Alloa Secondary Plan Area

Community Energy and Emissions Plan

Town of Caledon, ON

Prepared for: Alloa Landowners Group

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Pratus Group Inc.

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Pratus

Issuance Approval

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A	June 24, 2024	Version 1.1	Christopher Mohabir, Zaid Khan	Eric Dunford	Oleksandra Onisko
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1. Executive Summary

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

1. Assess the anticipated energy requirements for the Secondary Plan Area based on prevailing development requirements for new building construction in the Town of Caledon (**Baseline Scenario**)
2. Identify strategies to improve energy conservation and reduce emissions within the Secondary Plan Area in alignment with the Town of Caledon's community-wide emissions reduction targets (**Near Net Zero Scenario**)
3. Assess the viability of community-based energy generation systems
4. Outline future actions that would enable further evaluation of opportunities for energy conservation and reduced emissions and promote successful implementation of strategies

The proposed Alloa Secondary Plan Area is expected to consist of 724 hectares of land, with 359 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 areas of denser development. The proposed building mix for the planned community includes freehold townhouses, detached homes, mixed used and medium density condos with an estimated total gross floor area of approximately 3,004,588 m^2.

Energy simulations were conducted to estimate energy use and carbon emissions that would be expected to be created if the Secondary Plan Area was ultimately built to meet standard requirements established by the Town of Caledon. 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 and Region decarbonization objectives.

Building Energy Systems Assessed

Scenarios were developed to guide and inform the community energy and emissions analysis as follows:

- **Baseline Scenario** – Predicted energy consumption and emissions production within the Secondary Plan Area based on the Town of Caledon Green Development Standard (GDS) Tier 1
- **Near Net Zero Scenario** – Proposed potential pathway to near net zero energy and emissions within the Secondary Plan Area

The **Near Net Zero Scenario** was constructed based on a composition of strategies identified through the analyses conducted that provide a pathway to a low-carbon development model to minimize the quantity of energy that must be supplied by any proposed community energy system. The energy results from analyses conducted were compared against the selected baseline scenarios to evaluate potential energy and carbon emission performance.

Various low-carbon design strategies and technologies were explored at a local level.

Transportation Systems Assessed

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
- **Transportation Case 2** – All parking spaces on site provided with EV Chargers

Transportation Case 1 used the 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.

Archetype Energy and Carbon Results

The relative energy and carbon emissions performance of the archetypes modeled for this CEERP are illustrated in **Table 1.** For the purpose of this study, the **Near Net Zero** energy system improvements were 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	Apartments	Constant volume corridor MUA and constant volume in suite ventilators served by condensing boiler and chiller	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	32%	72%
	Townhouses	3 season ASHP with natural gas backup		37%	82%
	Stacked Townhomes & Apartments	Constant volume corridor MUA and constant volume in suite ventilators served by condensing boiler and chiller		39%	84%
	Detached Homes	3 season ASHP with natural gas backup		32%	72%
Commercial	Commercial - Offices	FCUs/DOAS system served by condensing boiler and chiller		26%	71%
	Commercial - Retail	FCUs/DOAS system served by condensing boiler and chiller		38%	78%
Educational	Schools	RTUs served by natural gas and DX cooling		44%	84%
Employment	Office	FCUs/DOAS system served by condensing boiler and chiller		26%	71%

Category	Archetype	Baseline Design	Net Zero Design (Improvements over Baseline)	% Savings over Baseline	
				Energy	Emissions
	Retail	FCUs/DOAS system served by condensing boiler and chiller		38%	78%
	Industrial	Packaged gas-fired/DX cooling RTUs with gas unit heaters		70%	93%

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	-25%	-25%

Near Net Zero Scenario

Of the various building systems assessed, 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. The energy use and greenhouse gas intensity reduction potential between the baseline energy requirements 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/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		
118	-18	-8	-13	-1	-40	78
% of individual reduction	15%	7%	11%	1%	34%	

