including street townhomes, detached homes, apartments, stacked townhomes and apartments.
- Schools – Includes existing and new proposed public schools; and,
- Commercial area – includes a mix of commercial services and retail.

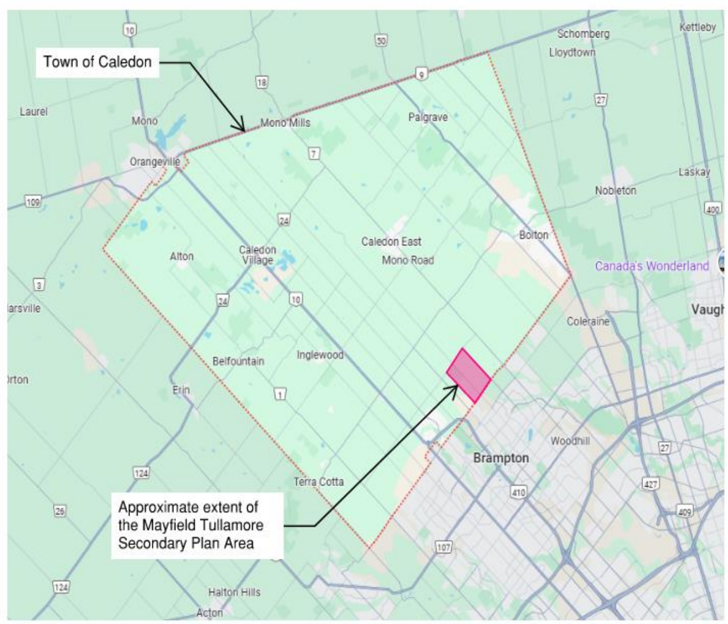
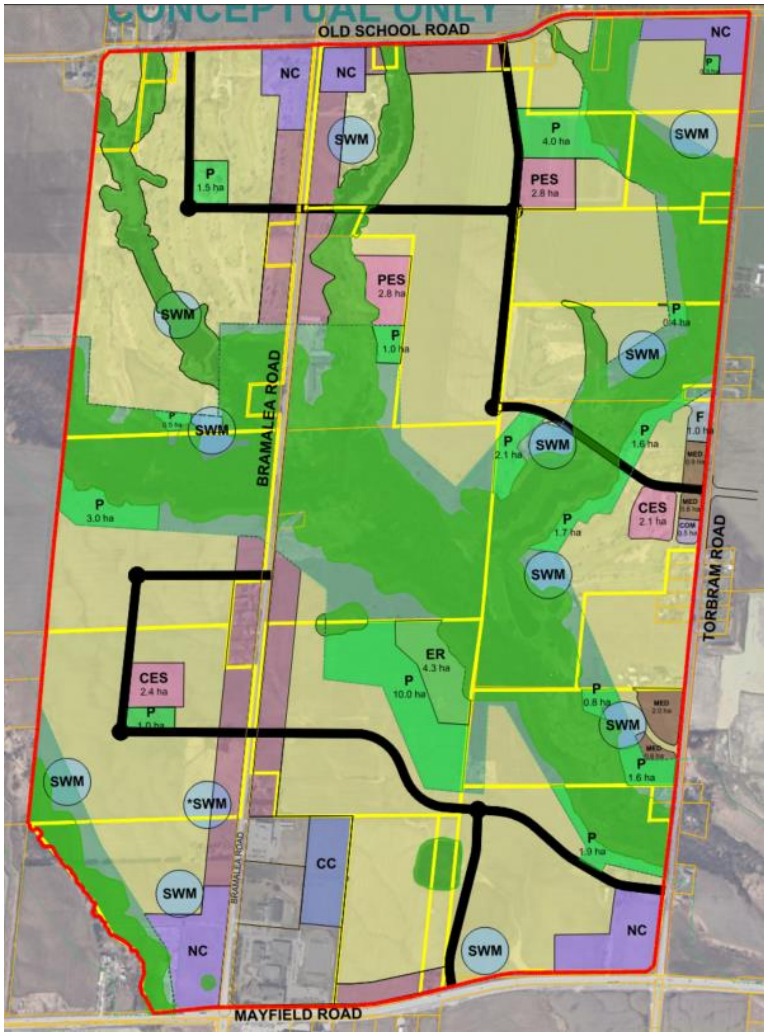


Figure 5: Approximate Extent of the Mayfield Tullamore Secondary Plan Area in the Town of Caledon



	LAND USE	AREA OUTSIDE GB	AREA WITHIN GB	TOTAL
	Community Area	266.6	0.0	**266.6**
	Medium Density	3.9	0.0	**3.9**
	Urban Corridor	32.3	0.0	**32.3**
	Neighbourhood Centre	20.6	0.0	**20.6**
	School	10.2	0.0	**10.2**
	Community Centre	0.0	0.0	**0.0**
	Park	6.3	24.6	**30.9**
	Open Space	25.6	161.6	**187.2**
	Existing Schools and Rec & Community Centre	20.0	0.0	**20.0**
	Environmental Restoration	0.0	4.3	**4.3**
	Collector Roads	21.3	0.7	**22.0**
	Existing Bramalea Road	11.0	0.0	**11.0**
	TOTAL	**417.8**	**191.2**	**609.0**

SWM Stormwater Management Facility

* Provisional SWM

Figure 6: Preferred Structure Plan Option for the Mayfield Tullamore Secondary Area

(Malone Given Parsons Ltd., July 30, 2024)

2.2. Demographics, Site Statistics and Building Types

The Mayfield Tullamore Secondary Plan Area includes a land area of ~609 hectares with a mix of land uses. Of the total 609 hectares of land, approximately 217 hectares are comprised of the Greenbelt and existing natural heritage features and headwaters of the Humber River watershed. 31.3 hectares consist of collector roads and the existing Bramalea Road which runs north to south in the centre of the Plan Area. These lands were excluded from the analyses conducted as they are not expected to support construction of residential, commercial, educational, or industrial buildings. Areas were selected for exclusion based on their classification per the current land use policies and the proposed Land Use Plan.

The proposed development plan for the community includes a variety of building types such as street townhouses, single and semi-detached homes, medium density stacked townhomes, apartments, designated commercial areas comprising retail, and commercial services, schools, community center and parks. The total gross floor area of the proposed development is approximately 360 hectares.

2.2.1 Details per Building Type

The current Mayfield Tullamore Secondary Plan Area concept plan consists of several land use profiles (See **Appendix B** for details). These building types and areas are listed in **Table 6** for reference. **Figure 7** shows a breakdown of the types of building within the current proposed Secondary Plan Area development.

Table 6: Mayfield Tullamore Secondary Plan Area Building Type Descriptions

Residential Building Types – Total 212 ha / 7,650 units

Low Rise (3 storeys or less)

Low Density Residential Single/ Semi Detached

150 ha / 4,740 Units

Low Density Street Townhomes

50 ha / 1,750 Units

MURB (≤ 6 storeys)

Medium Density Stacked Townhomes

10 ha / 780 Units

Medium / Higher Density Apartments

2 ha / 380 Units

Non-Residential Building Types - Total 30 ha

Schools

2 Public Elementary School Buildings
10 ha

Commercial Spaces

Commercial Services and Retail
20 ha

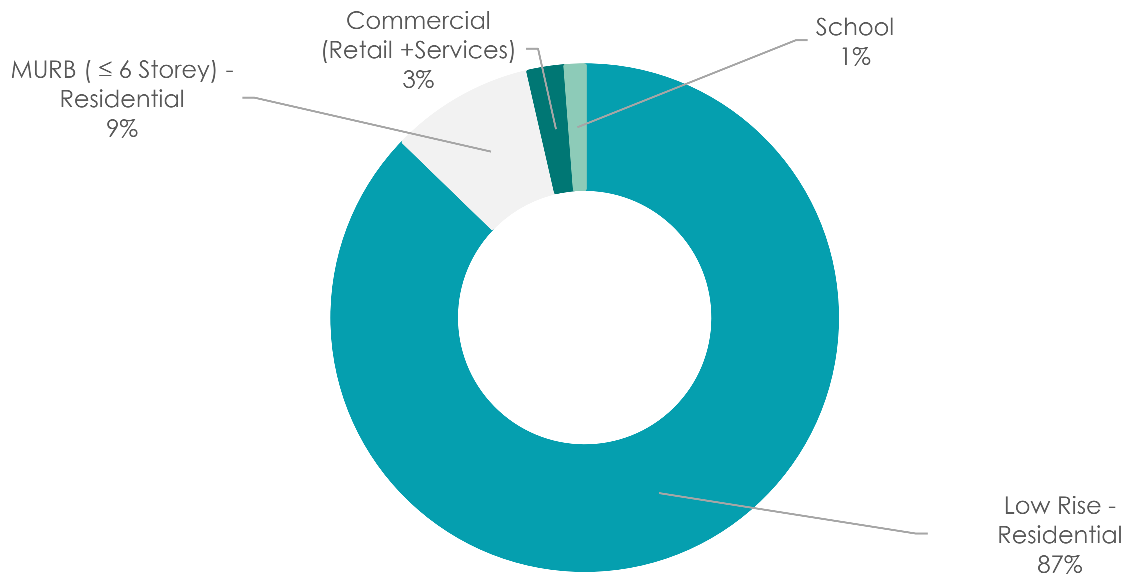


Figure 7: Mayfield Tullamore Secondary Plan Area Building Type Breakdown (Gross Floor Area)

2.3. CEERP and Net Zero Targets

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

2.4. 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 7**.

Table 7: Town of Caledon's GDS Absolute Performance Targets (Town of Caledon, 2024a)

Building Type	Energy and Carbon Performance Measures			EV Charger-Ready Requirements*
	TEUI [kWh/m²/yr.]	TEDI [kWh/m²/yr.]	GHGI [kgCO$_{2e}$/m²/yr.]	
Low Rise Residential (<3 storeys)	Energy Star or equivalent OR NBC Tier 3 performance and 20% reduction in GHG emissions from OBC		15	Minimum one charging space per dwelling unit
Multi-unit Residential (>6 storeys)	135	50	15	Minimum 50% of parking spaces are EV-ready
Multi-unit Residential (≤6 storeys)	130	40	15	
Commercial Office	130	30	15	Total of 20% parking spaces are EV-ready

Commercial Retail	120	40	10	Minimum 5% of spaces to be equipped with EV Supply Equipment (EVSE)
Industrial	130	60	15	

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

2.5. 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). DES provide access to a low-carbon fuel source with minimal infrastructure required needed 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 were explored in this study.

District energy systems rely on building density and supporting infrastructure to be viable. Consequently, these systems are best suited to medium to high-density development areas.

The density classification of archetypes was completed based on units per hectare, provided by the Mayfield Tullamore planning consultant:

- Low-density residential:
  - Single/Semi detached (30 units per hectare)
  - Street townhouses (60 units per hectare)
- Medium and higher density residential:
  - Stacked townhouses (78 units per hectare)
  - Apartments (190 units per hectare)
- Commercial services and retail are classified as medium density. (2,000 jobs)

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. 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.

3. Energy Analysis Considerations

3.1. Building Energy Systems

Energy and operational GHG emissions for the individual archetypes and the entirety of the buildings proposed in the Mayfield Tullamore 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 outlined in **Appendix D**.

Potential energy conservation measures were selected based on low-carbon design principles, with the exception that active measures (i.e., HVAC system implementation) were considered prior to passive measures (i.e., enclosure 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.

