Wildfield Village Secondary Plan Area

Community Energy and Emissions Plan

Town of Caledon, ON

Prepared for: Wildfield Village Landowners Group Inc.

Project No.: PR-24-024

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Pratus Group Inc.

Pratus

Issuance Approval

Prepared by:	Reviewed by:	Approved by:
Zaid Khan, M.Eng.	Eric Dunford, M.Sc., MBA	Oleksandra Onisko, P.Eng.
Simonne Varela, M.Eng., EIT	Chris Mohabir, P.Eng	
Ryan Hewat, B.Eng.		

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1.0	September 9, 2024	Draft for Internal Review	Zaid Khan, Simonne Varela, Ryan Hewat	Eric Dunford, Chris Mohabir	Oleksandra Onisko
2.0	November 18, 2024	Issued for Secondary Plan Submission	Zaid Khan, Simonne Varela, Ryan Hewat	Eric Dunford, Chris Mohabir	Oleksandra Onisko

Limitations

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

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1. Executive Summary

Pratus Group Inc. was retained by the Wildfield Village 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 Wildfield Village Secondary Plan Area located in the Town of Caledon, Ontario. The purpose of this study was to:

- Assess the anticipated energy requirements for the Secondary Plan Area based on prevailing development requirements for new building construction in the Town of Caledon (termed the **Baseline Scenario**)
- Identify strategies to improve energy conservation and reduce emissions within the Secondary Plan Area in alignment with the Town of Caledon's community-wide emissions reduction objectives (termed the **Near Net Zero Scenario**)
- Assess the viability of community-based energy generation systems for subareas of the proposed Secondary Plan Area
- Outline future actions that would contribute to energy conservation and reduced emissions and promote successful implementation of the strategies proposed in the **Near Net Zero Scenario**

The proposed Wildfield Village Secondary Plan Area is 356 hectares, with 189 hectares consisting of land that is allotted to be developed as new buildings. The Plan Area as currently envisioned is expected to be primarily low-rise residential with some areas of denser development. Denser development is proposed at the southwest corner of the site (identified as the Neighbourhood Centre), and along the primary transportation corridors (identified as the Urban Corridor). The proposed building mix for the planned community includes freehold townhouses, detached homes, and medium density condos with an estimated total gross floor area of approximately 1,551,205 m^2.

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

Building Energy Systems Assessed

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

Transportation Systems Assessed

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

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

Under **Transportation Case 1**,a minimum number of EV chargers based on dwelling type and population was modeled based on the requirements of the Town of Caledon GDS. For **Transportation Case 2**, it was assumed that 100% of the residential and non-residential parking spaces would be equipped with EV chargers. While the GDS solely requires that homes be EV-ready, modeling necessarily considered the peak use case (e.g., it was assumed that all homes with charging infrastructure would install a charger).

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 styles identified by the project owner and planning team. The relative energy and carbon emissions performance of the archetypes modeled are illustrated in **Table 1.** In terms of energy performance, like-for-like system efficiencies are comparable whether looking at energy systems on a local or district level as the technologies used for heating, cooling or energy production adhere to the same operating principles. For the purpose of this study, the **Near Net Zero** energy system improvements were modeled to be implemented across all building archetypes.

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

Category	Archetype	Baseline Design	Net Zero Design (Improvements over Baseline)	% Savings over Baseline	
				Energy	Emissions
Residential	Detached Homes & Townhouses	3 season air source heat pump (ASHP) with natural gas backup	Installation of solar photovoltaic panels, geothermal heat pump system for HVAC, and upgradation of domestic hot water to ASHPs with natural gas back up from 100% gas and passive measures	37%	75%
	Stacked Townhomes & Apartments	Constant volume corridor make-up air unit (MUA) and constant volume in-suite ventilators served by condensing boilers and chillers		39%	82%
Commercial	Commercial - Retail	Fan coil units (FCUs) / Dedicated Outdoor Air Systems (DOAS) served by condensing boilers and chillers		45%	81%

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

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 considered for the **Near Net Zero Scenario**, based on their potential energy and emissions performance as identified by the analyses conducted. The energy use and greenhouse gas intensity reduction potential between the Baseline Scenario and the Near Net Zero Scenario is shown in **Table 2** and **Table 3**, respectively.

Table 2 : Estimated EUI Reduction Potential

Baseline Scenario EUI [kWh/m^2]	Reduction Strategies [kWh/m^2]				Total Reduction Potential EUI [kWh/m^2]	Near Net Zero Scenario EUI [kWh/m^2]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
114	-14	-11	-17	-1	-43	72
% of individual reduction	12%	10%	15%	1%	37%	

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	-0.33	-4.7	-0.03	-6.8	2.1
% of reduction	18%	4%	52%	0%	76%	

The results of the analyses conducted demonstrated that adoption of electric vehicles in the Secondary Plan Area will impose a significant increase in electrical demand . Approximately 50 MW of electricity for **Transportation Case 1** and 51 MW for **Transportation Case 2**, representing additional capital cost requirements of approximately $7.6 million for Transportation Case 1 and $8.0 million for Transportation Case 2 respectively. These costs solely represent the anticipated cost for EV charging stations required and do not include estimated costs for any additional electrical infrastructure such as higher capacity transformers or sub-stations. It is not feasible to offset this increased electrical demand with low-carbon community energy sources within the Secondary Plan Area due to the magnitude of the demand. Therefore, electric vehicle charging demand was considered separately from the **Near Net Zero Scenario**.

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

Table 4 and **Figure 1** 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. Referencing the prevailing Ontario Building Code offers context for the energy requirements of the Town of Caledon's GDS as compared to other municipalities in Ontario that do not have their own standard. As shown, the Town of Caledon GDS requirements are significantly more stringent than OBC, meaning that the Baseline Scenario represents significant energy conservation and emissions reduction over the provincial code.

Table 4: Estimated EUI and GHGI Reduction Potential 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	114	73	63%	36%
GHGI [kgCO2e/m²]	26	8.9	2.2	92%	75%

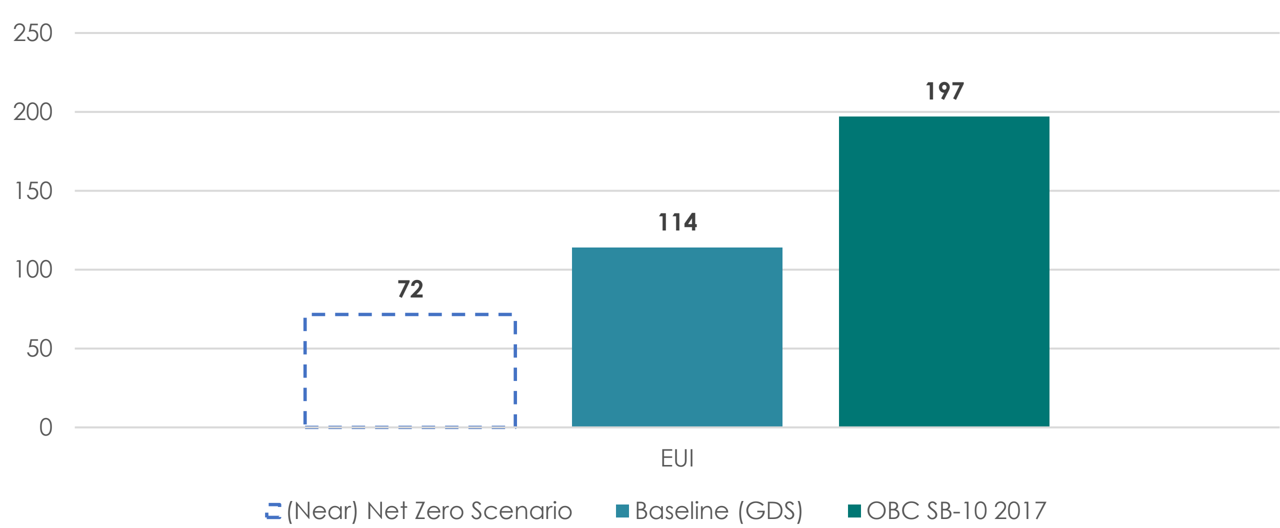


Figure 1: Estimated EUI Reduction Potential Reduction Potential Comparison to OBC and Baseline Scenario

The **Near Net Zero Scenario** demonstrates a potential pathway to achieving a low-carbon development within the Plan Area that nearly achieves net-zero carbon emissions for the Wildfield Village Secondary Plan Area. This potential roadmap is shown in **Figure 2** and **Figure 3**.

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.

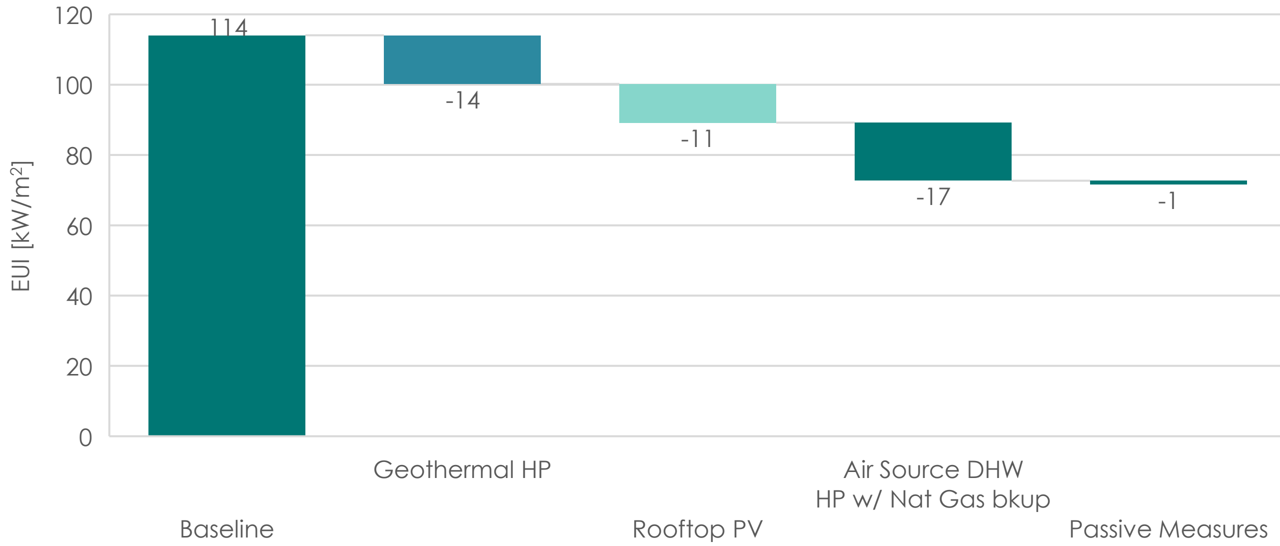


Figure 2: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential

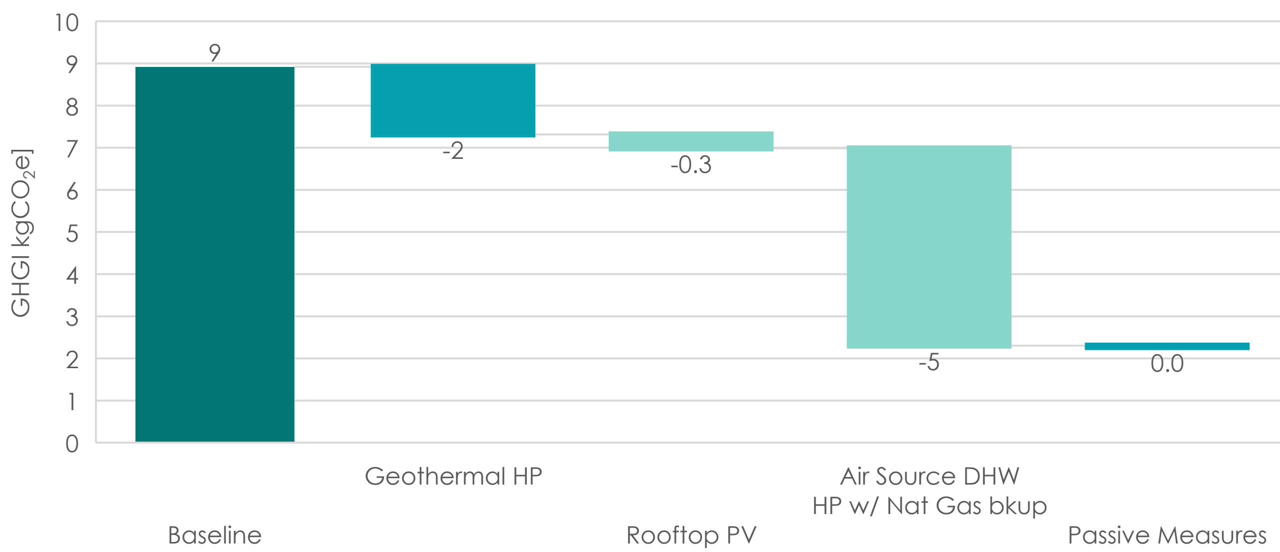


Figure 3: Greenhouse Gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

District Energy System Considerations

District energy systems (DES) rely on high building density and supporting infrastructure to be viable community energy systems. These systems are better suited to service medium to high-density developments greater than one million square feet in total serviceable area.