Table 3: Estimated GHGI Reduction Potential

Baseline Scenario GHGI [$kgCO_2e$ / m²]	Reduction Strategies [$kgCO_2e/m^2$]				Total Reduction Potential GHGI [$kgCO_2e$ /m²]	Near Net Zero Scenario GHGI [$kgCO_2e$ / m²]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
10	-3.3	-1.2	-4	-0.04	-8.5	1.5
% of reduction	33%	12%	40%	0%	85%	

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 **413.4 MW** for **Transportation Case 1** and **548.8 MW** for **Transportation Case 2**, representing additional capital cost requirements of approximately **$287.1 million** for Transportation Case 1 and **$396.2 million** for Transportation Case 2 respectively. These costs solely represent the anticipated cost for EV charging stations required and do not include additional electrical infrastructure costs such as for higher capacity transformers and sub-stations. It is not feasible to offset this 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** increases the energy demand and carbon emissions by an estimated **25%** from **Transportation Case 1**.

Table 3 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. This offers a comparison of the Town of Caledon's developments, at a minimum as per the GDS, compared to other municipalities in Ontario that use the existing Building Code.

Table 3: 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]	196	118	78	60%	34%
GHGI [kgCO2e/m2]	25	10	1	96%	85%

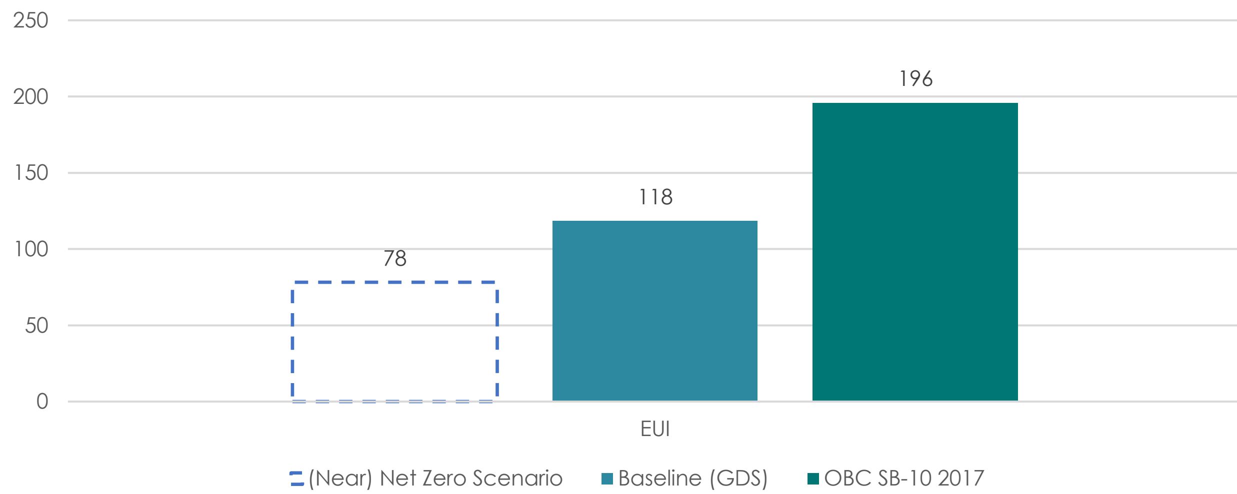

Figure 1: Estimated EUI Reduction Potential Reduction Potential Comparion to OBC and Baseline Scenario

The **Near Net Zero Scenario** provides a potential pathway to achieving a low-carbon development within the Plan Area that nearly achieves net zero carbon emissions for Alloa Secondary Plan Area. This potential roadmap is shown in **Figure 2** and **Figure 3**. Note that the pathways and upgrades outlined here assume future Plan-wide adoption at the local building level in order to demonstrate the full potential of each system.