Table 8 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 8 - Low-Carbon Building Technologies Assessed

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

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

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

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

The Near Net Zero Scenario consists of building-scale energy conservation strategies beyond those required in the baseline. 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. Transportation Systems

The GDS, at a minimum, requires that all single-family residential dwellings, 50% of multi-unit residential buildings (MURBs) and 20% of all non-residential spaces are equipped with the required infrastructure to be EV-charger ready, as shown in **Table 7** in **Section 2.4**. To estimate the electrical demand from EV chargers for the Mayfield Tullamore Secondary Plan Development, population and employment projections for each type of dwelling were used. **Table 9** summarizes the number of parking spaces required to be EV charger ready for the Mayfield Tullamore Secondary Plan Area.

The assumed costs for equipping residential and non-residential spaces to be EV-charger ready include those associated with electrical infrastructure that can be included at the time of construction such as conduits, and electrical cable runs at each dwelling.

Table 9 - Number of Parking Spaces Required to be EV-Charger Ready

Building Type		Caledon GDS EV Charger-Ready Requirement	# of Level 2 Parking Spaces	# of Level 3 Parking Spaces	Minimum Required EV-Ready Chargers	Total Parking Spaces (Assumed)
Residential	Low Rise Residential (<3 storeys)	Minimum one charging space per dwelling unit	6,490	0	Level 2: 6,909	6,909
	Multi-unit Residential (>6 storeys)	Minimum 50% of parking spaces are EV-Ready.	419	0		
Non-Residential	Commercial Retail	20% of parking spaces are EV-ready.	18	1	Level 2: 75 Level 3: 4	396
	Schools	Minimum 5% of spaces to be equipped with EV Supply Equipment (EVSE).	57	3		

Per the Town of Caledon TOR, the Town's GDS was used to estimate the energy demand associated with implementing electric vehicle chargers for the following scenarios shown in **Table 10**.

Table 10 - Transportation Scenarios Assessed

Transportation Analysis Case	Number of Residential Chargers Utilized	% of Residential Chargers Utilized	Number of Non-Residential Chargers Utilized	% of Non-Residential Chargers Utilized
Transportation Case 1	Level 2: 1,727	25%	Level 2: 75 Level 3: 4	20%
Transportation Case 2	Level 2: 3,455	50%	Level 2: 75 Level 3: 4	20%
Transportation Case 3	Level 2: 6,909	100%	Level 2: 75 Level 3: 4	20%
Transportation Case 4	Level 2: 6,909	100%	Level 2: 377 Level 3: 20	100%

Transportation Case 1 and Case 2 represent scenarios in which 25% and 50% of residential dwellings install and utilize EV chargers, along with the minimum required 20% of all other spaces, as per the GDS, in the Secondary Plan Area. **Transportation Case 3** represents a conservative scenario in which the GDS's minimum required chargers are all installed and utilized. For **Transportation Case 4**, it was assumed that the entirety of the Secondary Plan area would be equipped with and utilize the EV chargers (i.e. 100% of residential and 100% of non-residential spaces). **Transportation Case 1** is used as a baseline in this analysis to compare other scenarios against.

BA Consulting Group completed a Transportation Study for the proposed Mayfield Tullamore Secondary Plan Area, entitled *Mayfield-Tullamore Community – Transportation Study* dated August 2024 (BA

Consulting Group, 2024). The purpose of the transportation study was to assess the impacts of the proposed community on the existing road network in Caledon, ON near the existing community and the forecasted vehicle traffic that is expected within the development area based on the proposed urban form.

BA Consulting Group's transportation study forecasted personal vehicle daily trips taken within the community, based on the proposed site layout. These values were used as a basis to inform the baseline estimate of the transportation GHG emissions from personal vehicles within the Mayfield Tullamore Secondary Plan Area. These values will be used as a basis to inform Scope 3 emissions from personal vehicles that have the potential to be reduced using forms of active transportation and implementation of the EV chargers.

3.3. District Energy System Considerations

Potential district energy systems were evaluated for medium and higher density subareas within the Mayfield Tullamore Secondary Plan Area are outlined in **Table 11.** Based on the density and square footage of these proposed subareas, they were evaluated for feasibility of district-level energy systems.

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

Table 11- 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 in the Mayfield Tullamore Secondary Plan Area and therefore this DES was excluded from consideration.*

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 E**. A summary of this analysis is provided in **Section 4.3.**

3.3.1 Subarea Analysis

Section 2.1 of the report discusses the land use concept plan of the Mayfield Tullamore Secondary Plan Area. Subareas selected for district energy analysis within the Secondary Plan Area included the Neighbourhood Centres located at the north and southwest corners of the site, and at the key intersections along the Urban Corridors. The remainder of the Secondary Plan Area is expected to consist of Neighbourhood Areas which are envisioned to be predominated by low-rise residential buildings that are poorly suited for district systems. A breakdown of these subareas, their dwelling types, and square footage is shown in **Table 12**.

Table 12 - Overview of the Subareas Within the Secondary Plan Area

Sub-Area	Building Archetypes & Square Footage	Total Dense Areas
Neighbourhood Centres	Commercial services and retail – 271,804 ft^2 Medium / Higher Density Apartments – 230,571 ft^2	502,375 ft^2
Urban Corridors	Medium Density Stacked Townhomes – 1,291,200 ft^2 Medium / Higher Density Apartments – 92,229 ft^2 Commercial services and retail – 51,326 ft^2	1,434,754 ft^2
Neighbourhood Areas	Low-Rise Street Townhomes – 3,443,200 ft^2 Low-Rise Single/Semi-detached – 11,943,600 ft^2	-
Schools	Elementary Schools – 215,200 ft^2	215,200 ft^2

3.3.1.1. Neighbourhood Centres and Urban Corridors

Less than 12% of the Mayfield Tullamore Secondary Plan's development total gross floor area consists of buildings that would be classified as medium or high density. Combined, the Neighbourhood Centres and Urban Corridors are 1,937,130 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. A summary of these findings are outlined in Table E-2 of Appendix E.

According to a commercial market impact study conducted by Altus Group Economic Consulting for Mayfield Tullamore the plan area, more than one million square feet of commercial space is currently in the development application process. A substantial portion of this space is located within the Mayfield West Phase 2 Stage 3 secondary plan application, as shown in Figure 9. The Neighbourhood Centres are also adjacent to planned development outside of the Mayfield Tullamore Secondary Plan Area. While neighbouring developments may also have high density areas that are well-suited to district systems, they are outside the scope of this study.

Site ID	Municipality	Address	Status	Estimated Commercial Component
				Sq.Ft.
1	Caledon	Mayfield West Phase 2 Stage 3	Submitted	485,000
2	Caledon	2068 Mayfield Road	In Circulation	80,700
3	Caledon	Kennedy Road and Mayfield Road (Snell's Hollow)	In Circulation	48,400
4	Caledon	16054 and 16060 Airport Road	Under Appeal	4,810
5	Caledon	16114 Airport Road	Approved 2021	13,160
6	Caledon	12599 and 12563 Highw ay 50 and 2 Industrial Road	In Circulation	34,000
7	Caledon	Bolton Option 3 Landow ners Group	Under Appeal	97,800
8	Caledon	Bolton North Landow ners Group - 0, 14289, 14291, 14337, 14442, 14445, 14475, 14530, 14600, 14616, 14684, 14685, 14687, 14700, 14766 Highw ay 50, 0, 14674, 14691 Duffys Lane and 0 Mount Hope Road	In Circulation	50,100
9	Caledon	14245 Highw ay 50	In Circulation	18,600
10	Brampton	Portion of lands east of Torbram Road betw een Mayfield Road and Countryside Drive	Approved	200,000
11	Brampton	10258 Airport Road	Approved	4,800
Total				1,037,370

Figure 8 – Development Applications Submitted in the Primary Trade Area (Altus Group Economic Consulting, August 29, 2024)

3.3.1.2. Neighbourhood Area

District systems are generally poorly suited to low-rise residential development patterns 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 negates the value of any district system. These areas of the Secondary Plan Area were therefore excluded from the analyses conducted. This style of development is the majority of the proposed site, at approximately 15.4 million ft^2.

3.4. Potential Policy Barriers and Planning Considerations

Beyond considerations of density and square footage, the Mayfield Tullamore Secondary Plan Area presents other potential logistical challenges for implementation of DES. 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.
- **School Board Construction Practices:** The Town of Caledon and the local school boards (Peel District School Board and Dufferin Peel Catholic District School Board) may not permit drilling of geothermal boreholes or installation of solar photovoltaic energy systems on parklands or school properties. This may reduce the potential land available to support energy generation capacity. These public land sites are among the most attractive for borehole drilling due to the relatively open space provided and the expected size of surface space available. Energy transfer stations can be integrated into the private sector lands, however, there may be restrictions based on

competing needs for private development which are likely to present cost and implementation barriers. It may be necessary for the Town of Caledon to purchase sections of privately owned land to deploy DES.

- **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 13.** The medium and higher density development (Urban Corridors and Neighbourhood Centres) 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 13 - : Energy and Carbon Emission Reduction Savings from Near Net Zero Designs

Category	Archetype	Baseline Design Scenario	Net Zero Design Scenario	% Savings over Baseline	
				Energy	Emissions
Residential	Single / Semi Detached Homes & Street 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	36%	74%
	Stacked Townhomes & Apartments	Constant volume corridor make-up air unit (MUA) and constant volume in-suite ventilators served by condensing boilers and chillers		40%	82%
Commercial	Commercial Services + Retail	Fan coil units (FCUs) / Dedicated Outdoor Air Systems (DOAS) served by condensing boilers and chillers		56%	84%
Educational	Schools	RTUs served by natural gas and DX cooling		44%	84%

Category	Archetype	Baseline Design Scenario	Net Zero Design Scenarios	Increase in Energy Consumption	
Transportation	**EV Chargers**	***Transportation Case 1*** 25% of residential and 20% of non-residential spaces utilize EV chargers	***Transportation Case 2*** 50% of residential and 20% of non-residential spaces utilize EV chargers	94%	1.9x
			Transportation Case 3 100% of residential and 20% of non-residential spaces utilize EV chargers	282%	3.8x
			Transportation Case 4 100% of residential and 100% of non-residential spaces utilize EV chargers	306%	4.1x

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 F.**

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 photovoltaic (PV) panels
- Domestic hot water heat pump with natural gas backup

4.1.1 Energy

Figure 9 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.