DESs are not viable options for low-rise residential buildings due to the extensive infrastructure required to implement DES within such dwellings, leading to additional costs. The Secondary Plan Area includes subareas (the Neighbourhood Centre and Urban Corridor) that encompass medium density dwellings and the feasibility of district systems were explored for these subareas.

It was determined that DES may be feasible in the Neighbourhood Centre if one of the following conditions are met:

- Planned medium to high density developments within the Urban Corridor are consolidated around the already dense Neighbourhood Centre, which would create a compact zone improving the feasibility of implementing a district system from both a technical and financial standpoint.
- Increased density (e.g., through increased building heights) within the Neighbourhood Centre.

Geothermal heat exchange was assessed as the most viable system based the site development areas. Solar Photovoltaic and Sewage Wastewater heat exchange systems were also explored, but the geothermal systems is recommended over these systems as it offers advantages in relative cost benefits and ease of integration across the site.

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 75% of the GHG emissions associated with the proposed building developments in the Wildfield Village Secondary Plan Area. This exceeds the Town of Caledon's target of 36% GHGI reduction by 2030 for community-wide emissions.
- The incremental capital cost of implementing these technologies over the requirements of the Town of Caledon Green Development Standard is estimated to be approximately $458M 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 $2.4 billion based on the Class D cost estimate conducted, which is approximately $ 0.7 billion greater than the baseline NPV.
- The increased electricity demand posed by the proposed electric vehicle charging requirements cannot feasibly be met through on-site generation within the Secondary Plan Area and was therefore excluded from the **Near Net Zero Scenario**.
- District-scale energy generation is potentially feasible within the dense Neighbourhood Centre and Urban Corridor subareas, which was estimated to be more than one million square feet. Consolidating the medium density developments located within the Urban Corridor around the Neighbourhood Centre would improve the feasibility of implementing such a system. Alternatively, further densification of the Neighbourhood Centre would also increase the feasibility. Implementation of a district-level system would require additional detailed analysis as the planning process advances.
- While district energy systems can offer potential improvements in energy efficiency due to more favorable part load conditions, these improvements aren't entirely predictable nor are they necessarily significant (from an energy performance standpoint) when compared to a like-for-like system implemented at the building scale. It should also be noted that a DES provider requires roughly 3-5 years of engineering discussions and economic planning to successfully implement such a system. As a result, all proposed energy conservation and emissions reduction strategies reported here are at the building scale . It will be important to monitor and evaluate requirements for deployment of these strategies during future planning and approvals phases as planning and design of buildings within the Secondary Plan Area advances.

2. Introduction and Study Context

The Wildfield Village 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 Wildfield Village 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 Wildfield Village Secondary Plan Area development is planned for the southeast lands of Town of Caledon, Ontario as shown in **Figure 4**. The site boundaries are the planned Highway 413 development to the north, Mayfield Road to the south, The Gore Road to the east, and Centreville Creek Road to the west, as depicted in **Figure 5**. The conceptual plan for the proposed Secondary Plan Area incorporates the following land uses:

- Residential – including townhomes, detached homes, apartments, and stacked townhomes.
- Retail – includes commercial retail building archetype (located in the Neighbourhood Centre and Urban Corridor)

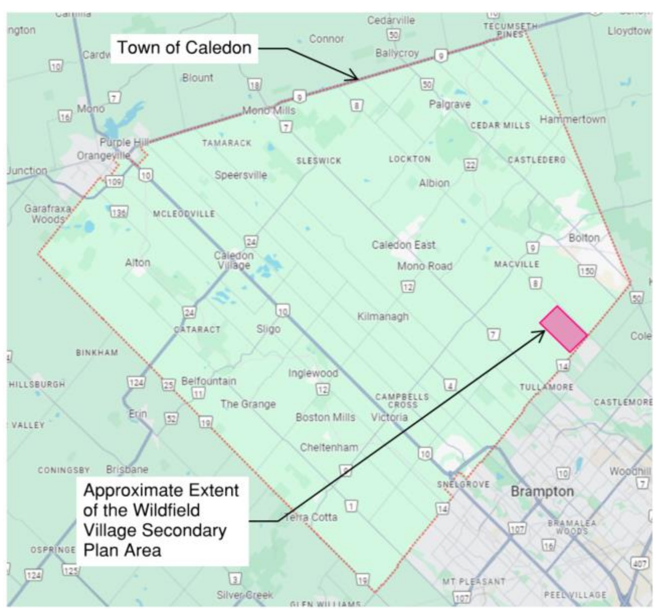


Figure 4: Approximate Extent of the Wildfield Village Secondary Plan Area in the Town of Caledon

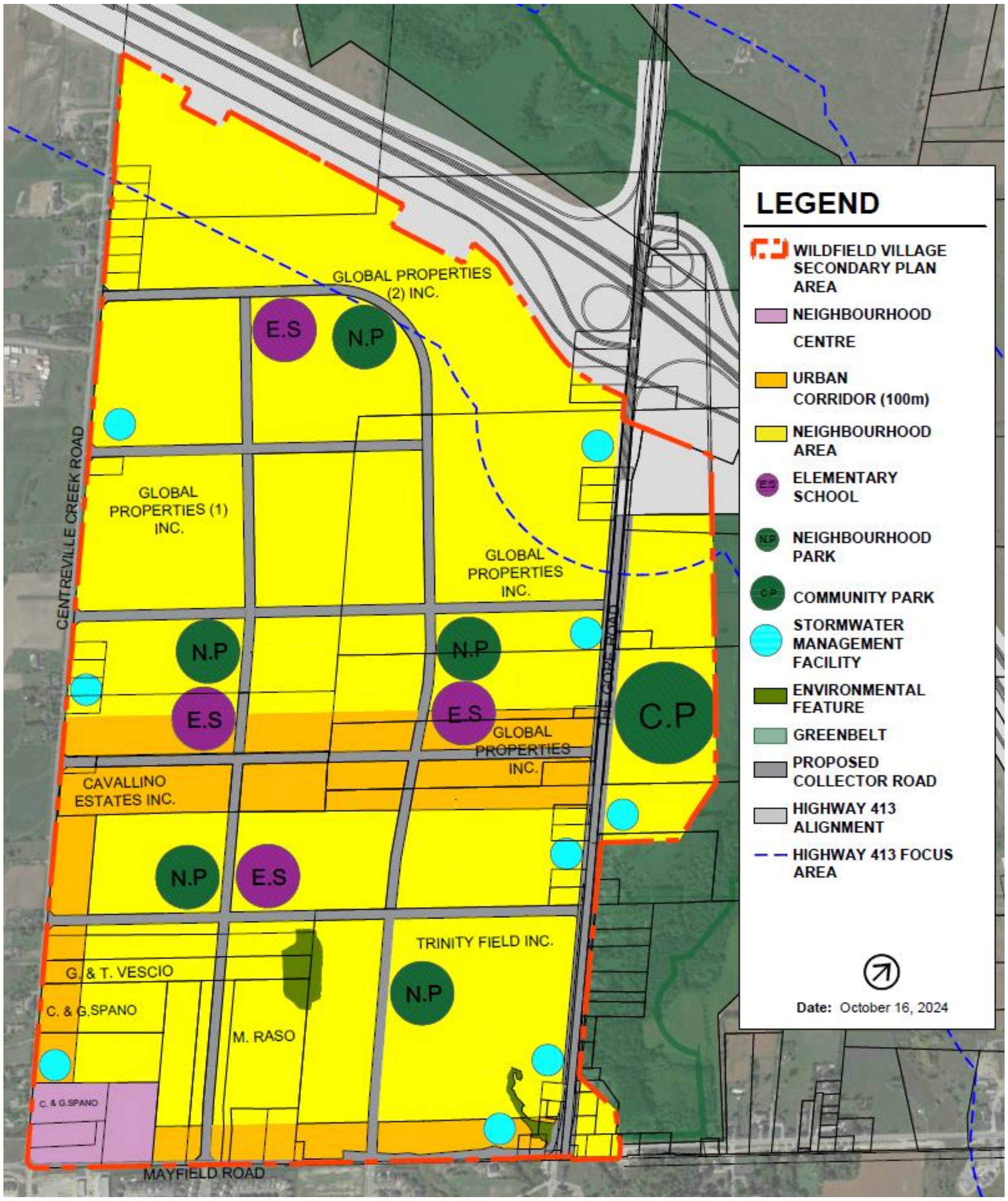


Figure 5: Proposed Conceptual Land Use Plan for the Wildfield Village Secondary Plan, October 16, 2024 (SGL Planning & Design Inc., 2024)

2.1.1. Demographics, Site Statistics and Building Types

The Wildfield Village Secondary Plan Area is proposed to include a land area of approximately 356 hectares of land with a mix of land uses. 189 hectares of the total land area is expected to be developed into new buildings at full build-out of the site.

Of the total 356 hectares of land, 167 hectares were excluded from community energy analyses conducted. These lands were excluded as they are not expected to support construction of residential and retail buildings. Areas were selected for exclusion based on their classification per the current land use policies and the proposed Land Use Plan.

Excluded areas include the following land use types:

- Natural Heritage System lands – 1.01 ha
- Roads (estimated to account for 30% of the net community area) – 32.22 ha
- Stormwater management facilities – 39.42 ha
- Neighbourhood parks – 10.12 ha
- Community parks – 4.00 ha
- Schools – 12.82 ha
- Vegetation Protection Zone – 66.53 ha

The proposed development plan for the community includes a variety of building types such as freehold townhouse, detached homes, stacked townhomes, apartments and retail buildings. The total gross floor area of the proposed development is approximately 1,551,205 m^2.

2.1.1.1. Details per Building Type

The current site consists of several land use profiles as described in the *Block Plan Concept with Ownership Stats* (See **Appendix A** for details). These building types and areas are listed in **Table 5** for reference. **Figure 6** shows a breakdown of the types of building within the Secondary Plan Area development.

Table 5: Wildfield Village Secondary Plan Area Building Type Descriptions

Residential Building Types – Total 185.3 ha / 7,546 units	
Low Rise (3 storeys or less)	**Mixed Used Residential Buildings (MURB) (<6 storeys)**
	
Low Density Residential – Detached – 172.4 ha / 5,950 Units	Medium Density Stacked Townhomes and Apartments – 12.9 ha / 1,596 Units

Non-Residential Building Types - Total 130.4 ha
Retail  Local commercial retail development, shopping malls, etc. - 4.04 ha

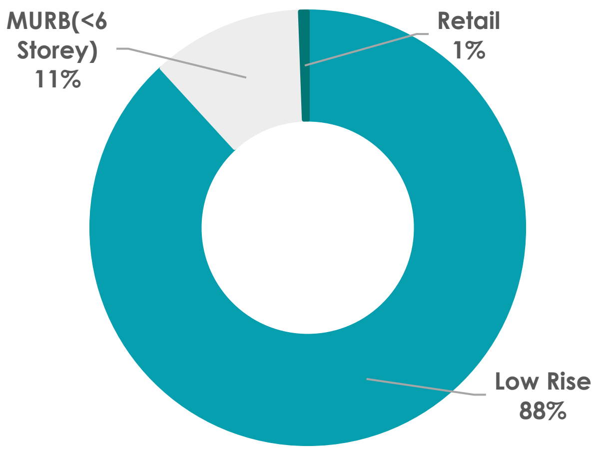


Figure 6: Wildfield Village Secondary Plan Area Building Type Breakdown (GFA)

2.2. CEERP and Net Zero Targets

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

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

and phasing in of the current and future energy performance requirements of the Ontario Building Code; and
- A strategy and policy direction to implement electric vehicle charging infrastructure.

In alignment with the Region's Official Plan requirements, the Town of Caledon implemented a Terms of Reference document in early 2023 outlining similar requirements for secondary plan areas. Caledon Town Council also previously passed a motion declaring a climate change emergency and adopted a community-wide greenhouse gas (GHG) emissions reduction target of net zero emissions by 2050 as well as an interim target of 36% reduction in emissions by 2030 (Town of Caledon, 2021). The Town subsequently developed the Resilient Caledon Community Climate Change Action Plan ('Resilient Caledon Plan') which outlines initiatives the Town plans to undertake to prepare for the expected future impacts of climate change. Additional information on the Energy and Carbon Environment can be found in **Appendix C**.

2.3. Caledon Green Development Standard

The Town of Caledon recently implemented its Green Development Standard (GDS), which establishes beyond-code requirements for building construction. The Town of Caledon's GDS establishes a suite of long-term, low-carbon goals and strategies that aim to reduce greenhouse gas emissions and enhance sustainability attributes of new construction in the Town's jurisdiction.

The GDS consists of tiers of performance measures with supporting guidelines that promote sustainable site and building designs. Tier 1 requirements of the GDS is 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. The 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. Adopting these metrics facilitates contextualization and understanding of site energy and GHG performance and can demonstrate how each of the proposed measures impact energy and GHG performance relative to a baseline scenario.