Further energy and emissions conservation within the Secondary Plan Area would only be achievable through deployment of more compact and dense 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 action by the Province of Ontario and provincial utilities to achieve a zero-carbon electricity grid.

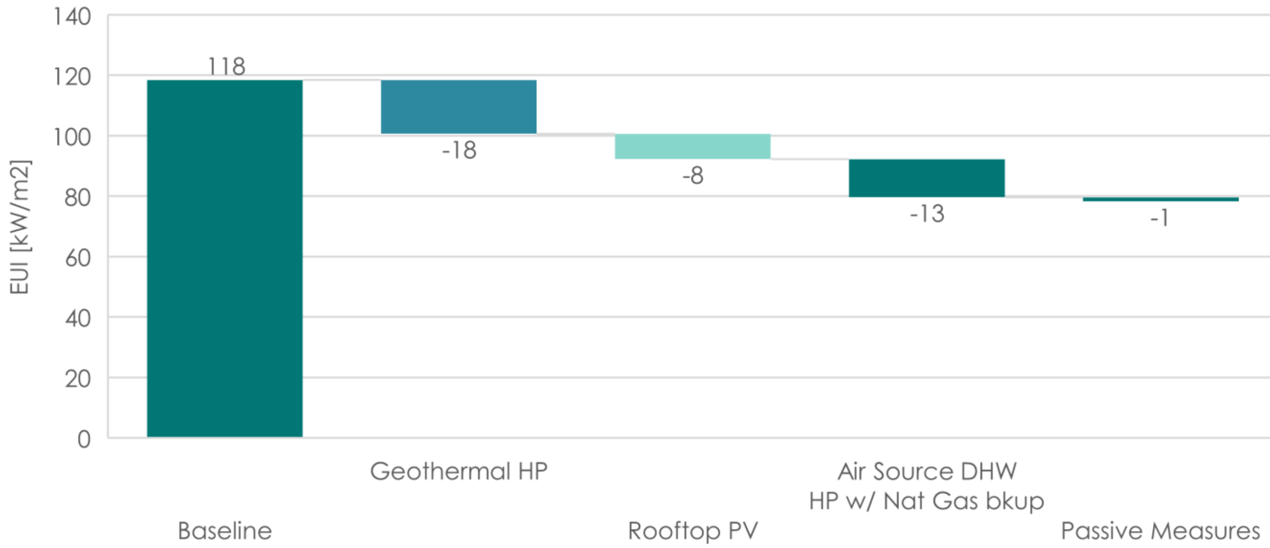

Figure 2: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential

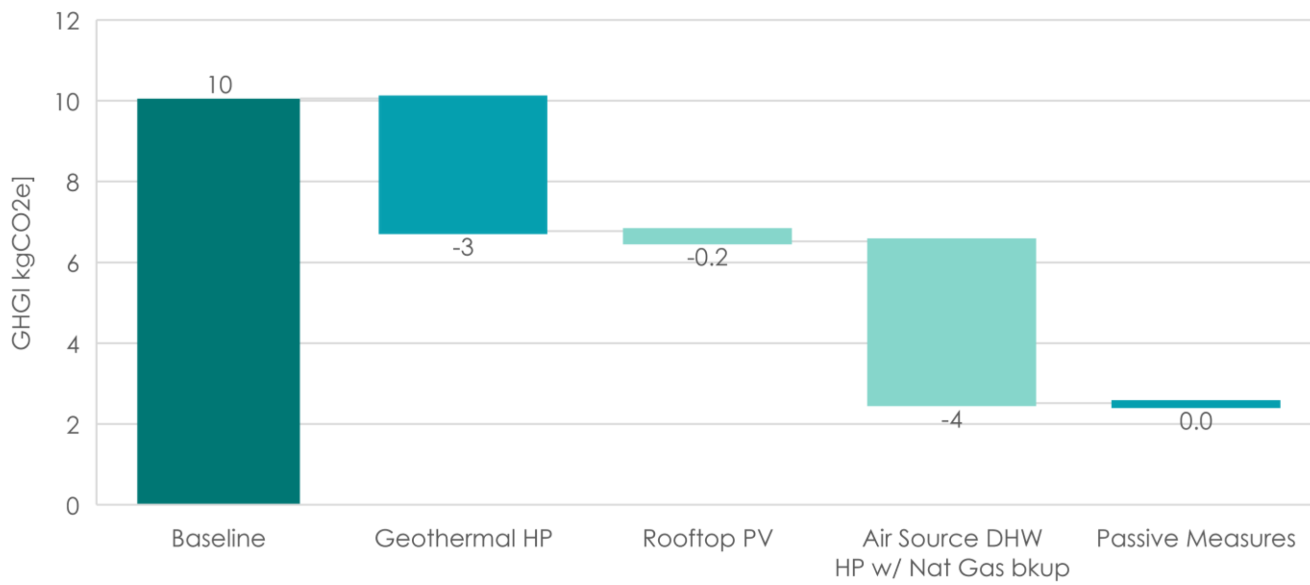

Figure 3: Greenhouse Gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

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 85% of the GHG emissions associated with the proposed building developments in the Alloa 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 $374M 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 $1.9 billion based on the Class D cost estimate conducted.
- The increased electricity demand posed by the proposed electric vehicle charging requirements cannot feasibly be met through on-site generation within the Secondary Plan Area and was therefore excluded from the **Near Net Zero Scenario**.
- District-scale energy generation is not feasible on this site due to the style of development, the expected density, the topography, and the development style of neighboring properties. Building-scale equivalents of the technologies reviewed are viable strategies for reducing emissions within the built environment.
- As all proposed energy conservation and emissions reduction strategies 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.

2. Introduction and Study Context

The Alloa 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. This community development is pursuing a Community Energy and Emissions Reduction Plan (CEERP) as per the requirements of the Region of Peel Official Plan 2051 (November 2022), designed as per the requirements of the Town of Caledon's Green Development Standard (GDS).

The purpose of the development of this CEERP is to explore opportunities to achieve significant energy conservation and emissions reduction in comparison to baseline practices for future community infrastructure that will be constructed within the Secondary Plan Area. Alternative energy systems are evaluated to determine how low emission buildings and transportation strategies can be utilized to reduce operational carbon to achieve a **Near Net Zero** energy and carbon emission system design for the Alloa Secondary Plan Area community development. Potential solutions were assessed based on their technical, spatial, and financial viability and their impact on GHG emissions for the proposed community development as currently envisioned.

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

2.1. Secondary Plan Area

The Alloa Secondary Plan Area development is planned for the south-west lands of Town of Caledon, Ontario as shown in **Figure 4**. The site is bound by the planned Highway 413 development to the North, Mayfield Road to the south, Chinguacousy road to the east, and Heritage Road to the west, as depicted in **Figure 5**. The conceptual plan for the proposed Secondary Plan Area includes two phases of development. the following types of neighbourhoods collectively in both Phase 1 and Phase 2:

- Residential Area – including townhomes, detached homes, apartments, stacked townhomes and mixed-use apartments.
- Schools – Includes existing and new proposed public schools; and,
- Commercial and Employment area – includes a mix of retail, office and industrial areas.