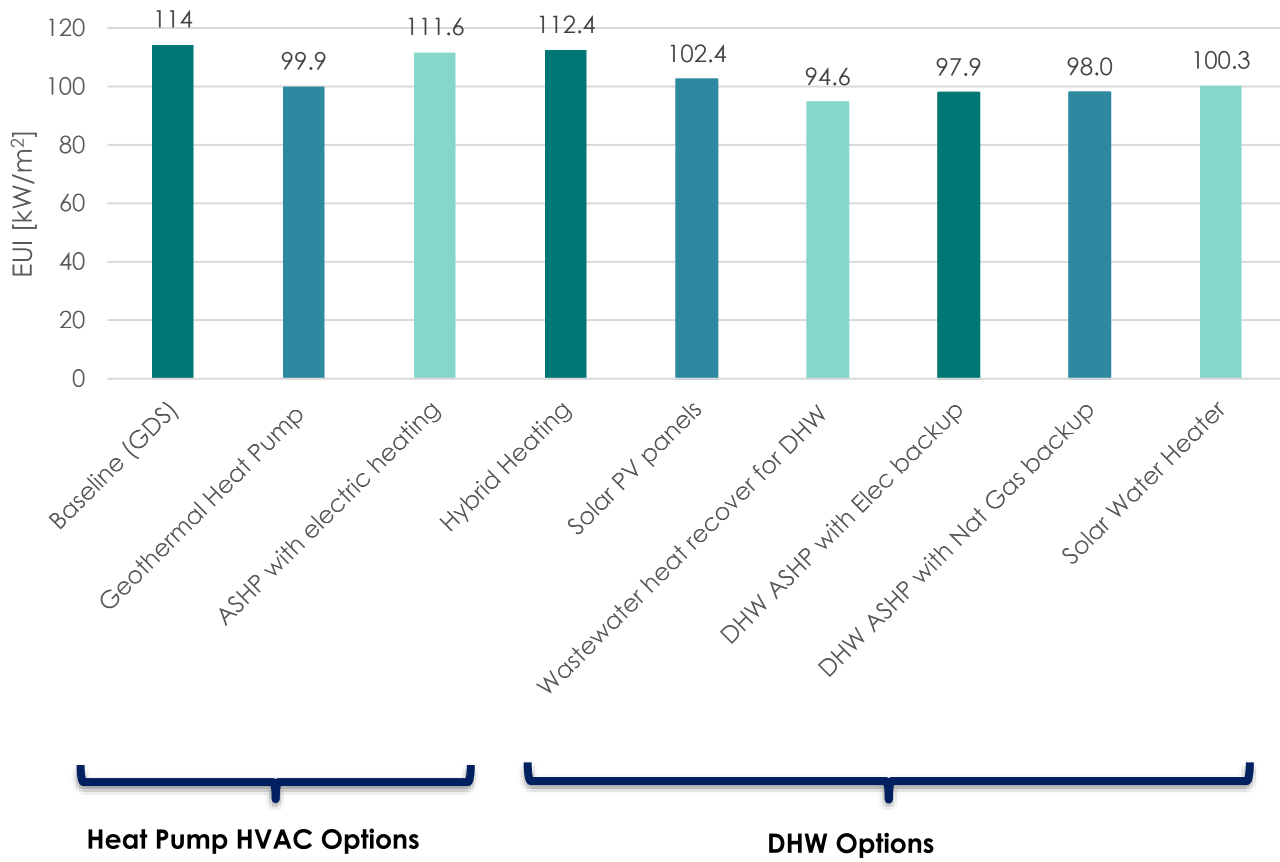


Figure 9 - Energy Use Intensity Results for Each HVAC System Assessed

4.1.2 Carbon

Figure 10 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 74% 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 87% of the site floor area, low-carbon space heating was already assumed for the majority of the Plan Area, reducing the impact of low-carbon strategies for reducing emissions in these areas. Consequently, there is less room for improvement in GHGI beyond the baseline through heating measures.

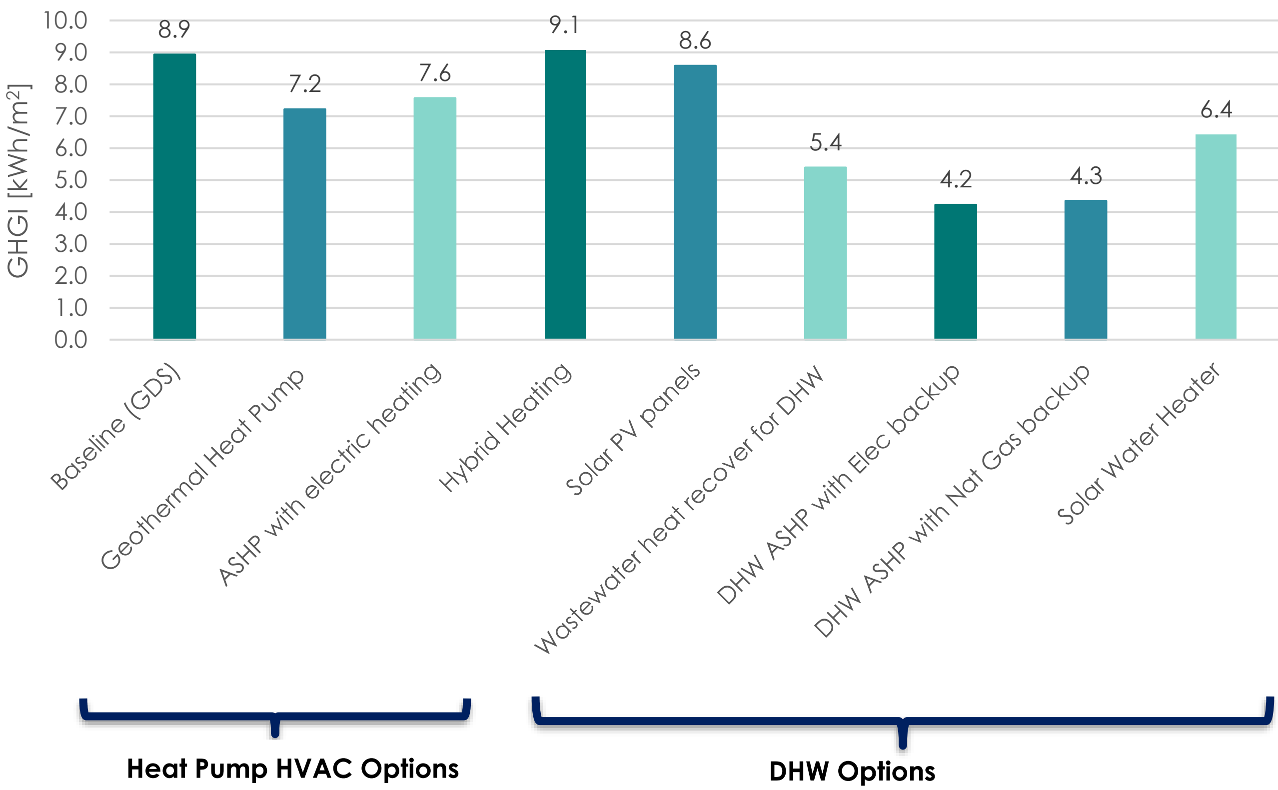


Figure 10 - Greenhouse Gas Use Intensity Results for Each HVAC System Assessed

4.2. 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 11** 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 14** below.

Equation 1 - Total Cost

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

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*

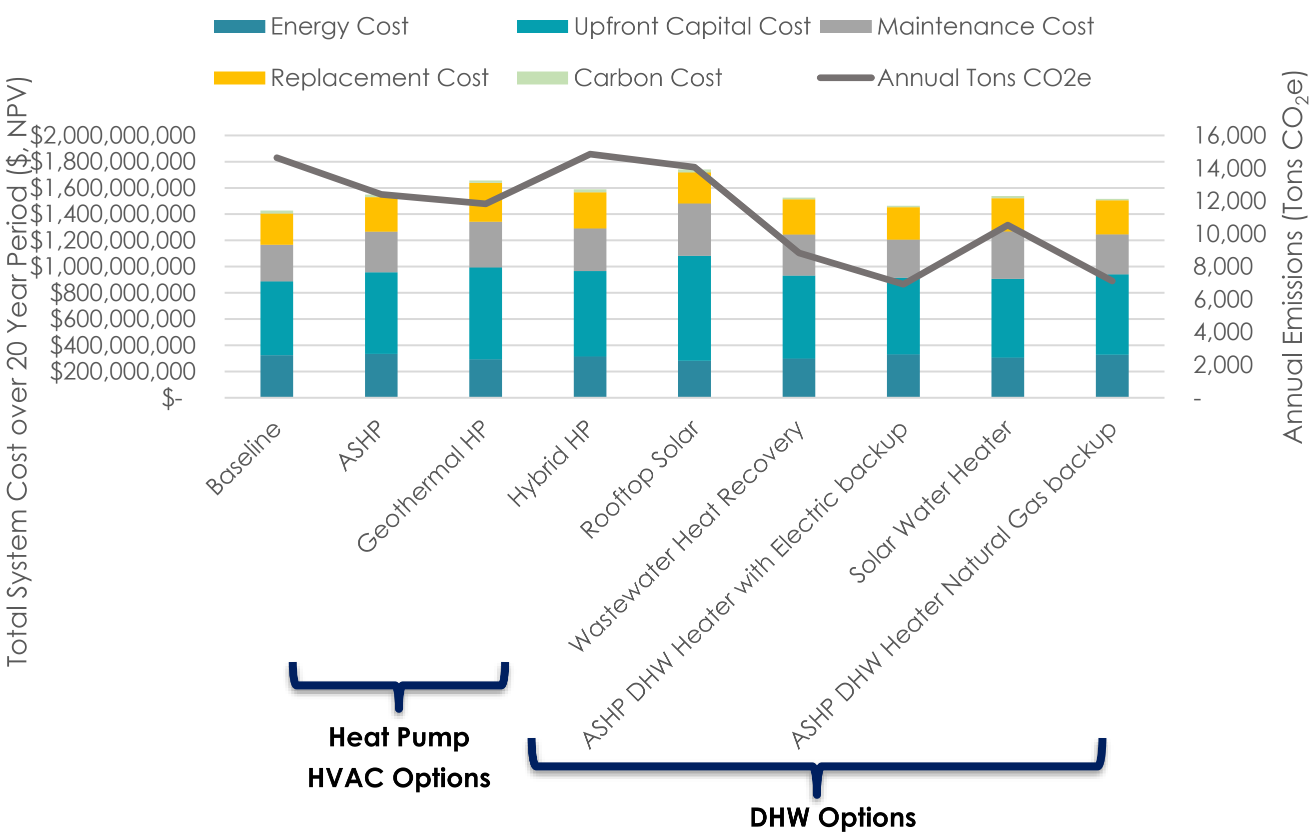


Figure 11: Total System Cost over 20 Year Period (NPV) of Each System Assessed Along with Annual CO_2e Associated with Each Measure

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 14** (See **Appendix G** for details).

Table 14: HVAC System Class D Estimate Cost Analysis

HVAC Option	System Type	Cost Analysis	Est. 20-Year NPV Cost (Baseline Scenario)	Incremental Capital Cost Over Baseline
Baseline HVAC	Per GDS	Aligns with GDS requirements	$1,427,312,528	N/A
ASHP	Heat Pump	Significantly reduces GHG emissions at little incremental cost over the Baseline Scenario. Barriers include higher upfront capital cost as well as impact on site kW demand.	$1,549,026,931	$121,714,000
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.	$1,657,278,586	$229,965,000
Hybrid HP	Heat Pump	Moderate impact on GHG emissions reduction at reduced incremental cost over the Baseline Scenario. On-site kW demand is a non-factor for this system type.	$1,589,590,891	$162,278,000

Renewables	System Type	Cost Analysis	Est. 20-Year NPV Cost (Baseline Scenario)	Incremental Capital Cost Over Baseline
Rooftop Solar	Electricity Production	Negligible impact on GHG with significant additional cost.	$1,740,997,808	$313,685,000

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.	$1,525,984,430	$98,671,000
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	$1,464,100,133	$36,786,000
Solar Water Heater	DHW Heating	Reduced GHG benefits as other DHW upgrades at costs relatively comparable to an ASHP Heater.	$1,538,168,790	$110,856,000
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.	$1,516,397,746	$89,085,000

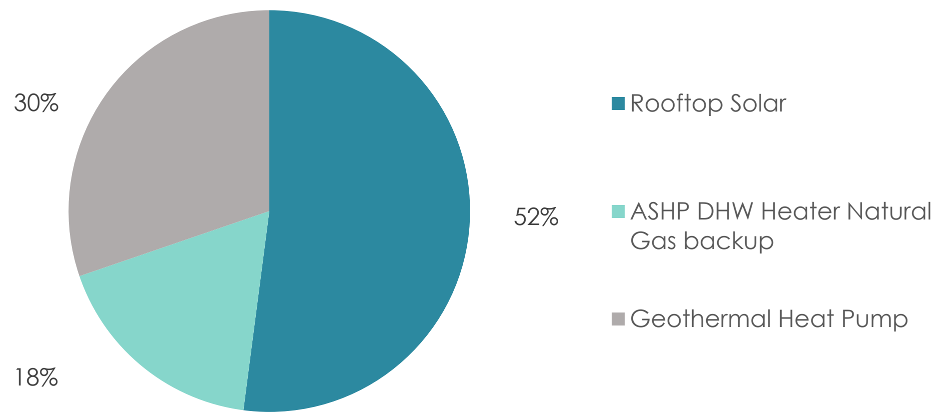


Figure 12: Total Incremental Upfront Capital Cost Distribution of Each Proposed Measure

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 $457.1M, or 55%.