The current targets for Caledon's GDS are outlined in **Table 6**.

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

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

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

2.4. District Energy Systems

District Energy Systems (DES) distribute heating and cooling generated at a centralized plant to provide energy to multiple buildings on a development or neighborhood scale. A DES consists of a heating and/or cooling centre, and a thermal network of pipes connecting groups of buildings (City of Toronto, 2023). DESs are capable of providing access to a low-carbon fuel source with minimal infrastructure required to tie into the piping network and can create economies of scale and energy-sharing opportunities to achieve large-scale, cost-effective GHG reductions. The feasibility of such systems is explored within this study. An example schematic of a typical DES is shown in **Figure 7**.

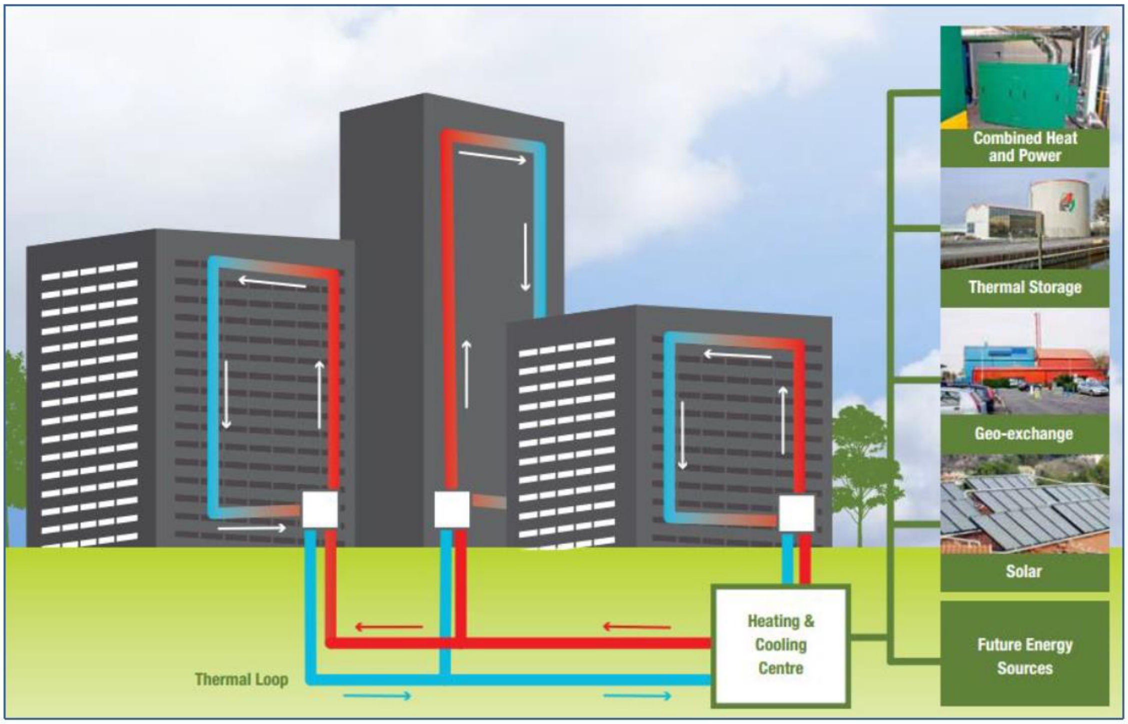


Figure 7 – Illustration of the function of a District Energy System (City of Toronto, 2016a)

3. Methodology and Assumptions

3.1. Building Energy Systems

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

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

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

Potential energy conservation measures were selected based on low-carbon design principles, with the exception that active measures (i.e., HVAC system implementation) were considered prior to passive measures (i.e., enclosure and ventilation considerations). The energy and carbon emission reduction achieved from passive measures are dependent on location and site orientation. These details have not been defined at this stage of planning and are expected to vary across the Secondary Plan Area.

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

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

Energy usage was informed by simulations completed using the IES-Virtual Environment 2023 (IES-VE) building performance simulation software. IES-VE is a sophisticated building energy simulation software that enables simulation of complex building systems including solar shading, daylighting, natural ventilation, and highly customizable HVAC systems. The software was used to develop multiple scenarios to guide and inform the analysis as follows:

- **Baseline Scenario** – Based on the Town of Caledon GDS (refer to **Table 5** in **Section 2.3**)
- **Near Net Zero Scenario** – A potential pathway to near net zero energy and emissions

The Near Net Zero Scenario consists of building-scale energy conservation strategies beyond those required in the baseline scenarios. This scenario accomplishes additional TEUI and GHGI reductions, reducing the demand for energy generation.

The evaluation of individual energy systems and technologies for the **Near Net Zero Scenario** was conducted 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

3.1.1. Building Strategies and Technologies Assessed

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

Table 7 summarizes the technologies that were assessed as part of the development of this study. The technologies include various heat pump system options, where heat pumps are systems that extract or reject heat from one source (air, water, geothermal, etc.) and transfer it to building spaces that require it in the heating or cooling seasons, respectively. This technology saves energy as heat is transferred rather than generated in conventional heating systems. Other technologies that were studied included domestic hot water (DHW) source options in which efficient and low-carbon HVAC options were suggested to serve DHW loads from buildings; a change from traditional natural-gas sources.

Table7 - 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 heat DHW.
Solar Energy Generation	Solar Photovoltaics (PV)	Rooftop solar photovoltaic panels installed on building roofs convert solar energy into electrical energy.

3.2. Transportation Systems

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

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

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

A transportation study for the proposed Wildfield Village Secondary Plan Area development is concurrently being prepared which will assess the impacts of the proposed community on the existing road network in Caledon and the forecasted vehicle traffic that is expected within the development area based on the proposed urban form. These values will be used as a basis to inform Scope 3 emissions from personal vehicles that have the potential to be reduced using forms of active transportation and implementation of the EV chargers.

3.3. District Energy System Considerations

District energy systems rely on high building density and supporting infrastructure to be viable. Consequently, these systems are best suited to medium to high-density development areas. For context, the density classification of archetypes was completed based on units per hectare. Based on classification of site statistics provided by the planning consultant for the Secondary Plan Area, the following classifications were made for the proposed developments:

- Low-density residential: Detached single (30 units per hectare).
- Medium-density residential:
  - Townhouses (50 units per hectare).
  - Stacked townhouses (90 units per hectare).
  - Apartments (225 units per hectare).
- Retail was classified as medium density. (50 jobs/sqm).

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 a DES is on par with that of a like for like building level system. The primary financial benefit to developers lies in the opportunity to avoid these upfront building level costs and instead defer these costs to tenants. District energy developers typically target a payback of 20 years, which aligns with the timeframe used for the NPV analysis for the various HVAC and other systems evaluated in this report. Assumptions regarding pricing and the analysis of these systems have been outlined in **Appendix D**. A summary of this analysis is provided in **Section 4.3.**

If implemented, district systems offer benefits including reduced space for heating and cooling equipment and reduced upfront capital costs. Some systems may also be able to leverage economies of scale to provide lower long-term utility costs than market rates. For some types of low-carbon energy, building-level systems are not technically or financially feasible. Centralized systems also offer opportunities for individual buildings to readily connect to a low carbon energy source. With centralized systems, mechanical room or penthouses for multistorey buildings can be reduced in size, and separate equipment is not required for low-rise buildings connected to the district network.

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

Table 8 - Overview of district energy systems evaluated

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

**Cogeneration systems require access to co-located industrial processes that can be leveraged to fuel the system. Based on planning documentation provided, it is expected that there will not be any nearby industrial processes or renewable fuel sources that could be accessed to provide a low carbon cogeneration energy source. Therefore this DES was excluded from consideration.*

***Water source exchange systems require proximity to large water bodies. Based on the planning documentation for the Secondary Plan Area, it was assumed that there are no proximal large water bodies to the Wildfield Village Secondary Plan Area and therefore this DES was excluded from consideration.*

3.3.1. Subarea Analysis

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

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

Sub-Area	Building Archetypes & Square Footage	Total Dense Areas
Neighbourhood Centre	Medium Density Apartments - 632,688 ft^2 Retail - 34,088 ft^2	666,776 ft^2
Urban Corridor	Medium Density Stackable Townhomes - 920,894 ft^2 Medium Density Apartments - 319,755 ft^2 Medium Density Retail - 61,547 ft^2 Medium Density Townhomes - 1,382,558 ft^2	2,684,754 ft^2
Neighbourhood Areas	Medium Density Townhomes – 1,905,633 ft^2 Low-Rise Residential – 11,433,799 ft^2	1,905,633 ft^2

3.3.1.1. Neighbourhood Centre and Urban Corridor

Almost 68% of the Wildfield Village Secondary Plan's development total gross floor area consists of higher density buildings. Combined, the Urban Corridor and Neighborhood Centre are 3,351,530 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.

The Neighbourhood Centre is also adjacent to planned development outside of the Wildfield Secondary Plan Area. It was outside the scope of this study to assess these additional areas, but it is reasonable to expect that similarly dense development is planned for the western side of Centreville Creek and Mayfield Roads.

3.3.1.2. Neighbourhood Areas

District systems are not viable for low-rise residential buildings due to extensive infrastructure costs and low population density. The Town of Caledon GDS mandates all single-family residential homes to include a 3-season air-source heat pump, which is inherently 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 overwhelming majority of the proposed site, at approximately 12 million square feet.

3.3.2. Potential Policy Barriers and Planning Considerations

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

- **School Board Construction Practices:** The Town of Caledon and the local school boards (Peel District School Board and Dufferin Peel Catholic District School Board) currently do not permit drilling of geothermal boreholes or installation of solar photovoltaic energy systems on parklands or school properties. The elimination of these spaces within the Plan Area may reduce the potential land available to support energy generation capacity. These public land sites are the most attractive for borehole drilling due to the open space and surface space available for these lands. 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 successfully deploy a district system.
- **Right of Way (ROW) and Utility Design**: The implementation of potential district energy solutions such as geothermal systems will require the Town of Caledon to consider alternative approaches to its existing ROW and utility design standards and directives to create an enabling environment for such technologies to be successfully deployed. New infrastructure requirements may also present competing demands for space with other infrastructure such as stormwater systems.
- **Ownership and Maintenance:** The ownership, maintenance and operations, and management of potential systems modeled was outside the scope of this study. It is expected that the Town of Caledon will need to assess policy, legal, financial, and operational considerations prior to

assuming ownership over any district-level energy utility or prior to entering financial and legal partnerships with third parties to operate and maintain such facilities.

- **Land / Space Availability:** Community energy systems can require space allocation for infrastructure elements. The system must be accessible to technicians for ongoing maintenance, and this may mean that dedicated space must be allocated to the system that may conflict with other desired development.
- **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 on a building scale, modeled for this Secondary Plan Area are illustrated in **Table 10.** The Neighbourhood Centre subarea of the Secondary Plan Area discussed in **Section 3.3.1** of the report was assessed as potentially viable to be considered as DES systems. In terms of energy performance, like-for-like system efficiencies are comparable whether looking at energy systems on a local or district level as the technologies used for heating, cooling or energy production adhere to the same operating principles. For the purpose of this study, the **Near Net Zero Scenario** energy system improvements were implemented across all building archetypes.

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

Category	Archetype	Baseline Design	Net Zero Design (Improvements over Baseline)	% Savings over Baseline	
				Energy	Emissions
Residential	Detached Homes & Townhouses	Three-season ASHP with natural gas backup	Installation of solar photovoltaic panels, geothermal heat pump system for HVAC, and upgradation of domestic hot water to ASHPs with natural gas back up from 100% gas and passive measures	37%	75%
	Stacked Townhomes & Apartments	Constant volume corridor MUA and constant volume in suite ventilators served by condensing boiler and chiller		39%	82%
Commercial	Commercial - Retail	Fan coil units (FCUs) / Dedicated Outdoor Air Systems (DOAS) system served by condensing boiler and chiller		45%	81%

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

4.1. Secondary Plan Area Results

Although energy use and carbon emissions are correlated, when considering net zero design, 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.

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

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

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

4.1.1. Energy

Figure 8 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 TED) 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 18% energy savings compared to the baseline.