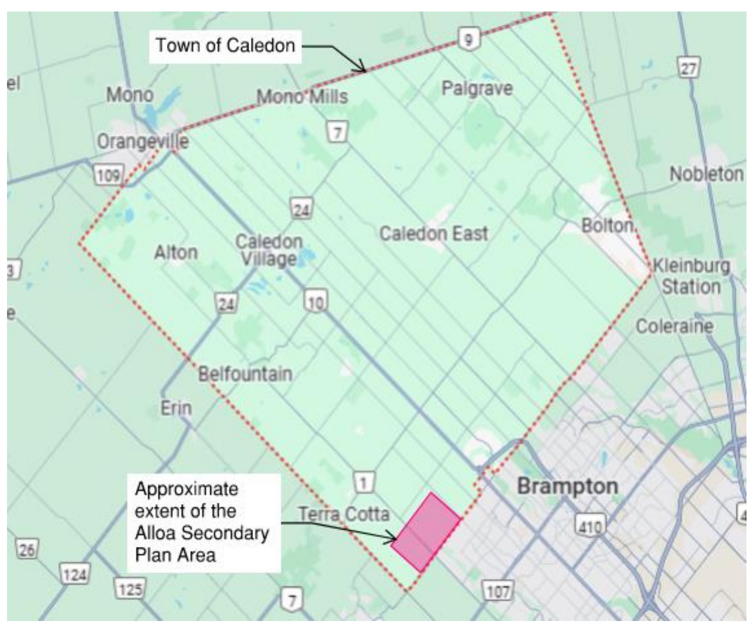

Figure 4: Approximate Extent of the Alloa Secondary Plan Area in the Town of Caledon