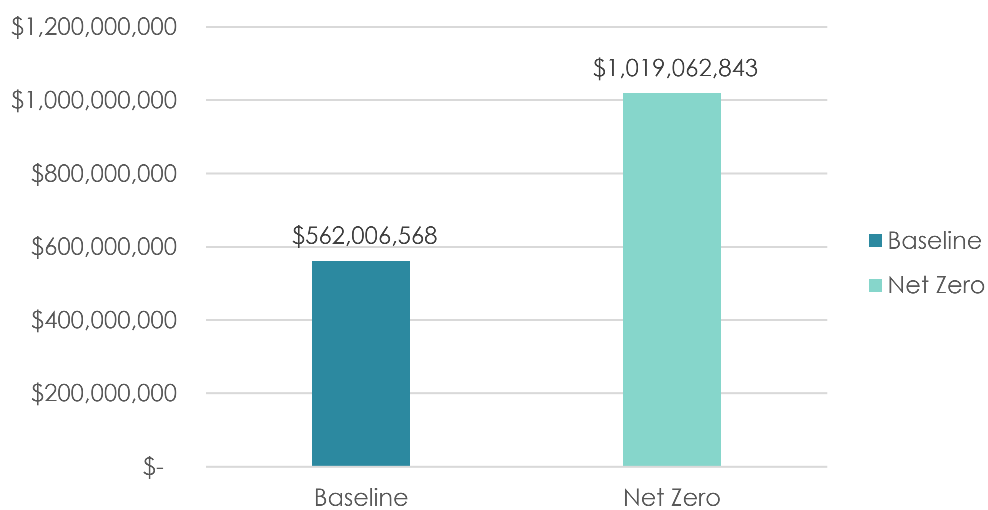


Figure 13: Total Incremental Upfront Capital Cost vs. Baseline Scenario

4.3. Traffic Vehicles & EV Charging

4.3.1 Estimated Electrical Demand

To estimate the electrical demand from EV chargers for the Mayfield Tullamore 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 have an electrical demand of 6.6 kW per charging station. Level 3 chargers for non-residential spaces have an electrical demand of 62.5 kW.

Transportation Case 1 and Case 2 represent scenarios in which 25% and 50% of residential dwellings install and utilize EV chargers, along with the minimum required 20% of all other spaces, as per the GDS, in the Secondary Plan Area. **Transportation Case 3** represents a conservative scenario in which the GDS's minimum required chargers are all installed and utilized. For **Transportation Case 4**, it was assumed that the entirety of the Secondary Plan area would be equipped with and utilize the EV chargers (i.e. 100% of residential and 100% of non-residential spaces). **Transportation Case 1** is used as a baseline in this analysis to compare other scenarios against.

The results of the analyses conducted demonstrates that EVs and their associated infrastructure requirements are expected to impose a significant electricity demand. The estimated overall energy demand associated with the scenarios modelled is summarized in **Table 15**.

Table 15: Estimated EV Charger Demand

Scenarios Assessed	Level 2 EV Chargers		Level 3 EV Chargers	Level 2 EV Chargers Demand [kW]	Level 3 EV Chargers Demand [kW]	Total Energy Demand [kW]	Total Carbon Emissions [$kgCO_2e$]
	Residential	Non-Residential					
Transportation Case 1	1,727	75	4	11,897	248	12,145	607
Transportation Case 2	3,455	75	4	23,298	248	23,545	1,177
Transportation Case 3	6,909	75	4	46,098	248	46,346	2,317
Transportation Case 4	6,909	377	20	48,087	1,239	49,325	2,466

Costing for the EV charging stations were based on average costs of $2,000 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, conduits, electrical cable runs and installation. These average costs were obtained from major supplies in Canada (ChargePoint, Switch Energy, & Flo). Approximately 35% and 15% of these costs are associated with charging station equipment and installation for residential and non-residential spaces, respectively, which the GDS indicates are to be borne by individual owners. The remainder of these costs are associated with the conduits, and electrical cable installation which are incurred to the developer.

This equates to $1,300 for level 2 residential chargers, $1,700 for level 2 non-residential and $42,500 for level 3 non-residential chargers. Based on the GDS requirements to make buildings EV-Charger ready, this results in a total of **$9,278,572**. Major suppliers have suggested that there is a factor of economies of scale that exists when chargers are installed in larger quantities. This value varies between suppliers and would be determined at the time of procurement as it is based on market demand. Networking opportunities also exist in which chargers are connected to a central plant to reduce the energy required to operate the individual chargers.

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.

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

In terms of emissions, **Transportation Case 4** would fully eliminate Scope 3 tailpipe emissions from the proposed community, however, **Transportation Case 4** also increases the energy demand and carbon emissions by 306% or 4.1x over **Transportation Case 1**.

4.3.2 Personal Vehicle GHG Reductions (Scope 3 Emissions)

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

For the purpose of this analysis, an average trip distance of 3.4 km was assumed. This is the approximate distance between Old School Road, bounding the north of the site, and Mayfield Road, bounding the south of the site. It was also assumed that 1 gallon of gasoline provides a personal vehicle with approximately 25 miles, or 40.2 km of travel. Additionally, a tailpipe CO_2 emission factor of 8.887 kg / gallon of gasoline is used, where tailpipe emissions are the product of fuel combustion from a tailpipe of a vehicle (EPA, 2023). Transportation or tailpipe emissions are a Scope 3 GHG emission, which are emissions that result from the activities of the community during operation (National Grid, 2023).

BA Consulting Group provided a forecasted trip generation within their transportation study, as shown in **Table 16**. Based on forecasted trip values and the assumptions and GHG emission factor above, approximately 6,817 kg of daily CO_2e were estimated for the **Business-As-Usual Scenario**.

Table 16: Estimated Future GHG Emissions from Personal Vehicles for the Secondary Plan Area (Business-As-Usual Scenario)

Types of Trips	AM Trips	kg of CO_2e
Residential Trips	4,050	3,042
Types of Trips	**PM Trips**	**kg of CO_2e**
Residential Trips	5,025	3,775
	Total kg of Daily CO_2e	6,817

A study on active transportation conducted by the Victoria Transport Policy Institute in British Columbia suggests that active transportation can reduce automobile trips by 5% to 14% (Litman, 2023). This could provide a daily GHG reduction of between 341 kg to 954 kg of CO_2e.

The largest reduction in transportation GHG emissions can be achieved via the use of electric vehicles as they do not have any tailpipe CO_2 emissions (EPA, 2023). Transportation Case 1 outlines the GDS requirements if all residential dwellings install and use EV chargers, which amounts to approximately 96% of the development having chargers. Provided that electric vehicle uptake corresponds with charger availability, this can be extrapolated to a 96% reduction in daily GHG emissions of 6,548 kg of CO_2e.

Should the proposed development move forward with implementing 100% of EV chargers, and assuming all community members make use of the chargers by owning EVs, 100% of tailpipe emissions will be reduced. As discussed in **Section 4.3.1,** the implementation of EV charging infrastructure and maintenance comes at a high cost and electrical demand and should be considered when determining whether this strategy should be included within the Mayfield Tullamore Secondary Plan Area.

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

4.4. Roadmap to Near Net Zero Discussion

Table 17 and **Table 18** summarize the Near Net Zero Scenario, a potential lower carbon development pattern. This scenario incorporates strategies to achieve additional energy and carbon emission reductions beyond the **Baseline Scenario**. The percentage of individual reduction was calculated by using the individual measure reduction potential over the total reduction potential value.

Table 17 : 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		
114.2	-14.2	-11.7	-16.2	-1.1	-43.3	72.0
% of individual reduction	12%	10%	14%	1%	38%	

Table 18: Estimated GHGI Reduction Potential

Baseline Scenario GHGI [$kgCO_2e$ /m²]	Reduction Strategies [$kgCO_2e$/m²] Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures	Total Reduction Potential GHGI [$kgCO_2e$ /m²]	Near Net Zero Scenario GHGI [$kgCO_2e$ /m²]
8.9	-1.7	-0.4	-4.6	0.0	-6.7	2.2
% of individual reduction	19%	4%	51%	0%	75%	

Table 19, **Figure 14,** and **Figure 15** 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 19: 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]	197.1	114.2	72.0	63%	37%
GHGI [kgCO2e/m²]	25.9	8.9	2.2	92%	76%

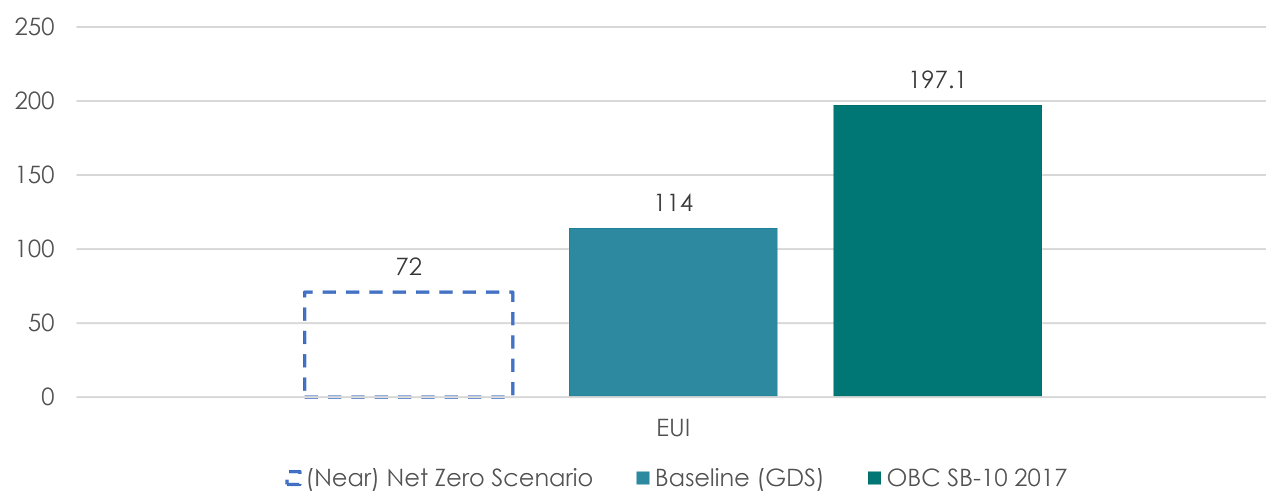


Figure 14: Estimated EUI Reduction Potential Comparion to OBC and Baseline Scenario