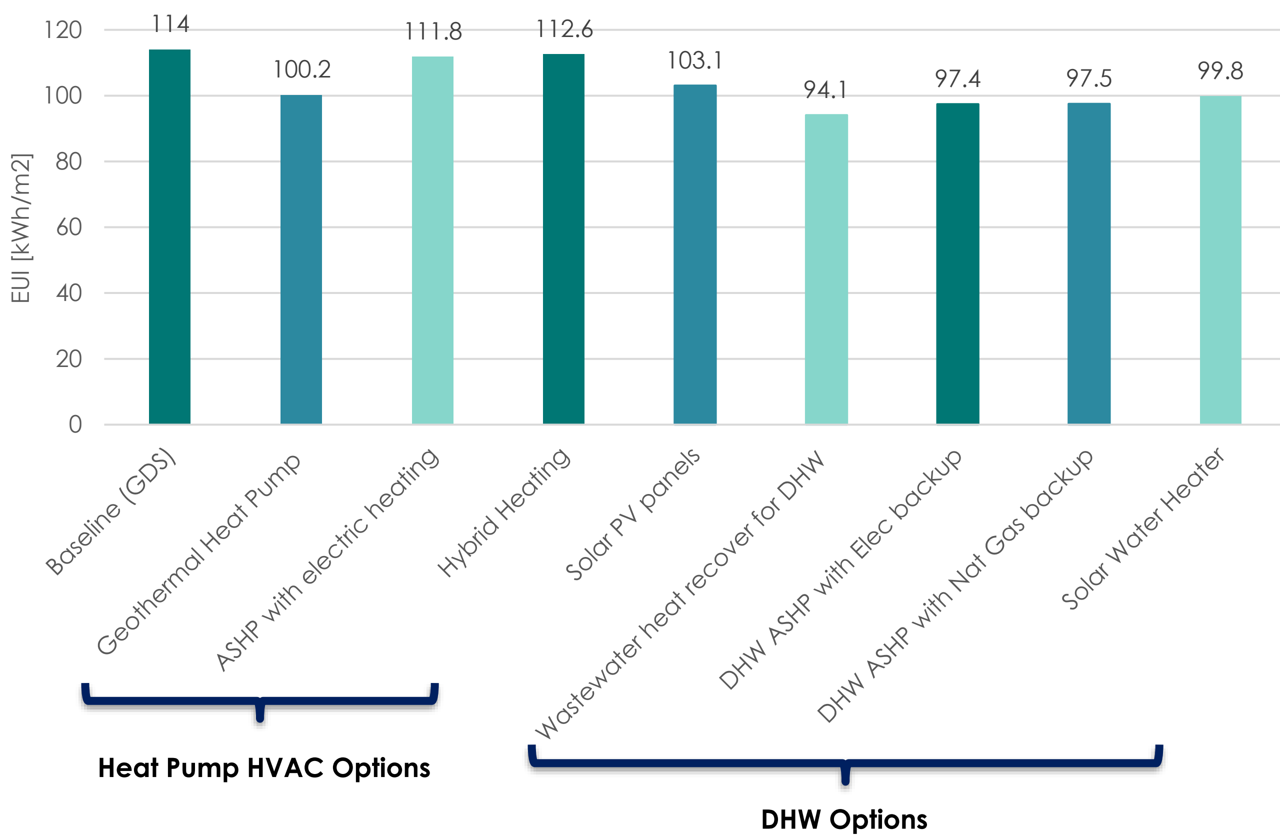


Figure 8 - Energy Use Intensity Results for Each HVAC System Assessed

4.1.2. Carbon

Figure 9 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 58% 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 GHG 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 88% 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.

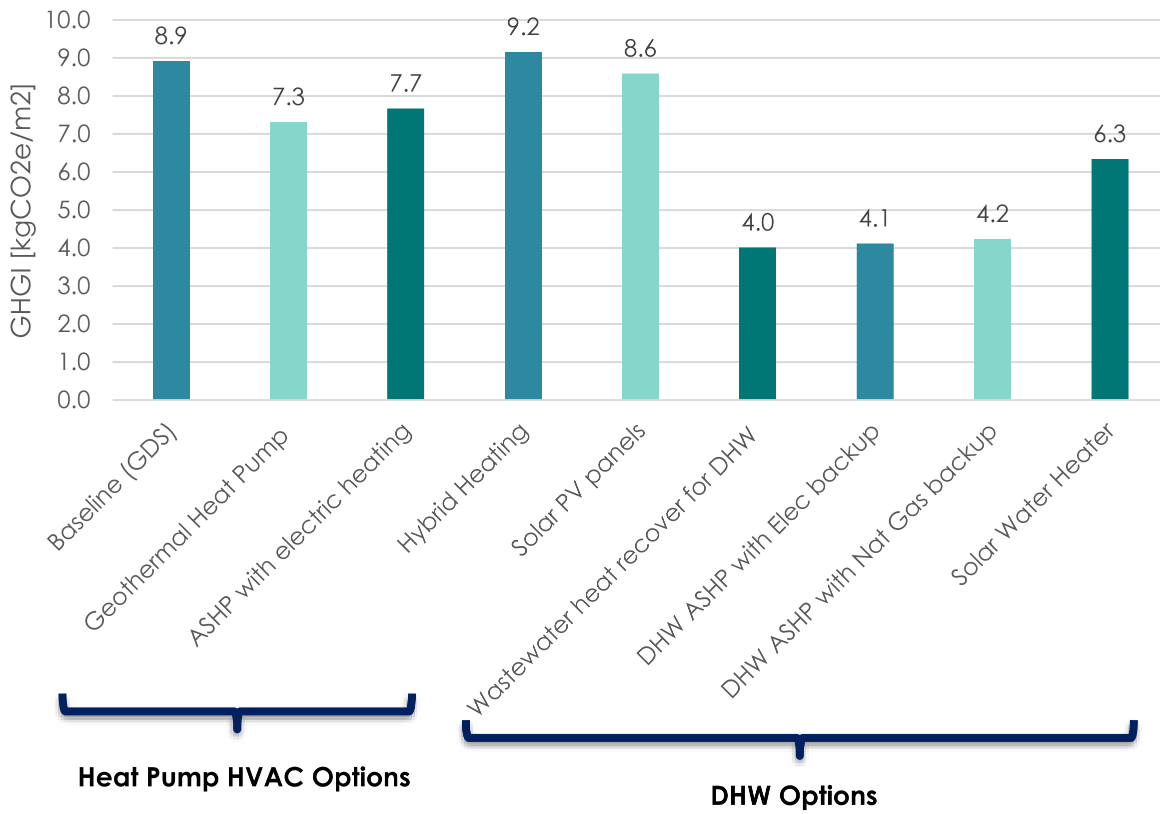


Figure 9 - Greenhouse Gas Use Intensity Results for Each HVAC System Assessed

4.1.3. Cost

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

Equation 1, as outlined in **Figure 10** 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 10** below.

Equation 1 - Total Cost

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

Total costs consist of several components as highlighted below:

Total Cost (30-year period)	*Total cost (in net present value) of implementing and operating the proposed system*

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

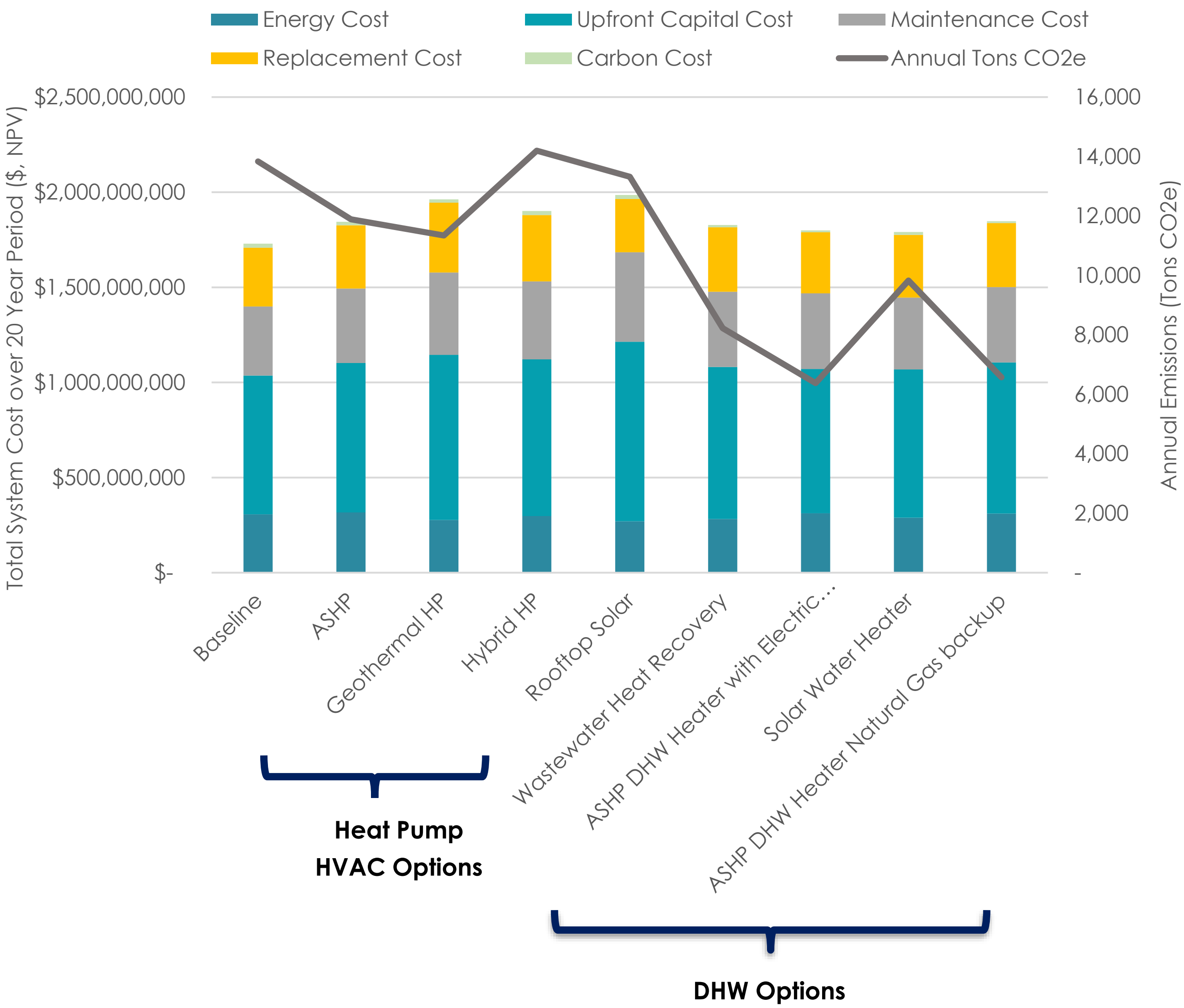


Figure 10: Total System Cost over 20 Year Period (NPV) of Each System Assessed Along with Annual CO_2e Associated with Each Measure

20-year costs are broken down by their respective cost components. Note that systems developed on a District scale are 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. The costs presented within the report are an estimated value and reflects a Class D estimate which has a variance of ±20% per the Public Services and Procurement Canada (Public Services and Procurement Canada, 2020).

The HVAC options and systems were assessed based on GHG impact as well as cost performance. Note that for the **Baseline Scenario**, it was assumed that there would be no solar energy installation, and that space heating and domestic hot water would be provided with traditional natural gas sources. An overview of the cost analysis is outlined in **Table 11**.

Table 11: HVAC System Class D Estimate Cost Analysis

HVAC Option	System Type	Cost Analysis	Est. 20-Year NPV Cost (Baseline Scenario)	Incremental Cost of Near Net Zero Condition (Net Zero Scenario)
Baseline HVAC	Traditional Natural gas Heating System	Relies on natural gas as a primary heating source resulting in elevated emissions. Lower in cost relative to heat pumps.	$1,729.7M	
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.	$1,844.9M	$115.2M
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.	$1,962.7M	$233.0M
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.	$1,901.2M	$171.5M

Renewables	System Type	Cost Analysis	Est. 20-Year NPV Cost (Baseline Scenario)	Incremental Cost of Near Net Zero Condition (Net Zero Scenario)
Rooftop Solar	Electricity Production	Negligible impact on GHG with significant additional cost.	$1,985.9 M	$256.2 M

DHW Option	System Type	Cost Analysis	Est. 20-Year NPV Cost (Baseline Scenario)	Incremental Cost of Near Net Zero Condition (Net Zero Scenario)
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.	$1,827.9 M	$98.2 M
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	$1,799.5 M	$69.8 M
Solar Water Heater	DHW Heating	Reduced GHG benefits as other DHW upgrades at costs relatively comparable to an ASHP Heater.	$1,790.9 M	$61.2 M
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.	$1,847.7 M	$118.0 M

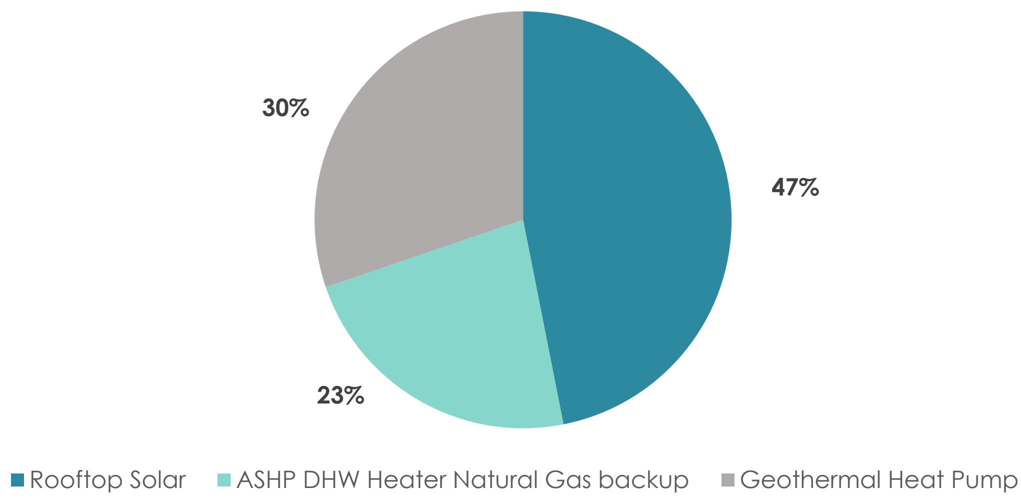


Figure 11: Total Incremental Upfront Capital Cost Distribution of Each Proposed Measure

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 11** illustrates the incremental upfront capital cost distribution for each measure in 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 $458.7M, or a 63% increase (refer to **Figure 12**).