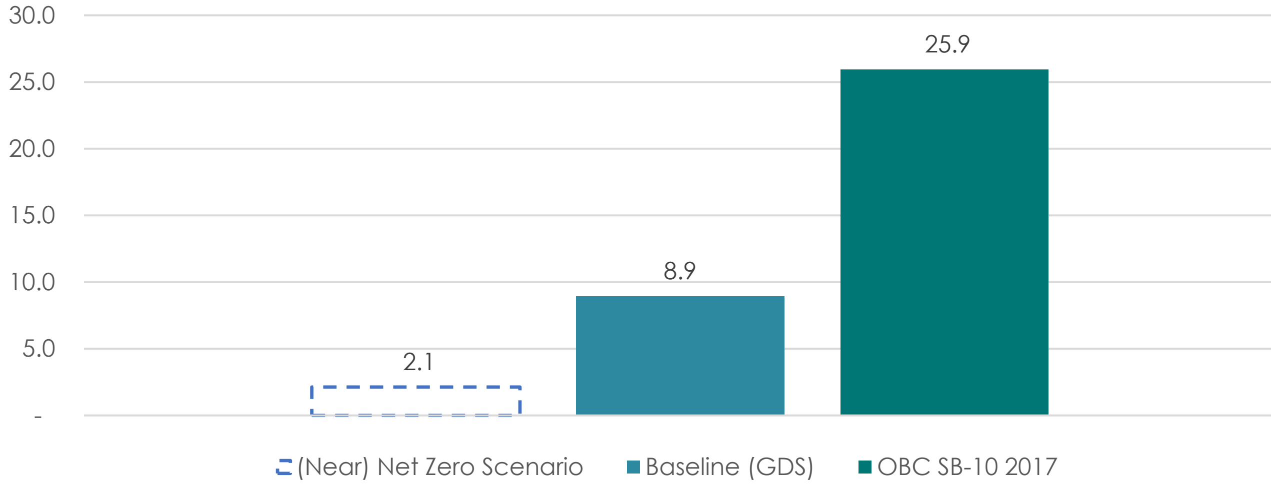


Figure 15: Estimated GHGI Reduction Potential Comparion to OBC and Baseline Scenario

The **Near Net Zero Scenario** demonstrates a potential pathway to near net zero carbon emissions for the Mayfield Tullamore Secondary Plan Area, which is visually presented in **Figure 16** and **Figure 17** showing how each considered viable strategy reduces the energy and carbon emission demand.

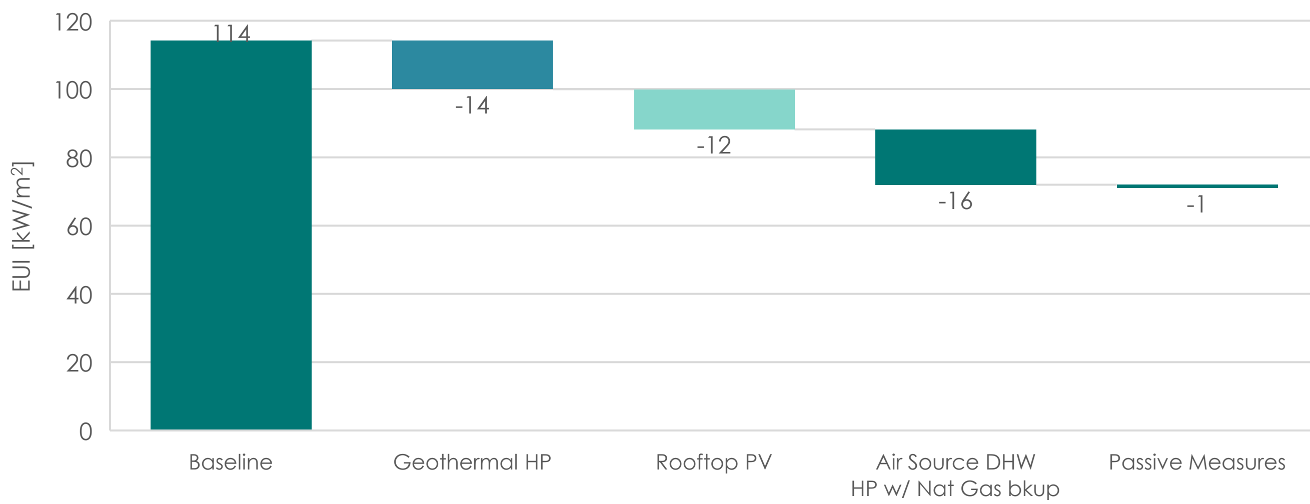


Figure 16: Energy Use Intensity Reduction Roadmap demonstrating EUI reduction potential

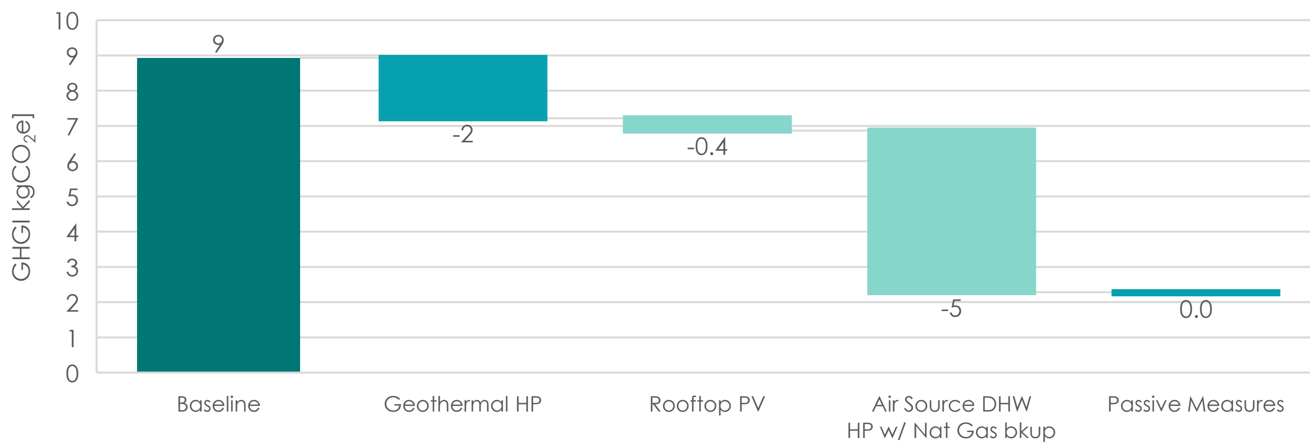


Figure 17: Greenhouse gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

Therefore, the **Near Net Zero Scenario** as modeled achieves an EUI of 76.8 kWh/m² and a GHGI of 2.3 kg CO2e/m². This represents 34% 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 **$159 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 **$24.7 million**. Passive measures are not reflected in this cost estimate as they are site dependent and will vary throughout the implementation process.

Table 20 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 20: 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	$1,657,278,586	$229,965,000
Solar Rooftop PV	$1,740,997,808	$313,685,000
Air Source DHW HP w/gas backup	$1,516,397,746	$89,085,000
Near Net Zero Scenario Total Cost	**$2,087,803,433**	**$632,735,000**

5. Implementation

Implementation of the proposed energy conservation and emissions reduction strategies within the Mayfield Tullamore Secondary Plan Area will require a range of actions at key milestones in the planning and development process. These are outlined in **Table 21.**

Table 21: Items For Implementation of the Near Net Zero Scenario

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

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 (e.g., heat pumps and solar photovoltaics).	N/A	Site Plan	None
4: Electric Vehicle Infrastructure			
The Landowners Group shall engage with the Town of Caledon to discuss and confirm electric vehicle charging capacity and infrastructure requirements (per building type).	Green Development Standard	Official Plan Amendment	Town of Caledon
The Landowners Group shall implement electric vehicle charging capacity and infrastructure requirements (by building type) based on agreed upon metrics with the Town of Caledon.	Green Development Standard Architectural & Urban Design Guideline	Draft Plan	Town of Caledon Hydro One Networks Inc.
The Landowners Group shall liaise with utility providers to confirm the total electrical demand requirements for the Secondary Plan Area for electric vehicles based on the standards and requirements agreed upon with the Town of Caledon.	N/A	Official Plan Amendment	Town of Caledon Hydro One Networks Inc.

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 Mayfield Tullamore 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 the Mayfield Tullamore Secondary Plan Area.

The results of the analyses conducted demonstrated EVs and their associated infrastructure requirements are expected to impose a significant electricity demand at their assumed usage. Average installation and material costs suggest that it would cost approximately $9.3 million to install electrical wiring and infrastructure at buildings to make EV-charger ready, as per the GDS minimum requirements. A factor of economies of scale exists for this installation, however, this will be determined at the time of procurement. It is not feasible to offset the expected electrical demand on-site through active or passive measures, and therefore electric vehicle charging demand was considered separately from the **Near Net Zero Scenario**.

District-scale energy generation is potentially feasible within the denser development in Mayfield Tullamore Secondary Plan. Combined, the Neighbourhood Centres and Urban Corridors are 1,937,130 ft2 in total. Based on the density and square footage of these proposed subareas, they were evaluated for feasibility of district-level energy systems.

The **Near Net Zero Scenario** achieves an EUI of 72 kWh/m^2 and a GHGI of 2.2 kg CO2e/m^2. This represents 37% 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 **$2.1 billion**, based on the Class D cost estimate conducted. The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$632.7 million**.

Implementation of the strategies associated with the **Near Net Zero Scenario** would enable the Mayfield Tullamore 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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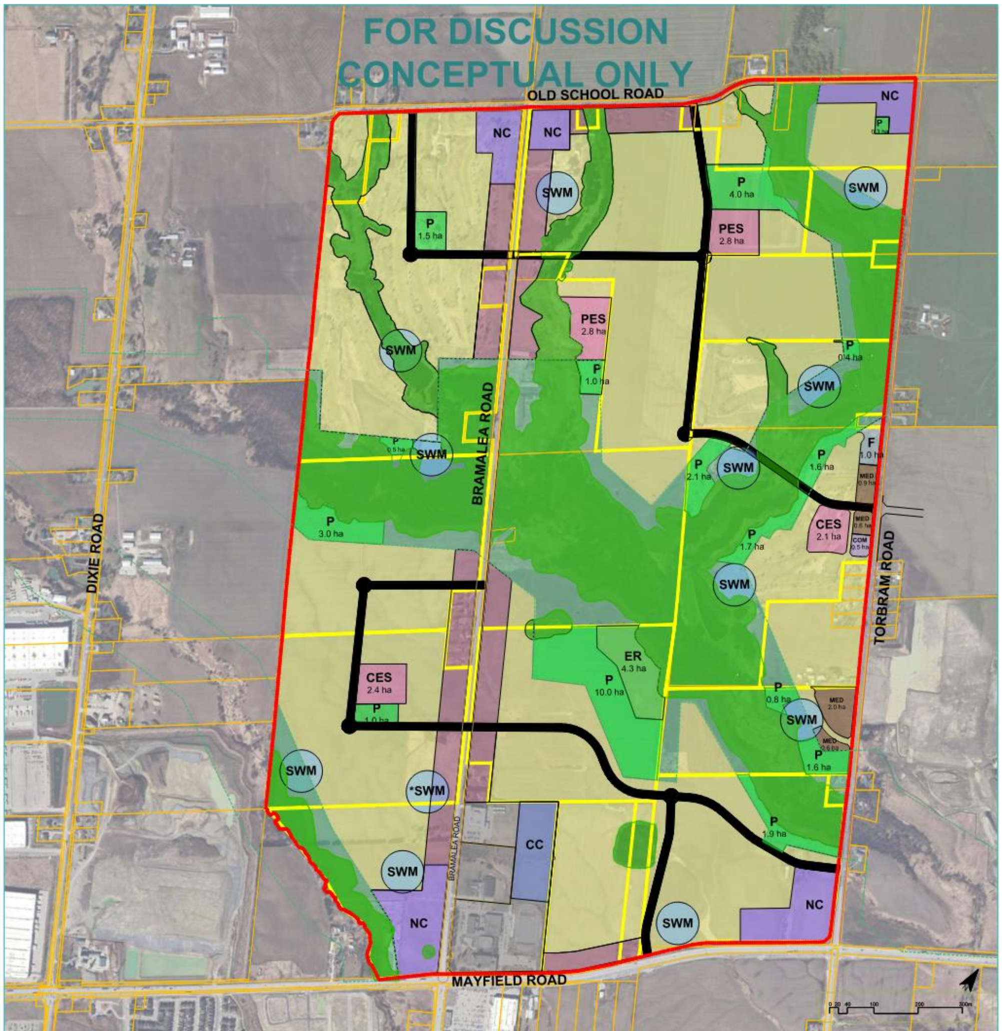
Appendix B. Site Plan and Statistics