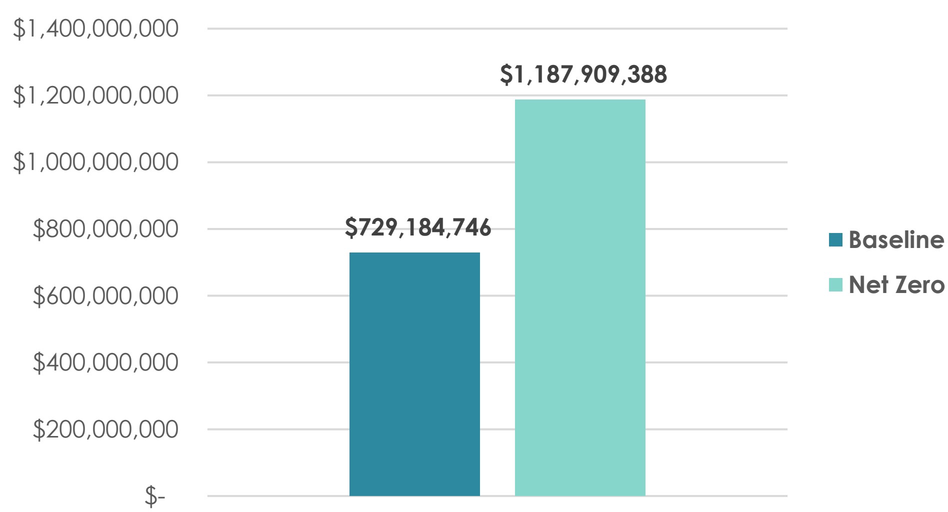


Figure 12: Total Incremental Upfront Capital Cost vs. Baseline Scenario

4.2. Traffic Vehicles & EV Charging

To estimate the electrical demand from EV chargers for the Wildfield 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 per the GDS requirements. Level 2 chargers were assumed to require 6.6 kW per charging station. Level 3 chargers for non-residential spaces were assumed to require 62.5 kW.

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

Table 12: Estimated EV Charger Demand

	Level 2 EV Chargers	Level 2 EV Chargers Demand [kW]	Level 3 EV Chargers	Level 3 EV Chargers Demand [kW]	Total [kW]	Total Carbon Emission [$kgCO_{2e}$]	Estimated Cost of EV Charging Stations* (Present $CAD)
Case 1 – GDS	7,565	49,930	1	63	49,993	2,500	**$7,635,890**
Case 2 – 100% EV Chargers	7,642	50,437	5	316	50,752	2,538	**$7,995,450**

**Costing for the EV charging stations were based on average costs of $1,000 per charger for Level 2 chargers and an average cost of $70,000 per charger for Level 3 chargers. These values were received from a third-party supplier of this equipment. Costs for electrical infrastructure upgrades (such as higher capacity transformers and sub-stations) were excluded from these calculations as further analysis will need to be conducted on anticipated usage of the EV chargers and transportation uses which is beyond the scope of this study.*

The implementation of EV charging infrastructure and maintenance comes at a high cost and electrical demand and should be considered when determining whether this strategy should be included within the Wildifeld Village Secondary Plan Area. While **Transportation Case 1** is required by the GDS, **Transportation Case 2** would fully eliminate Scope 3 tailpipe emissions from the proposed community. **Transportation Case 2** increases the energy demand and carbon emissions by 1% over **Transportation Case 1**. This is due to the small difference in non-residential chargers required as per the transportation cases explored.

4.3. District Energy

4.3.1. Neighbourhood Centre

The Neighbourhood Centre is located at the southwest corner of the secondary plan area and has a planned area of 666,776 ft^2. This area does not currently meet the required gross floor area needed to justify the implementation of a DES. An average building height of 5 storeys was assumed for developments in this area. An additional 3 storeys (8 storeys total) would be necessary to meet the required GFA threshold needed to justify a DES solution. A DES would also become feasible if there was consolidation of denser developments located in the surrounding Urban Corridor lands around the Neighbourhood Centre in a compact style.

Technical Feasibility: DES is not feasible for the Neighbourhood Centre as it is currently planned

4.3.2. Urban Corridor

The Urban Corridor as it currently envisioned is comprised of medium density dwelling types, amounting to an estimated GFA of 2,684,754 ft^2.

While the GFA threshold meets the requirement to justify a DES solution, the proposed layout is impractical as it is spread along road corridors. Consolidation of this denser development style, preferably near and around the Neighbourhood Centre, would improve the feasibility of deploying DES for this area. Consolidation would also contain infrastructure to a limited area, improving financial feasibility.

Technical Feasibility: Infeasible as currently planned. Potentially feasible with the consolidation of denser development near and around the Neighbourhood Centre

4.3.3. Site Summary

A DES could have potential if denser developments within the Urban Corridor are consolidated around the already dense Neighbourhood Centre, reducing the network size for the prospective DES and meeting the required GFA threshold of 1M ft^2. Consolidation of denser development would also improve the financial feasibility of a DES. As currently planned, there is insufficient GFA within the Wildfield Village Neighbourhood Centre to implement a DES. The Urban Corridor, which does contain a significant amount of medium to high density GFA is sprawled and could require multiple DES sites, which limit feasibility due to the amount of infrastructure required to service such a widespread area. If dense development is planned immediately to the west of the Secondary Plan Area along Mayfield Road, a DES may be feasible if these areas were combined. This was outside the scope of the study.

Technical Feasibility: Infeasible as currently planned. Potentially feasible with the consolidation of denser developments near and around the Neighbourhood Centre

4.3.4. Evaluation of District Energy Systems

In all cases evaluated below it is assumed that a proposed DES would service a dense area of development centered around the Neighbourhood Centre that includes medium to high density developments from the Urban Corridor. This configuration allows for compact development of the DES network and a reduced service area (in terms of physical size).

4.3.4.1. Geothermal District Energy Systems

The medium density archetypes' peak heating and cooling load for the Neighbourhood Centre and Urban Corridor subareas are estimated to be 730 kBTU/hr and 514 kBTU/hr, and 1,410 kBTU/hr and 1,004 kBTU/hr respectively, making the site dominated by heating loads.

To meet this demand, approximately 220 boreholes drilled to a depth of 850 feet would be required to meet the expected demand of the Neighbourhood Centre. 430 boreholes drilled to a depth of 850 feet would be required to meet the full demand of the Urban Corridor for a total of 650 boreholes.

In terms of borehole field sizing, a borehole spacing of 15 feet between adjacent boreholes results in a field with a total area of approximately 72,300 $ft^{2.}$ This equates to approximately 2.5% of the Neighbourhood Centre, indicating that there would be limited space restrictions and that the deployment of the system would be technically viable.

Additionally, energy loads can be reduced through a variety of passive measures as described in **Section 3.1,** which are not explicitly considered at this stage of the analysis. Should such passive measures be implemented, the size of the geothermal field could potentially be reduced.

The approximate NPV cost of implementing this system would be $231,533,000.

4.3.4.2. Solar Photovoltaics

Solar PV is traditionally mounted on building roofs (energy estimates provided in the previous section assume approximately 30% roof coverage). 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. Options for PV installation locations within the Secondary Plan Area include the following:

- Public Parks: 4,230 m^2 (~5% of park land use area)
- Elementary Schools: 128 m^2 (~1% of school land use area)

A district style solar PV system installed in Public Parks and Elementary Schools near the Urban Corridor / Neighbourhood Centre would allow for approximately 4,358 m^2 of panel area, which is equivalent to mounting panels on roughly 9% 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 ~1%. 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 $234,267,300.

4.3.4.3. Sweage (Wastewater) Heat Recovery

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 13** below.

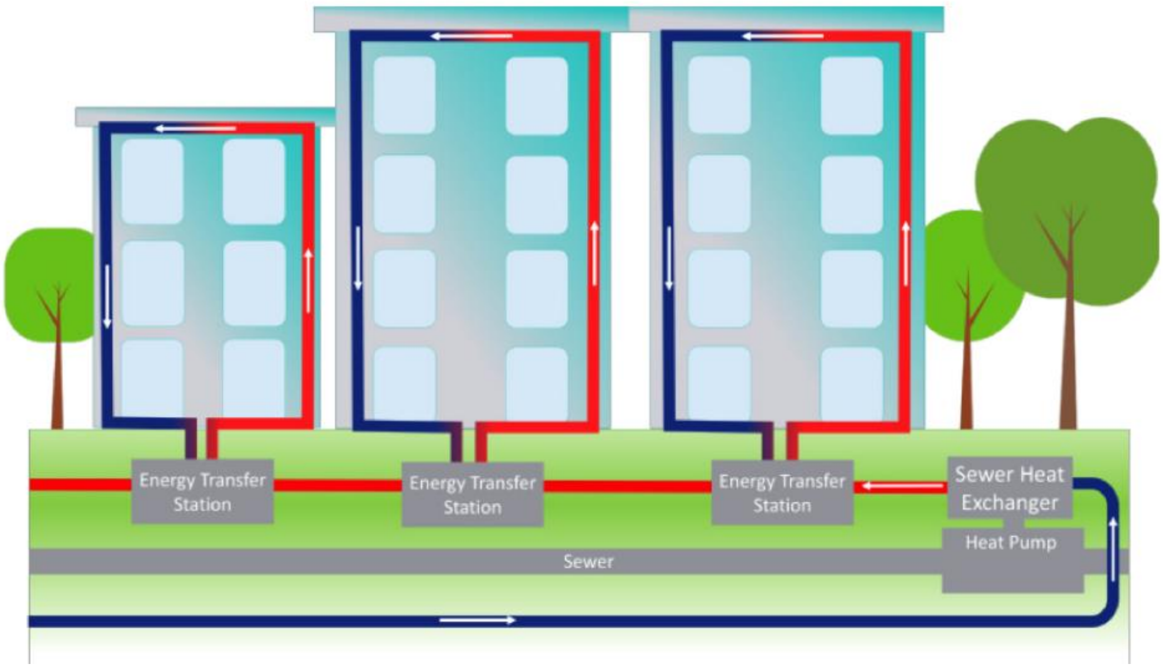


Figure 13: DES Schematic of Wastewater Heat Recovery (City of Toronto, 2017)

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

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

The required wastewater generation to meet the Neighbourhood Centre's DHW load demand was estimated to be approximately **50.7 million gallons/ year.** The overall analysis summary is summarized in the **Table14** below.

Table 14: Estimated wastewater generation vs estimated wastewater required for Neighbourhood Centre subarea

Wastewater Factor	Projected Flow Rates
Total wastewater generated	70,364,585 gallons/year
Total wastewater required	50,710,793 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. One or more cisterns would be needed to handle the flow and house one or more heat exchangers, which would need to be needed to capture the available waste heat from the water.

The approximate NPV cost of implementing this system for the medium density dwellings in the neighborhood Centre would be $224,275,200.

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.

4.3.4.4. *DES Result Summary*

Table 16 summarizes the evaluation of DES viability results for the study.

Table 16: DES Viability

System	Infrastructure Required (Enbridge, 2024)	Considerations	Estimated Cost (Subareas)
Geothermal Pumps System	• 220 boreholes and 24,400 ft^2 land area for Neighbourhood Centre • 430 boreholes and 47,900 ft^2 land area for urban corridor	• 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	$231,533,000
PV Array (District Level)	• 4,225 m^2 roof area for Neighbourhood Centre • 9,460 m^2 roof area for Urban Corridor	• Low energy generation potential • Location of PV arrays and racks are limited to publicly owned property • Metering/financing considerations for owners/operators	$234,267,300
Sewage Waste Heat Recovery	• 2,270 sqm land area for Neighbourhood Centre • 4,450 m^2 for Urban Corridor	• Typically can only serve DHW loads • Access to available sanitary waste matter streams • Metering/financing considerations for owners/operators	$224,275,200

4.4. Roadmap to Near Net Zero Discussion

Table 17 and **Table 18** present the systems **Near Net Zero Scenario** a potential solution results based on relative energy and carbon emission reduction potentials in comparison to **Baseline Scenario** studied, respectively. The percentage of individual reduction is calculated by using the individual measure reduction potential over the total reduction potential value.