MAYFIELD TULLAMORE LAND OWNERS GROUP — STRUCTURE PLAN-PREFERRED OPTION

LAND USE	AREA OUTSIDE GB	AREA WITHIN GB	TOTAL
Community Area	266.6	0.0	**266.6**
Medium Density	3.9	0.0	**3.9**
Urban Corridor	32.3	0.0	**32.3**
Neighbourhood Centre	20.6	0.0	**20.6**
School	10.2	0.0	**10.2**
Community Centre	0.0	0.0	**0.0**
Park	6.3	24.6	**30.9**
Open Space	25.6	161.6	**187.2**
Existing Schools and Rec & Community Centre	20.0	0.0	**20.0**
Environmental Restoration	0.0	4.3	**4.3**
Collector Roads	21.3	0.7	**22.0**
Existing Bramalea Road	11.0	0.0	**11.0**
TOTAL	**417.8**	**191.2**	**609.0**

SWM Stormwater Management Facility
* Provisional SWM

TRAILS
Multi Use Trail
Multi Use Path

Note:
Natural Heritage features are not show as they are under study. The developable area is preliminary and requires further technical study to confirm the limit. As such, the developable area is subject to change.

MGP File No.: 24-3365
Date: July 30, 2024
Date or Air Photography: April 2024 Google

Figure B-1 Preffered Structure Plan Option for the Mayfield Tullamore Secondary Area (Malone Given Parsons Ltd., July 30, 2024)

Appendix C. Energy and Carbon Utility 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.

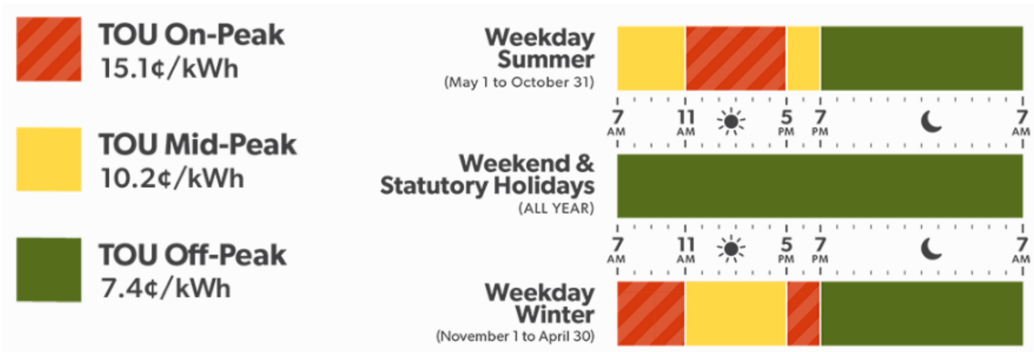


Figure C-1 – Hydro One Time-of-Use Rates Effective until October 31, 2023 (Hydro One, 2023)

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

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

Gas Consumption	Cost (cents/m^3)
First 30 m^3	65.8218
Next 55 m^3	65.0697
Next 85 m^3	64.4808
Next 170 m^3	64.0418

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 Modelling Considerations

Energy Modelling Considerations

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

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

Building Strategies and Technologies Assessed

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

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

Table D-1 - Low-Carbon Building Technologies Assessed

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

Appendix E. Evaluation of District Energy Systems

Should DES be chosen to be implemented within the dense areas of development centered around the Urban Corridors and Neighbourhood Centres within the Mayfield Tullamore Secondary Plan, which includes medium and higher density developments, the following analysis was carried out.

Geothermal Analysis

The medium and higher density archetypes' peak heating and cooling load for the Urban Corridors and Neighbourhood Centres subareas are estimated to be 2,100 kBTU/hr and 1,494 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 636 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 71,380 ft^2. This equates to approximately 3.7% of the medium and higher density development, indicating that there would be limited space restrictions and that the deployment of the system could be technically viable.

The cost per borehole was assumed to be $20,000 per borehole which enabled calculation of the total geothermal field cost. The cost of 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 $182,057,071.

Solar Photovoltaics Analysis

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

PV is extremely flexible in the context of spatial feasibility. The ideal location for a District style PV array would be near electrical substations and on/near public property/buildings with adequate space to accommodate a sizable array. Using PV panels as potential shading devices would allow for additional panel area. Based on the site statistics provided by the planning consultant (refer to section 2.1.1.), 5% of the parks, and 1% of the Public Elementary Schools lands, comprising a land area of 44,671 square feet, has been allocated for photovoltaic (PV) installation. The estimated annual energy production of approximately 799,786 kWh is calculated based on the solar radiation for the city of Caledon for each month of the year.

A district style solar PV system installed in Public Parks and Elementary Schools would allow for approximately 44,671 square feet of panel area, which is equivalent to mounting panels on roughly 2.3% 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 parks and schools relative to the denser development, a solar PV system is not well suited for the Secondary

Plan area. This style of system was therefore evaluated to be infeasible due to the large space demands and the small contribution to meeting energy needs.

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 $191,253,986.

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 E-1** below.

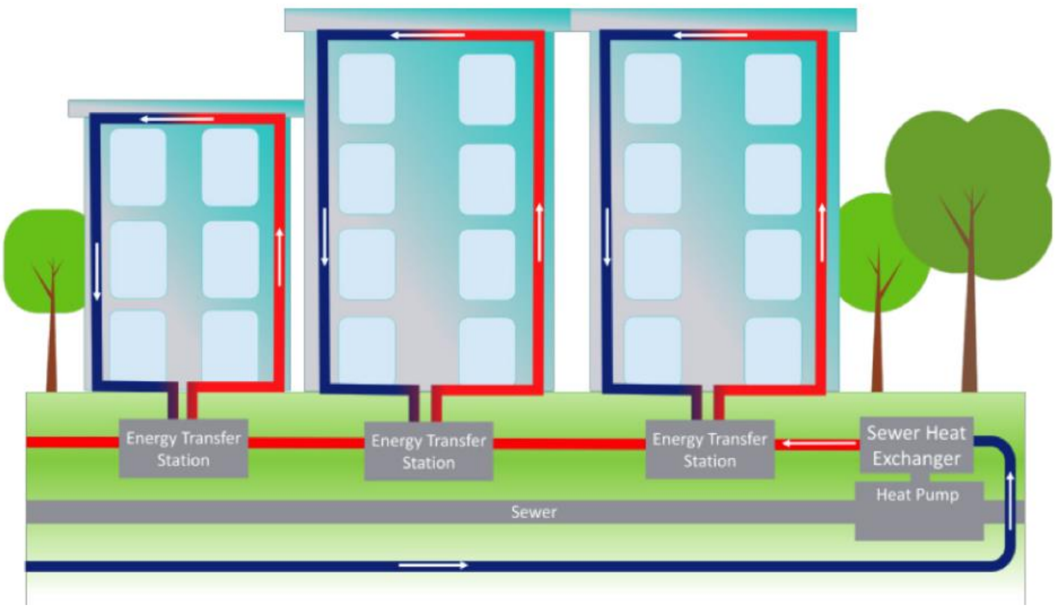


Figure E-1: DES Schematic of Wastewater Heat Recovery (City of Toronto, 2017)

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

To evaluate and demonstrate the feasibility of utilizing a wastewater heat recovery DES for the medium and higher density dwellings of the Urban Corridors and Neighbourhood Centres, 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

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

- Population – 25,100 (as per land use statistics provided by MGP)
- Jobs -2000 (as per land use statistics provided by MGP)
- Annual days of operation – 365 days
- Washroom flush rate- 1.6 GPF*
- Urinal flush rate-1 GPF*
- Public lavatory flow rate- 0.5 GPM*
- Lavatory faucet flow rate- 2.2 GPM*
- Kitchen faucet flow rate-2.2 GPM*
- Showerhead flow rate-2.5 GPM*

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

Required wastewater generation to meet DHW load demand

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

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

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

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

From the energy modelling results the condenser energy (Qh) of this cycle is obtained, and it is estimated to be around **6,898,798.02 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 **4,139,278.81 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 **190 million gallons/ year.** The overall analysis summary is summarized in the **Table E-1** below.

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

Wastewater Factor	Projected Flow Rates
Total wastewater generated	239,564,594 gallons/year
Total wastewater required	190,046,888 gallons/year

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

The approximate NPV cost of implementing this system in the neighborhood Centre would be $167,633,986.

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

DES Result Summary

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

Table E-2: DES Anlaysis Results

System	Infrastructure Required (Enbridge, 2025)	Considerations	Estimated Cost (Subareas)
Geothermal Pumps System	636 boreholes and 71,380 ft² land area for Urban Corridors and Neighbourhood Centres	• 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	$182,057,071
PV Array (District Level)	33,907 ft² of Public Parks and 10,764 ft² of Elementary Schools (44,671 ft² in total)	• Low energy generation potential • Location of PV arrays and racks are limited to publicly owned property • Metering/financing considerations for owners/operators	$191,253,986
Sewage Waste Heat Recovery	25,405,598 ft³ cistern volume for Urban Corridors and Neighbourhood Centres	• Can only serve DHW loads • Access to available sanitary waste matter streams • Metering/financing considerations for owners/operators	$167,633,986

Appendix F. Energy and Carbon Analysis Results

Energy

Low-Rise Residential

Figure F-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 street 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, wastewater heat recovery DHW measure gives 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. 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 87%).

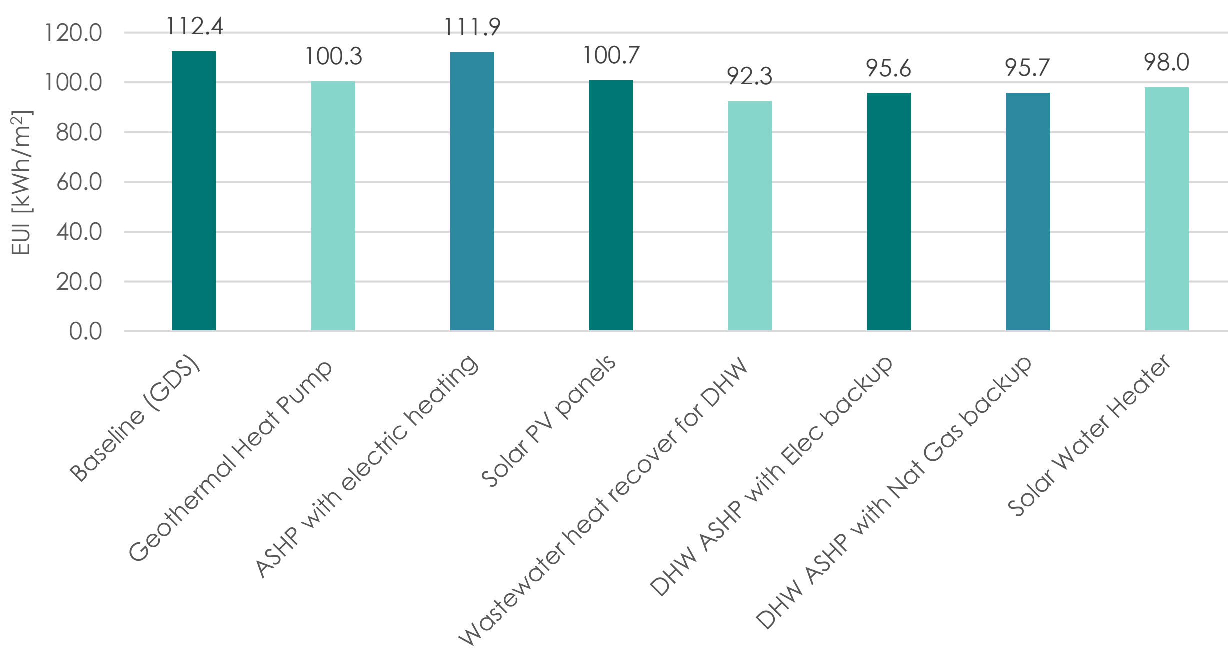


Figure F-1 – EUI Results for Low-Rise Residential

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

Medium and higher density stacked townhomes and apartments fall under this archetype. Heating measures are as effective as domestic hot water measures for this archetype, the reason being gas based traditional HVAC system in baseline. Note that solar has 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. Geothermal heat pumps were the best performing measure with approximately 21% in energy savings as observed in **Figure F-2**

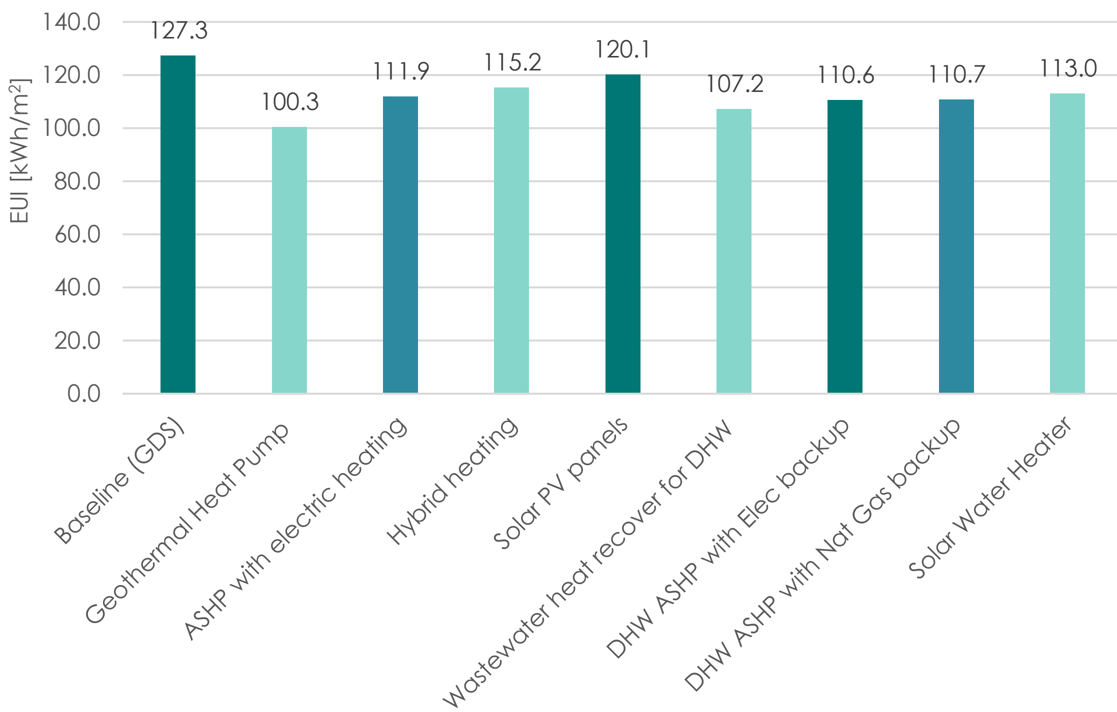


Figure F-2 – EUI Results for MURBs (≤6 storeys)

Commercial

The commercial services and retail fall under this archetype category. Geothermal and Solar PV panels were the best performing measure with an estimated 27% energy savings as observed in **Figure F-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.