Table 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	-14	-11	-17	-1	-43	72
% of individual reduction	12%	10%	15%	1%	37%	

Table 18: Estimated GHGI Reduction Potential

Baseline Scenario GHGI [$kgCO_2e$ /m²]	Reduction Strategies [$kgCO_2e$/m²]				Total Reduction Potential GHGI [$kgCO_2e$ /m²]	Near Net Zero Scenario GHGI [kg CO_2e/m²]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
8.9	-1.7	-0.33	-4.7	-0.03	-6.8	2.1
% of reduction	18%	4%	52%	0%	76%	

Table 19 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**. This offers a comparison of the Town of Caledon's developments, at a minimum as per the GDS, compared to other municipalities in Ontario.

Table 19: Estimated 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	114	73	63%	36%
GHGI [kgCO2e/m²]	26	8.9	2.2	92%	75%

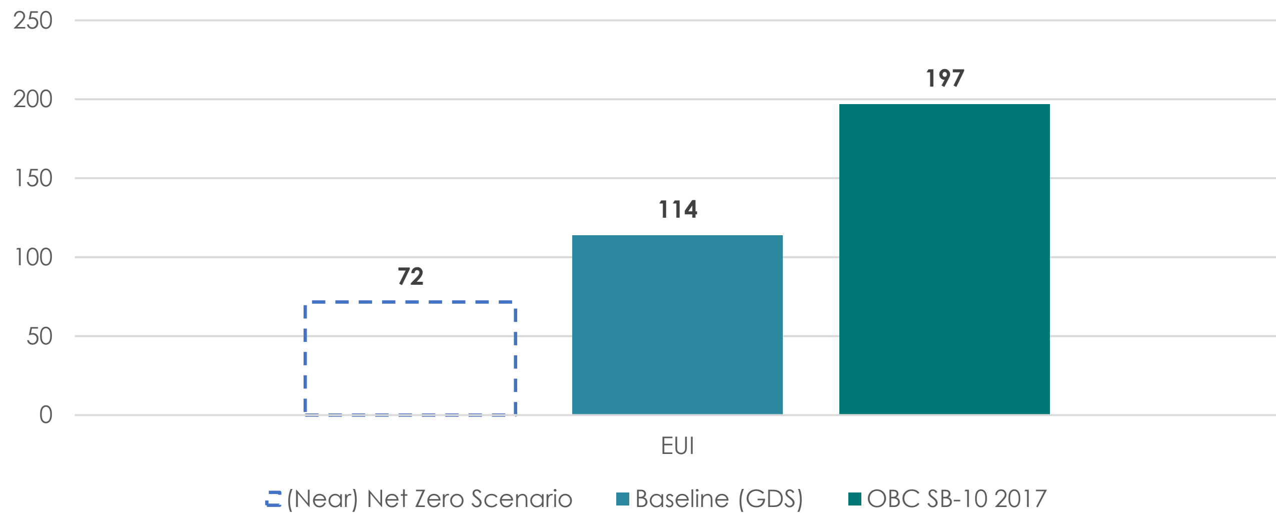


Figure 15: Estimated EUI Reduction Potential Reduction Potential Comparion to OBC and Baseline Scenario

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

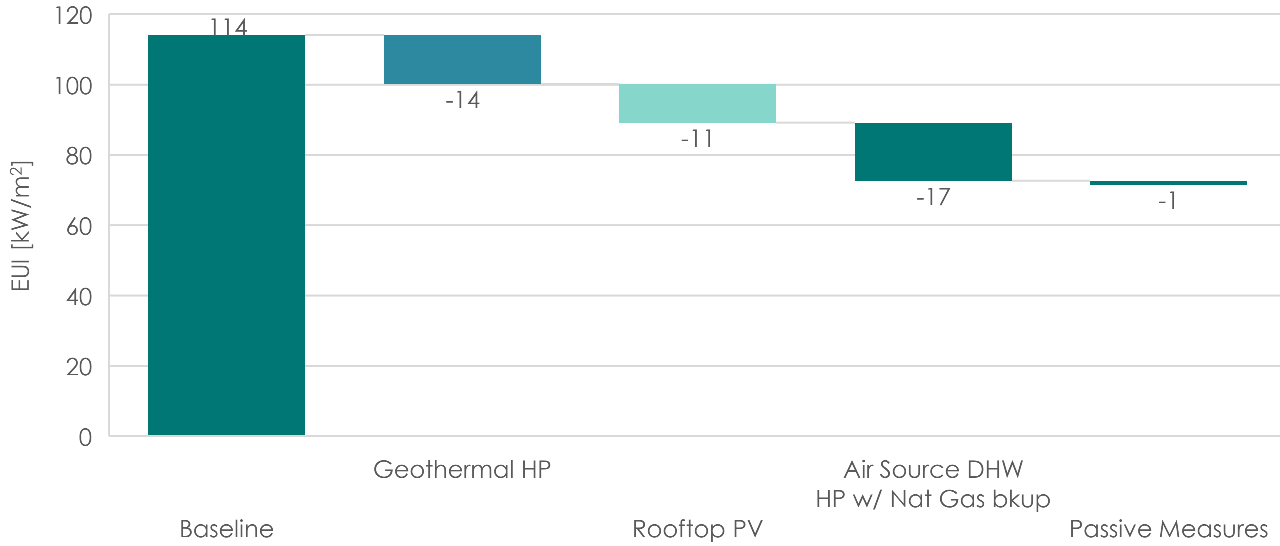


Figure 16: Energy Use Intensity Reduction Roadmap demonstrating EUI reduction potential

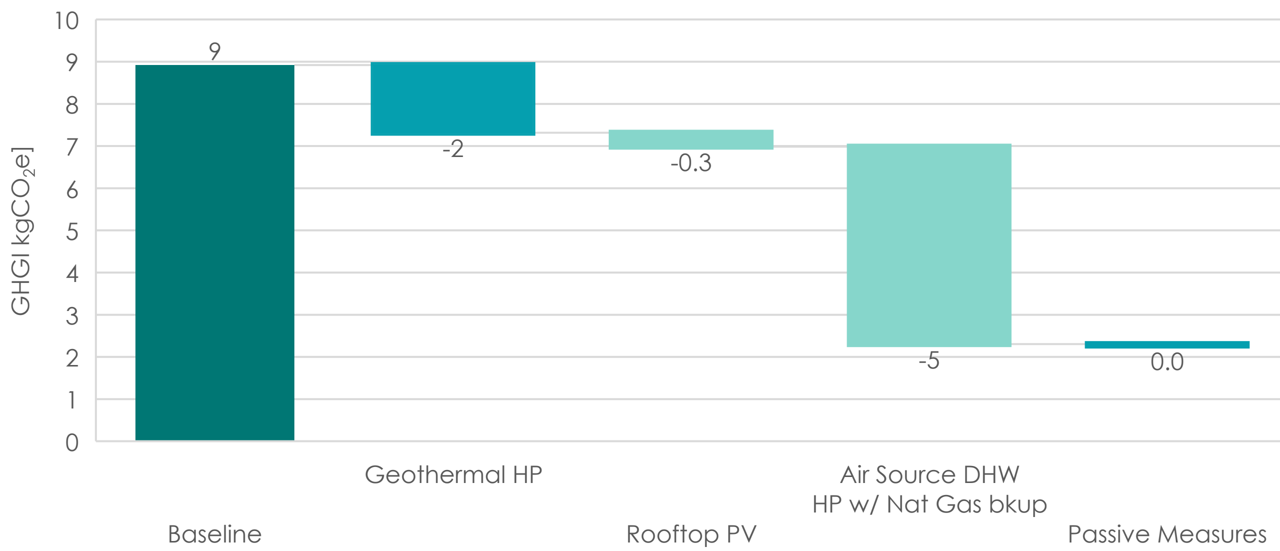


Figure 17: Greenhouse gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

Therefore, the **Near Net Zero Scenario** as modeled achieves an EUI of 72 kWh/m^2 and a GHGI of 2.1 kgCO_2e/m^2. This represents 37% savings in EUI and 76% in GHGI over the **Baseline Scenario**.

The 20 Year NPV total cost of implementing the strategies in this scenario is expected to be **$2.4 billion**, 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 **$458.7 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 Over Baseline
Geothermal Heat Pump	$1,962,706,000	$138,735,000
Solar Rooftop PV	$ 1,985,883,000	$ 215,116,000
Air Source DHW HP w/gas backup	$1,847,676,000	$ 104,874,000
Near Net Zero Scenario Total Cost	**$ 2,379,315,000**	**$458,724,000**

5. Implementation

Implementation of the proposed energy conservation and emissions reduction strategies within the Wildfield Village 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	Timeline	Responsibility
1. Building Scale Measures		
The Landowners Group shall demonstrate compliance with energy and emissions performance targets for all building typologies defined by the Tier 1 requirements of the Town of Caledon Green Development Standard	Site Plan	Town of Caledon
The Landowners Group shall engage with prospective renewable energy providers (solar and geothermal) and utility companies to confirm design requirements for building-scale, or district energy systems and financial models available for operating these systems.	Site Plan	Building Developers
2. Electric Vehicle Infrastructure		
The Landowners Group shall identify and integrate electric vehicle charging capacity and infrastructure requirements by building type based on the requirements of the Town of Caledon Green Development Standard.	Site 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 communicated by the Town of Caledon.	Official Plan Amendment	Town of Caledon Hydro One Networks Inc.
3. District Energy System Feasibility		
The Landowners Group shall evaluate potential for increased density within the Neighbourhood Centre or consolidation of neighbouring Urban Corridor lands within a larger Neighbourhood Centre. Review whether neighbouring Secondary Plan Area to the west anticipates a similarly dense development style adjacent to the Neighbourhood Town Centre.	Draft Plan	Wildfield Village Landowners + Town of Caledon
The Landowners Group shall engage with district energy system vendors and suppliers to assess interest and feasibility of implementing a DES system within the Neighbourhood Centre to inform consideration of any changes to proposed density.	Draft Plan	Wildfield Village Landowners

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 Wildfield Village Secondary Plan Area. This information was used to inform understanding of the likely energy performance within the development. The technical feasibility of several building-scale energy systems was then assessed based on the overall energy demand and the sizing of systems that would be required to meet this demand. Other factors including spatial, and financial considerations were considered to define a potential low-carbon community development design, termed the **Near Net Zero Scenario**. Of the potential building-scale energy systems considered, geothermal heat pumps, solar rooftop PV systems, domestic hot water systems with air-source heat pumps (and natural gas backup), and passive measures were considered as the most viable options for deployment in the Wildfield Village Secondary Plan Area.

In terms of transportation systems, EVs and their associated infrastructure requirements are expected to impose a significant electricity demand - approximately 50 MW for **Transportation Case 1** and 51 MW for **Transportation Case 2,** representing additional capital cost requirements of approximately $7.6 million for **Transportation Case 1** and $8.0 million for **Transportation Case 2**. While **Transportation Case 1** is mandatory as per the GDS, it is not feasible to offset the expected electrical demand with active or passive measures, and therefore electric vehicle charging demand was considered separately from the **Near Net Zero Scenario**.

In terms of DES, the Neighbourhood Centre and Urban Corridor, together, offer opportunities to implement geothermal heat exchange DES. These subareas are locations of dense areas within the Secondary Plan Area. Policy restrictions such as management and operations limit the viability of this approach and should be evaluated prior to design implementation.

The **Near Net Zero Scenario** achieves an EUI of 72kWh/m^2 and a GHGI of 2.1 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 **$2.4 billion**, based on the Class D cost estimate conducted. The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$458.7 million**.

Implementation of the strategies associated with the **Near Net Zero Scenario** would enable the Wildfield Village 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 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.

Report Prepared By:

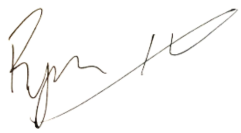
Zaid Khan, M.Eng., EIT

Building Performance Analyst
zaid.khan@pratusgroup.com

Simonne Varela, M.Eng., EIT

Building Performance Analyst
simonne.varela@pratusgroup.com

Ryan Hewat, B.Eng.



Senior Building Performance Analyst
Ryan.hewat@pratusgroup.com

Report Reviewed By:

Christopher Mohabir, P.Eng.

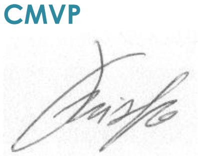
Building Performance Team Lead
chris.mohabir@pratusgroup.com

Eric Dunford, M.Sc., MBA

ESG Sector Lead
eric.dunford@pratusgroup.com

Report Approved By:

Oleksandra Onisko, P.Eng., LEED AP BD+C, BEMP, CMVP



Building Performance Vice President
oleksandra.onisko@pratusgroup.com

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Appendix B. Site Plan and Statistics

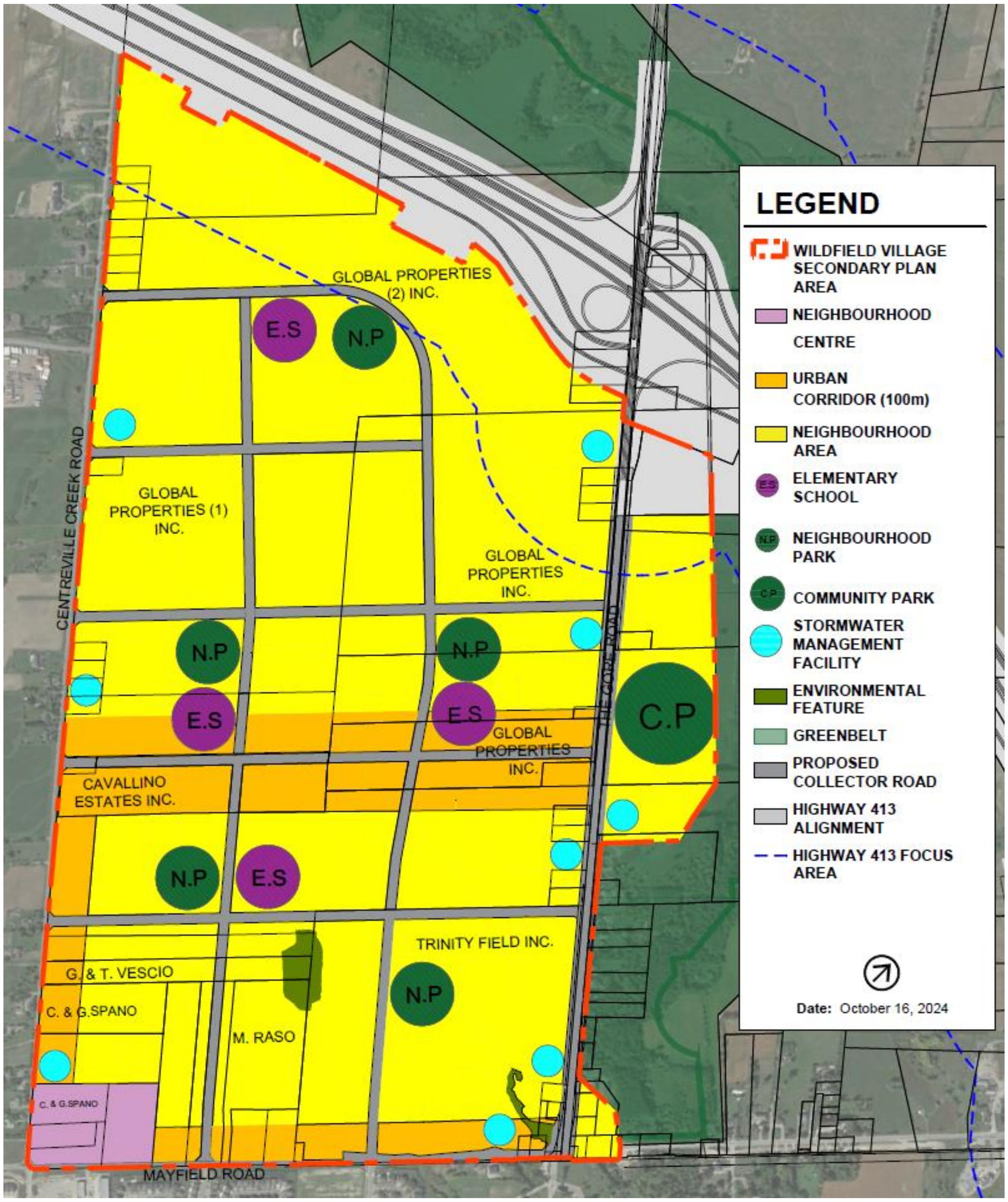

Figure A-1 – Proposed Conceptual Land Use Plan for the Wildfield Village Secondary Plan, October 16, 2024

(SGL Planning & Design Inc., 2024))

Land Development Type		Gross Area (ha)*	Net Development Area (ha)**
Available Development Land	**Neighbourhood Area**	213.69	158.13
	Urban Corridor	35.72	26.43
	Neighbourhood Area	6.49	4.80
Areas excluded from Constructable Land	**Schools**	12.82	-
	Stormwater Management Facility	39.42	-
	Neighbourhood Parks	10.12	-
	Community Park	4.00	-
	NHS	1.01	-
	HWY 417	3.67	-
	Proposed Collector Roads	28.55	-
	Existing Roads	0.00	-
	Total	355.49	189.37

*These residential areas include a Vegetation Protection Zone (VPZ) which is approximately 26% of the gross area
**These areas are the net area which excludes the VPZ

Figure A-2 – Proposed Conceptual Land Use Plan breakdown adapted from the Land Analysis Data provided May 30, 2024 (SGL Planning & Design Inc., 2024))

Appendix C. Energy and Carbon Cost Assumptions

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

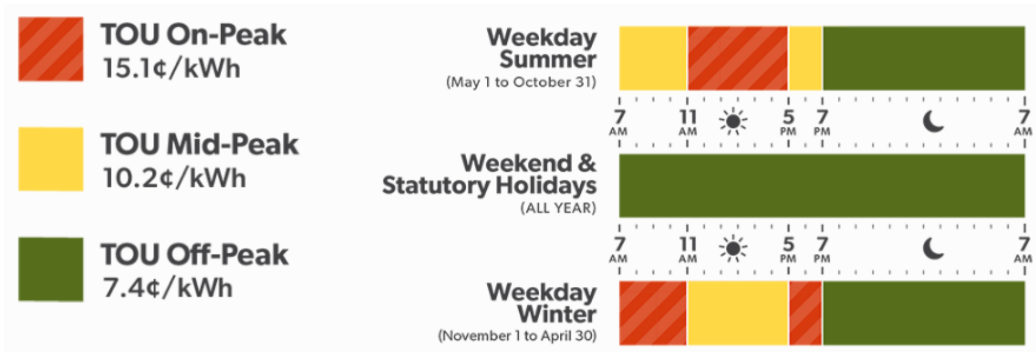

Figure B-1 – Hydro One Time-of-Use Rates Effective until October 31, 2023 (Hydro One, 2023)

Prevailing natural gas rates are summarized in below:

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

Gas Consumption	Cost (cents/m^3)
First 30 m^3	60.9364
Next 55 m^3	60.2673
Next 85 m^3	59.7433
Next 170 m^3	59.3527

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

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

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

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

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

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

Appendix D. Energy and Carbon Analysis Results

Energy

Low-Rise Residential

Figure D-1 below illustrates the Energy Use Intensity (EUI) of the baseline design, as well as the updated baseline incorporating various energy conservation and emission reduction measures for low rise residential archetype buildings which includes detached homes and townhomes.

As discussed in the Carbon section, low rise residential is already served by heat pump-based HVAC system, which results in lesser scope of energy savings for space heating. Solar PV panels tend to give more energy savings, since the electric EUI is offset up to a considerable extent by electricity generation through solar PV. Other than that, wastewater heat recovery DHW measure gives the best performing results with around 18% 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 site construction net floor area (approximately 88%).

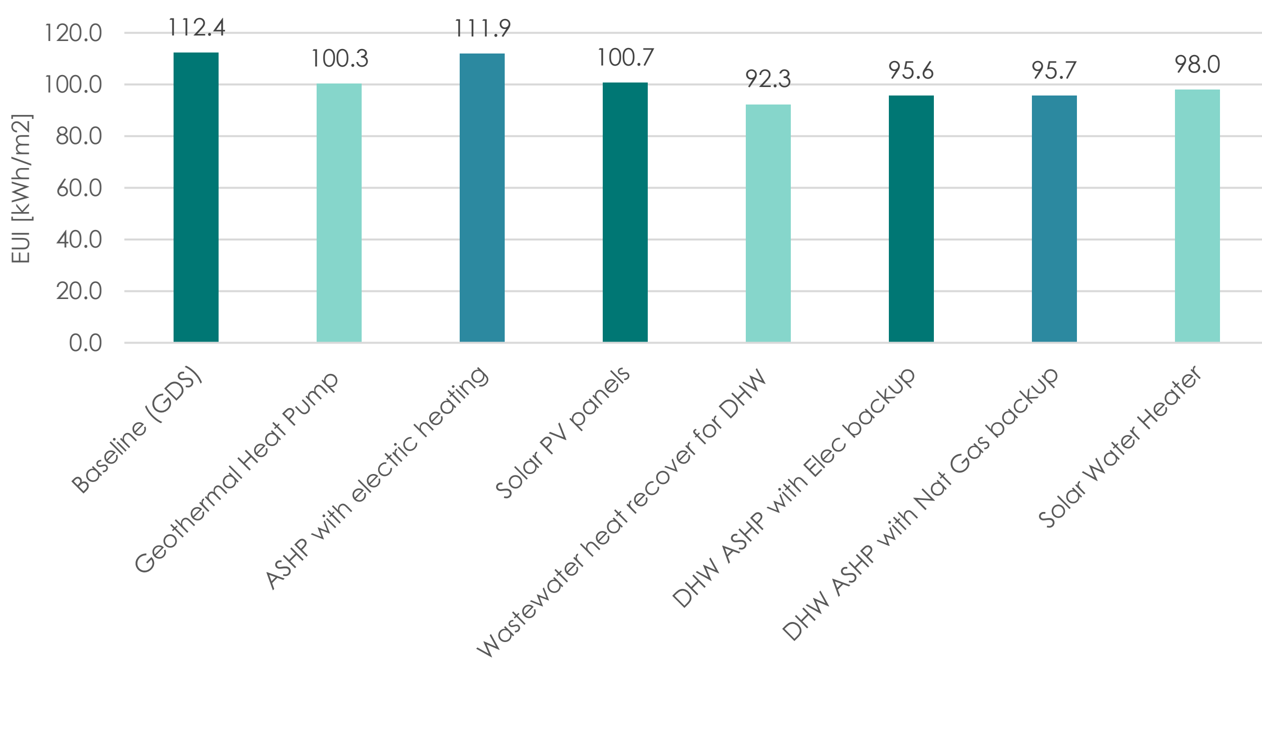

Figure D-1 – EUI Results for Low-Rise Residential

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

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

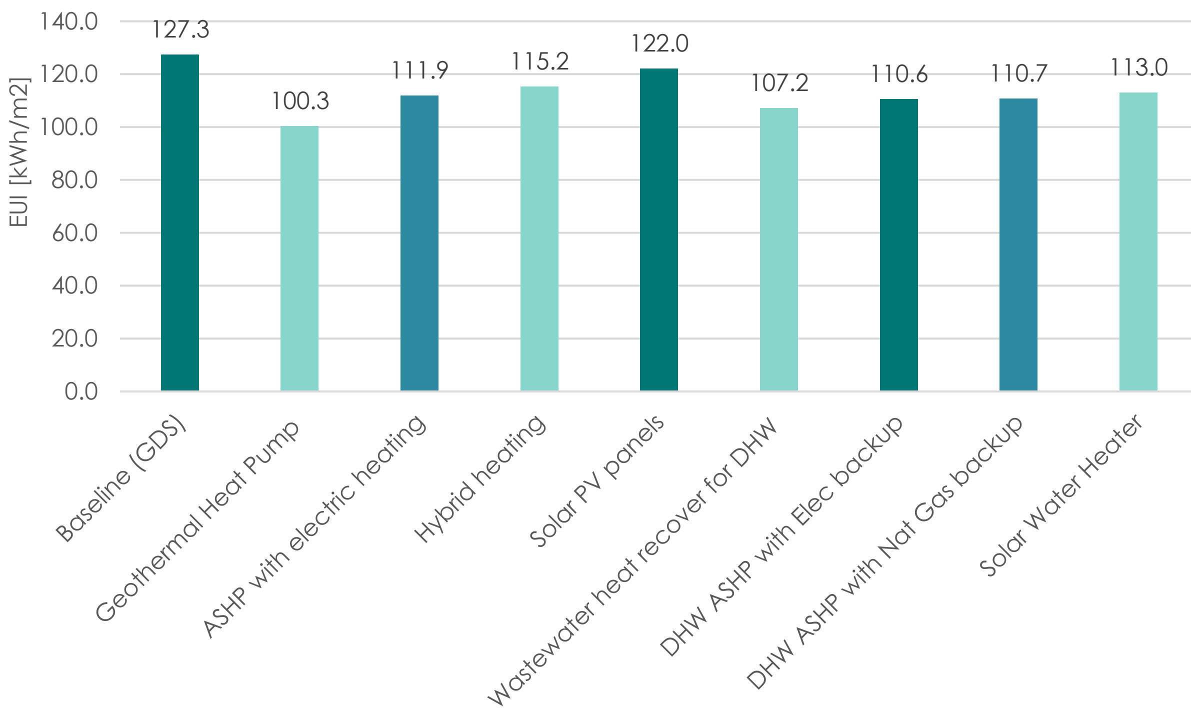

Figure D-2 – EUI Results for MURBs (<6 storeys)