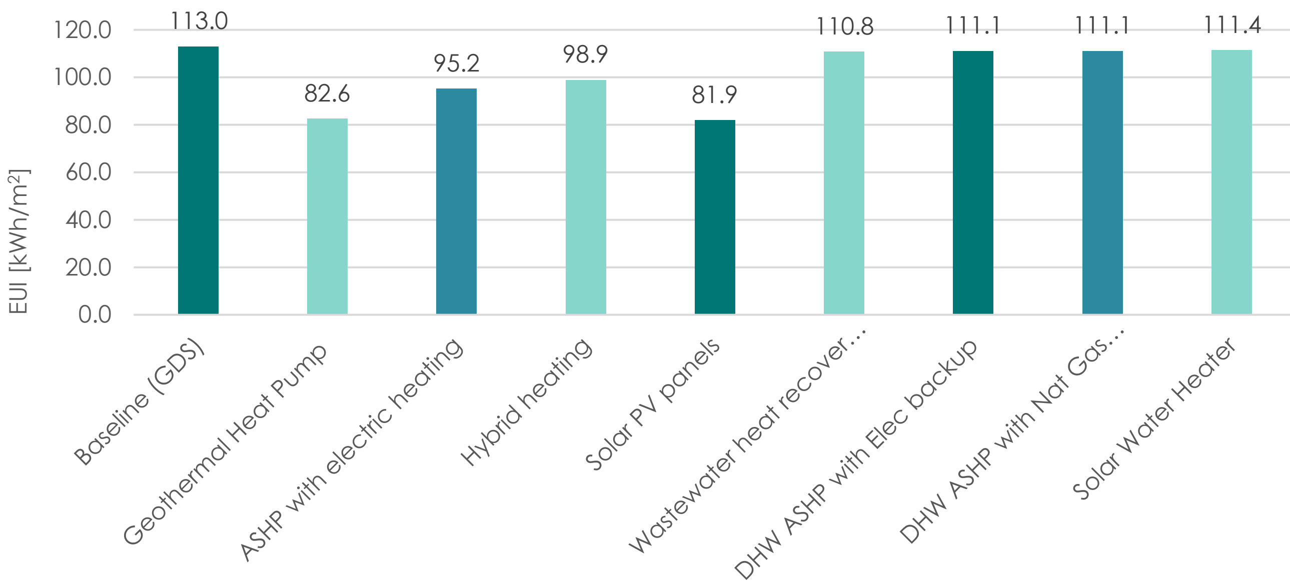


Figure F-3 – EUI Results for Commercial Retail

Schools

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

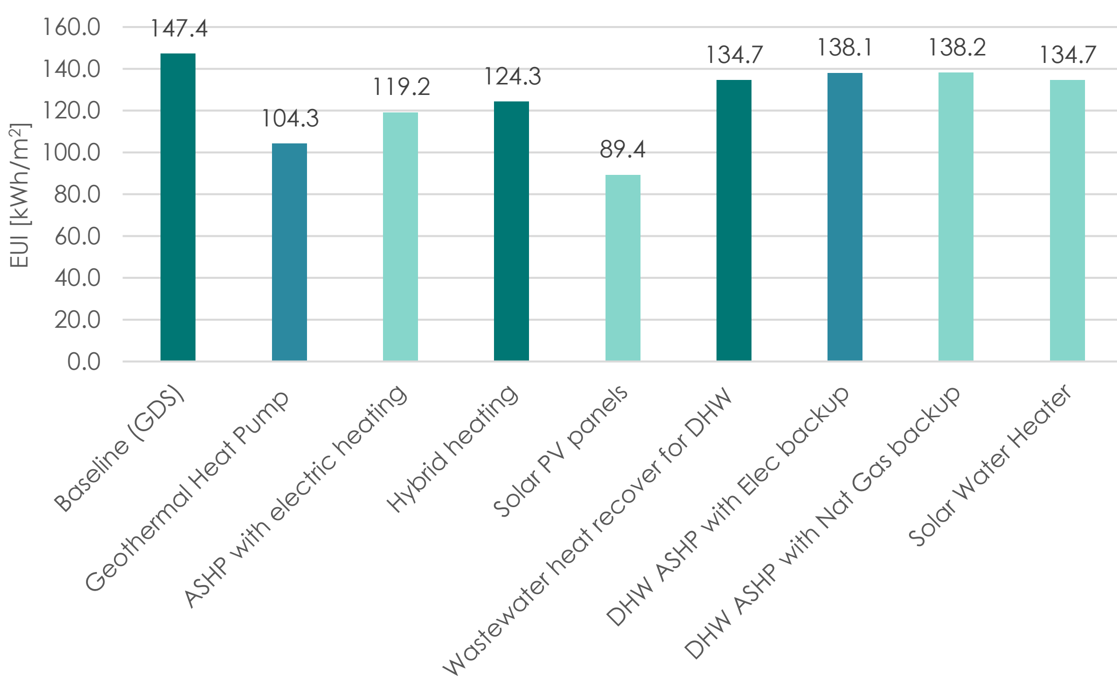


Figure F-4 – EUI Results for Schools

Carbon

The emissions factor used to calculate GHGI emissions are-

- Electricity- 0.03kgCO2e/kwh
- Natural Gas- 1.899 kgCO2e/m3

Low-Rise Residential

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

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

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

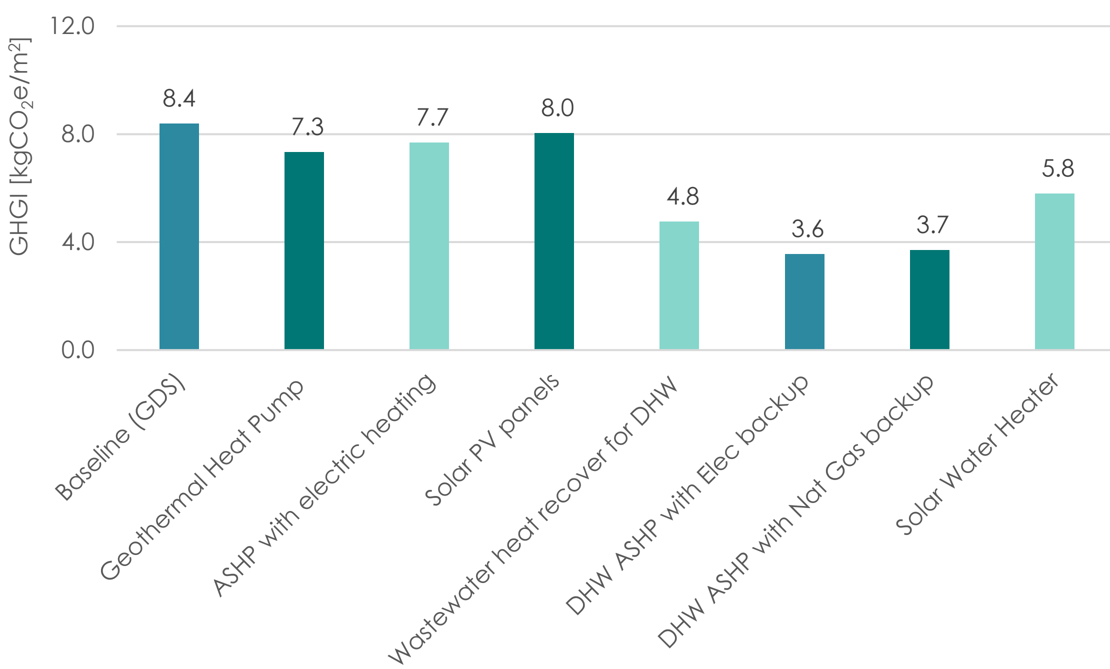


Figure F-5 – GHGI Results for Low Rise Residential

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

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

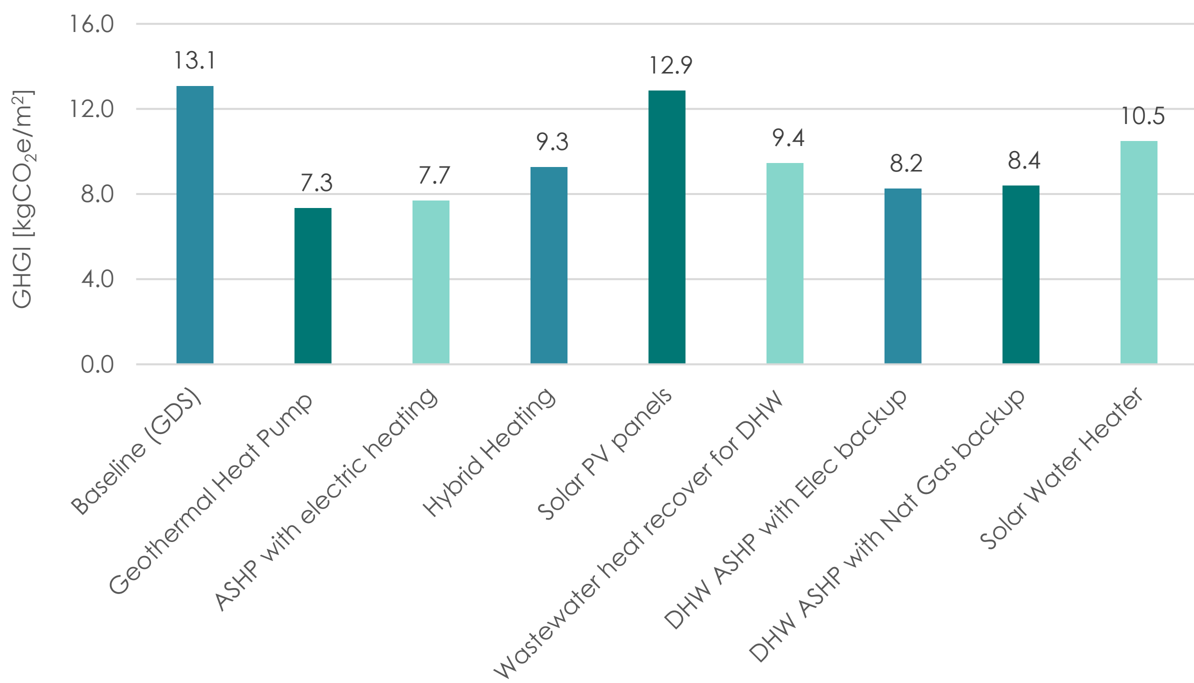


Figure F-6 – GHGI Results for MURBs (≤6 storeys)

Commercial

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 F-7** below. Among these measures, geothermal heat pumps offered the greatest reduction potential, with an expected reduction of approximately 69%.

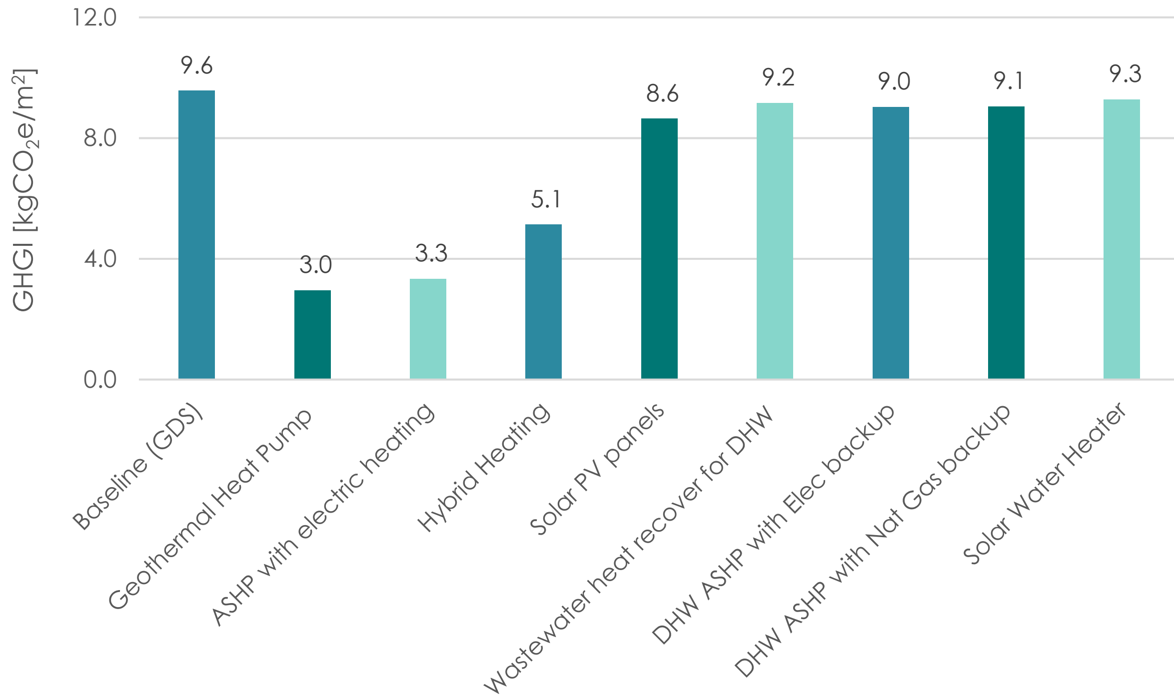


Figure F-7 – GHGI Results for Commerical Retail

Schools

For reasons similar to the commercial services and retail archetypes, the school archetype offers greater scope for improvement through heat pump-based measures. Consequently, geothermal heat pumps could achieve an estimated 62% reduction in GHGI, as observed in **Figure F-8** below.

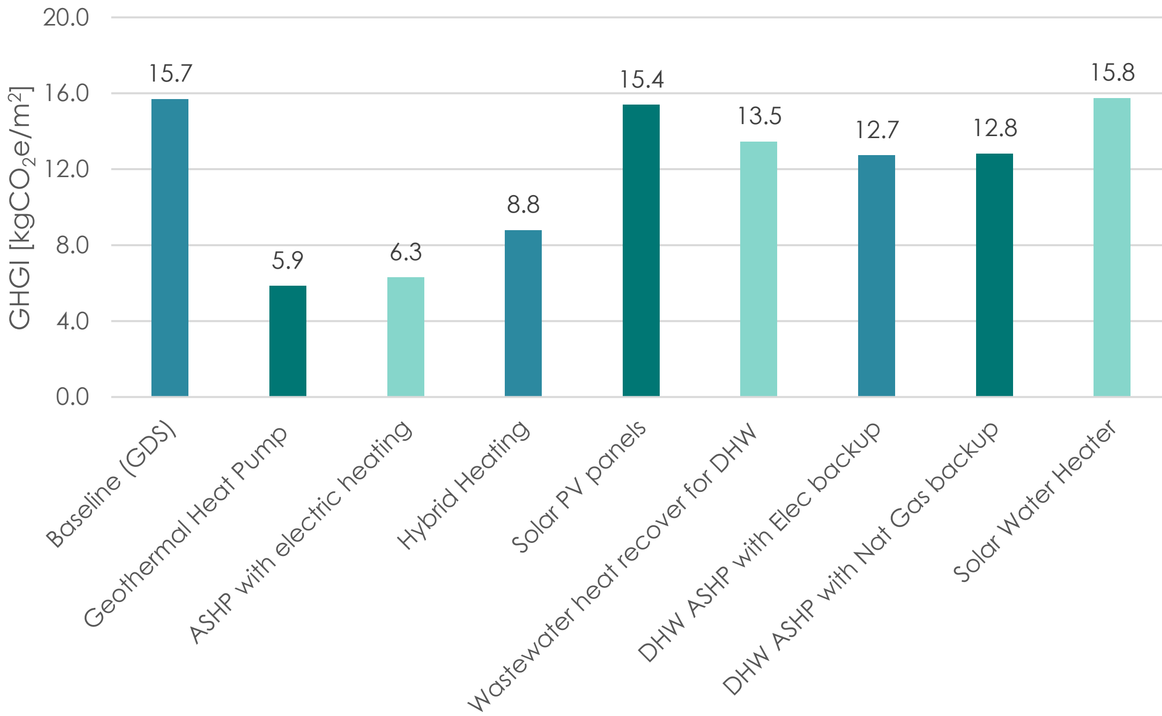


Figure F-8 – GHGI Results for Schools

Appendix G. 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 G-1** outlines the total cost/ft^2 for each building type.

Table G-1: Total Capital Cost Per Building Type

Building Type	Low-rise	MURB (≤ 6 stories)	Commercial	School
Total cost/ft^2	288	317	265	374

Air Source Heat Pump

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

Table G-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 19,120 kBTU/hr and 13,567 kBTU/hr, respectively, making the site dominated by heating loads. To meet this demand, approximately 5,794 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 G-3** outlines rooftop solar capital cost calculations.

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

	Metric	Cost
Panel	150 W	$458
DC to AC inverter	5,500 W	$3,208
Rack/panel	-	$41
Roof area:	809,828.5 m²	-
PV Area	404,914.2 m²	-
Total Size of PV system	60,858,610 W	-
Number of Panels	405,724	-
Amount of inverter	11,066	-

Wastewater Heat Recovery

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

Table G-4: Total Capital Cost of the system

cost/kW	$1,053,
Peak Load	758 kW
Total Cost	$ 631,141,687

ASHP DHW Heater

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

Table G-5: Total Capital cost for the system

cost/kW	$1,137
Peak Load	19,698 kW
Total Cost	$584,397,910

Solar Water Heater

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

Table G-6: Total Capital of the system

cost/kW	$1,932
Peak Load	19,698 kW
Total Cost	$600,070,149

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

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

Heat Pump Options	Energy Demand (kW)
Baseline	45,900
Geothermal HX	45,900
Air Source HP	68,850
Hybrid HP	47,871

Futureproofing HVAC Systems

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

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

    - Allocate power for the low-carbon heating source - A reasonable estimate is to double the power allocated to the cooling plant to account for the lower efficiency. When a similar technology is producing beneficial heat.

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

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