Retail

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

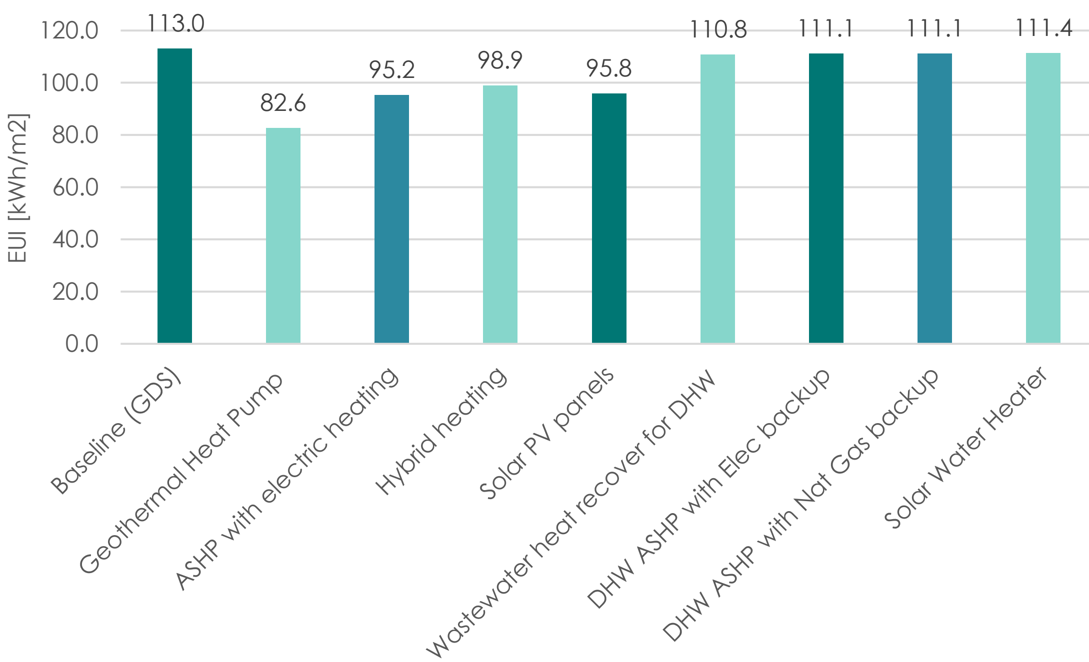

Figure D-3 – EUI Results for Commercial Retail

Carbon

Low-Rise Residential

Figure D-4 below illustrates the Greenhouse gas Intensity (GHGI) of the baseline design, as well as the updated baseline incorporating various energy conservation and emission reduction measures for low rise residential archetype buildings which includes detached homes and townhomes.

The GHGI performance with measures follows a similar trend as when considering the entire site. Measures focused on Domestic Hot Water (DHW) provide a greater scope for GHG reduction, as DHW in the baseline scenario relies 100% on natural gas and contributes approximately 58% of the emissions. Consequently, Energy Conservation Measures (ECMs) that focus on DHW tend to have a higher impact on reducing GHGI. DHW with wastewater recovery offer most GHGI reduction potential with around 59% expected GHGI reduction.

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

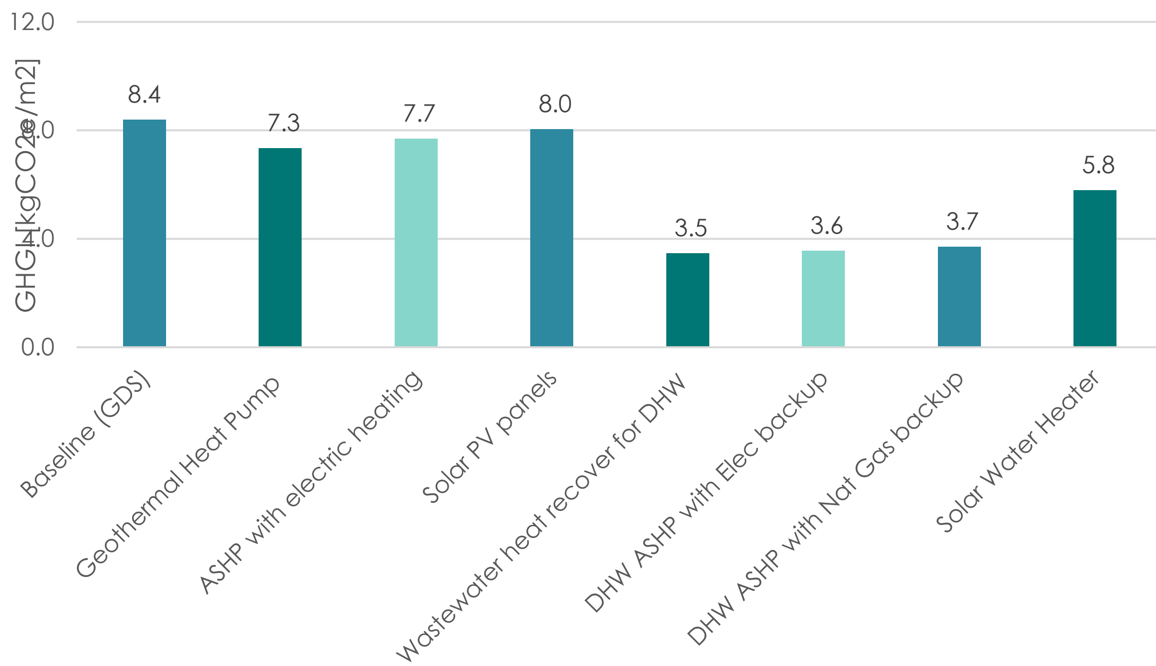

Figure D-4 – GHGI Results for Low Rise Residential

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

In contrast to the low-rise residential archetype, multi-unit residential buildings (MURBs) under 6 storeys tend to perform better in terms of emissions, as illustrated in **Figure D-5** below. Unlike low-rise residential buildings, MURBs are served by mid-efficiency boiler plant-based HVAC systems. As a result, space heating constitutes around 44% of GHGI emissions in the baseline, which is less compared to the 39% contribution by DHW. Therefore, measures focused on heat pumps and geothermal systems tend to reduce emissions more effectively compared to DHW measures. Geothermal heat pumps were assessed as the most effective GHGI reducing measure for this archetype with an estimated 44% GHGI reduction potential.

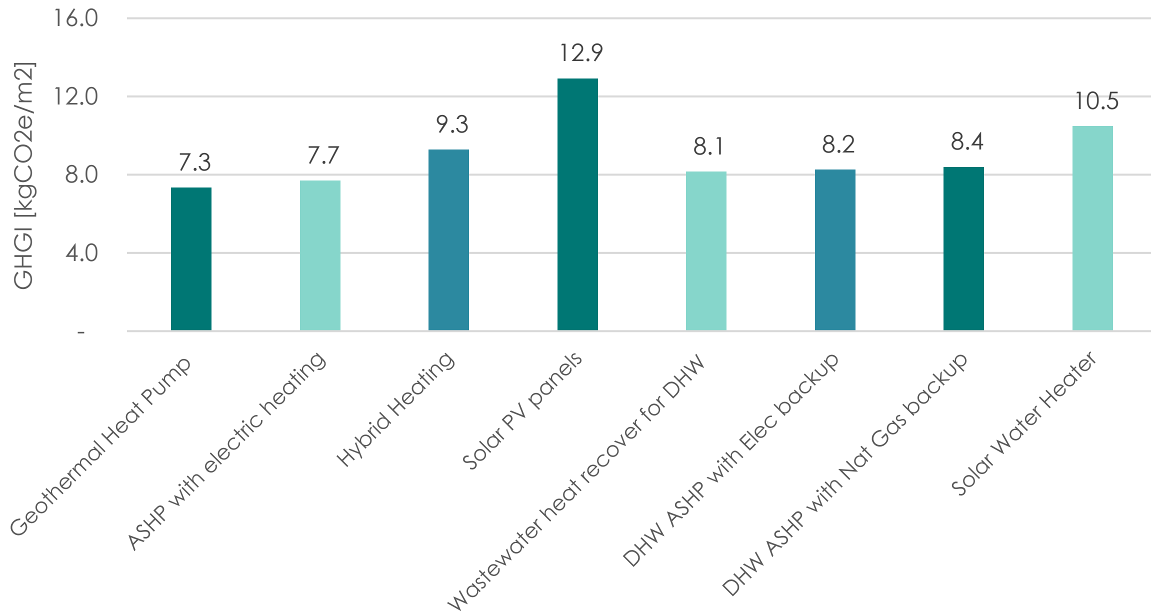

Figure D-5 – GHGI Results for MURBs (<6 storeys)

Retail

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

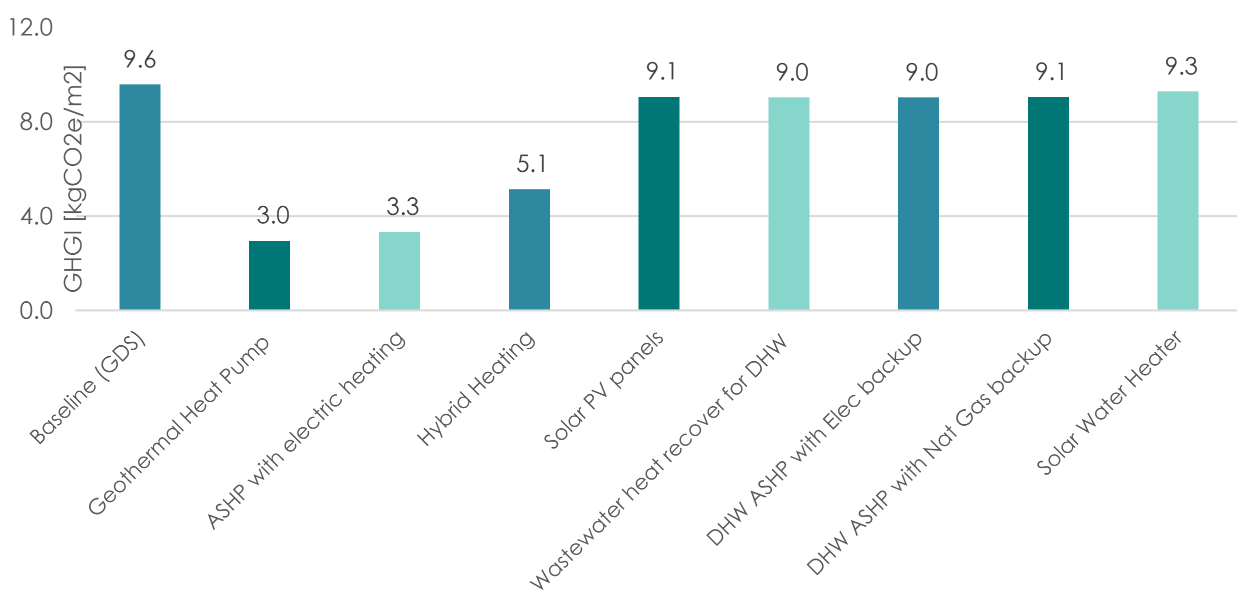

Figure D-6 – GHGI Results for Commerical Retail

Appendix E. Geothermal and Wastewater DES Analysis

Geothermal Analysis

The peak heating and cooling demand rate were obtained from the modelling analysis. The number of 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.

The cost per borehole were 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.

Wastewater DES Analysis

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 use for this calculation is described below-

- Population – 1,740 (per stats provided by planning consultant)
- Jobs -195 (as per stats provided by planning consultant)
- 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 simple formulae of thermal energy

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

- 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 **2,262,297 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 **1,357,378 kwh.** This value represents the thermal energy value to be plugged in the formula (1) discussed above.

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

Appendix F. 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 requirements significantly and would be relatively comparable to the **Baseline Scenario** or the baseline scenario with a geothermal heat pump option for peak demand. **Table 15** outlines estimated kW demand for the heating and cooling systems under consideration.

Table 15: Estimated Peak Demand of Alternate Heating/Cooling Systems

Heat Pump Options	Energy Demand (kW)
Baseline	45,276
Geothermal HX	45,276
Air Source HP	67,914
Hybrid HP	47,220

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 common areas). These connections would also prepare the building for a central heat pump.
    - Provide space for future vertical piping - Allocate vertical space from the parking through to the building level to the reverse return piping connections, in the form of sleeves over which flooring may be installed to avoid future costs. Service vestibules (elevator, garbage, corners of stair landings) may minimize the impact on space planning.
    - Provide space for the energy transfer station or central heat pump - Allocate parking spaces adjacent to the building core to create physical space for a future energy transfer station (ETS) or central heat pump. An ETS requires two (2) spaces, while a central heat pump would require approximately ten (10). MURBs using 4-pipe fan coil units in particular require additional power to be allocated for the future low carbon heating equipment. The estimated cost is $105/kVa.
    - Allocate power for the low-carbon heating source - A reasonable estimate is to double the power allocated to the cooling plant to account for the lower efficiency. When a similar technology is producing beneficial heat.

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

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