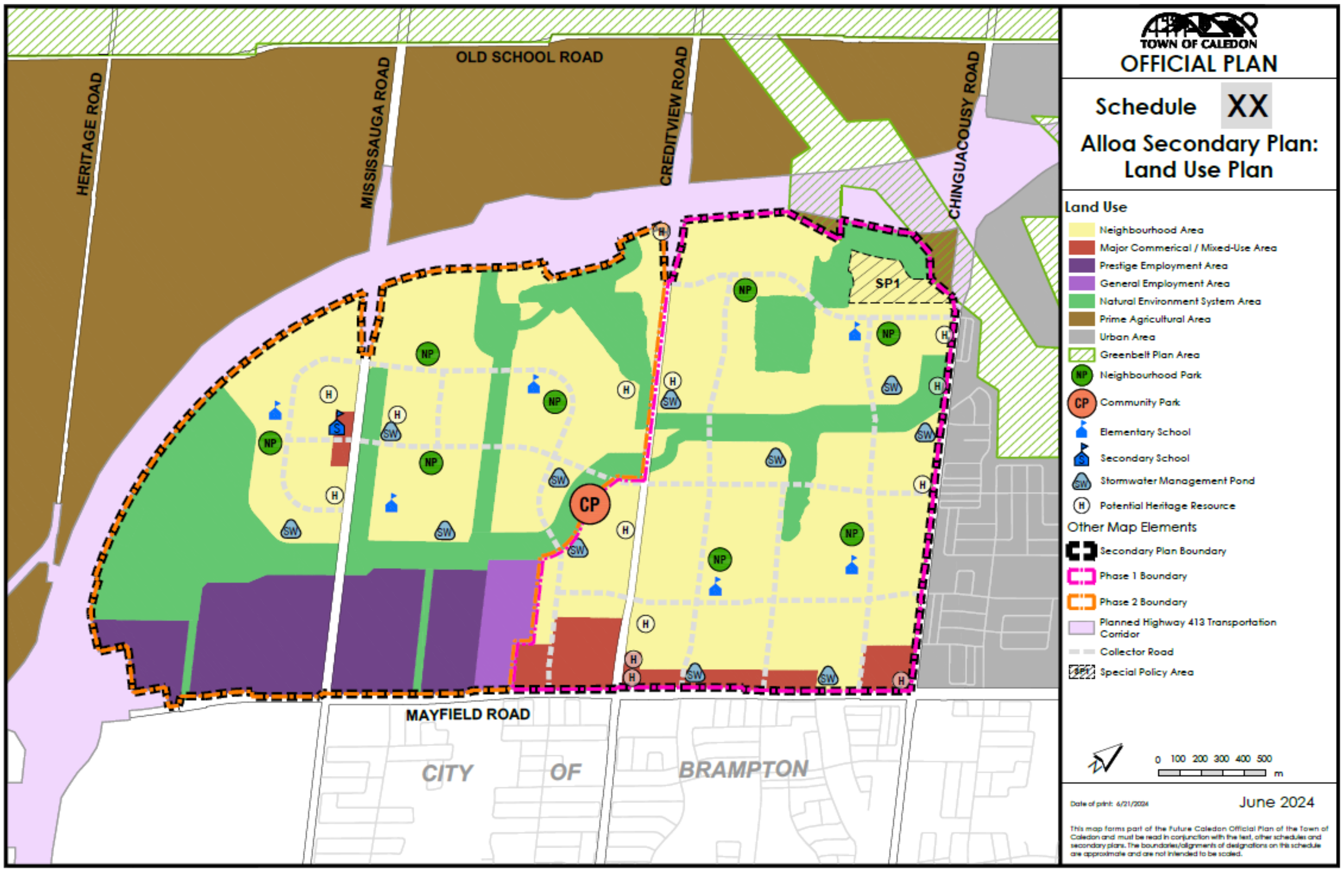

Figure 5: Proposed Conceptual Land Use Plan for the Alloa Secondary Plan Phases 1 & 2, June 2024 (Glen Schnarr & Associates Inc., 2024a)

As shown, Phase 1 of the proposed development constitutes the eastern half of the Secondary Plan Area. Phase 1 consists primarily of low-density residential development (shown in yellow) and higher density development along Mayfield Road to the south. Phase 1 also includes a proposed Special Policy Area at its northeast corner where higher density development is proposed than that currently afforded by zoning.

Phase 2 of the Secondary Plan Area will also primarily consist of low-density residential development. Phase 2 also includes significant employment lands (shown in purple) along Mayfield Road.

2.1.1. Demographics, Site Statistics and Building Types

The Alloa Secondary Plan Area will include a land area of approximately 724 hectares of land (including both Phase 1 and Phase 2) with a mix of land uses. 359 hectares of the total land area is expected to ultimately be developed into new buildings.

Of the total 724 hectares of land, 365 hectares were excluded from community energy analyses conducted. These lands were excluded as they are not expected to support construction of residential, commercial, educational, or industrial buildings. Areas were selected for exclusion based on their classification per the current land use policies and the proposed Land Use Plan.

Excluded areas include the following land use types:

- Natural Heritage System lands – 169.49 ha
- Roads (30% of the net community area) – 137.96 ha
- Stormwater management facilities – 32.21 ha
- Neighbourhood parks – 20.00 ha
- Community park – 5.00 ha

The proposed development plan for the community includes a variety of building types such as freehold townhouses, detached homes, mixed-use buildings, medium density stacked townhomes, and designated employment and commercial areas comprising office, retail, and industrial spaces. The total gross floor area of the proposed development is approximately 3,004,588 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 4** for reference. **Figure 6** shows a breakdown of the types of building within the Secondary Plan Area development.

Table 4: Alloa Secondary Plan Area Building Type Descriptions

Residential Building Types – Total 228.4 ha / 14,084 units

Low Rise (3 storeys or less)

Low Density Residential – Detached
– 58.2 ha / 3,589 Units

Medium Density Townhomes
– 68.8 ha / 4,242 Units

MURB (<6 storeys)

Medium Density Stacked Townhomes and Apartments
– 66.1 ha / 4,079 Units

MURB (> 6 storeys)

Mixed Use Apartments
– 35.3 ha / 2,174 Units

Non-Residential Building Types - Total 130.4 ha

Schools

Elementary and High School Buildings
- 23.8 ha

Industrial

Manufacturing plants, storage and warehouse buildings
Employment Area – 31.4 ha

Residential Building Types – Total 228.4 ha / 14,084 units	
Retail	**Office**
	
Strip malls, shopping plazas and malls Commercial Area – 6.2 ha Employment area – 31.4 ha	Workspaces (i.e., administrative, managerial, etc.) Commercial Area – 6.2 ha Employment Area – 31.4 ha

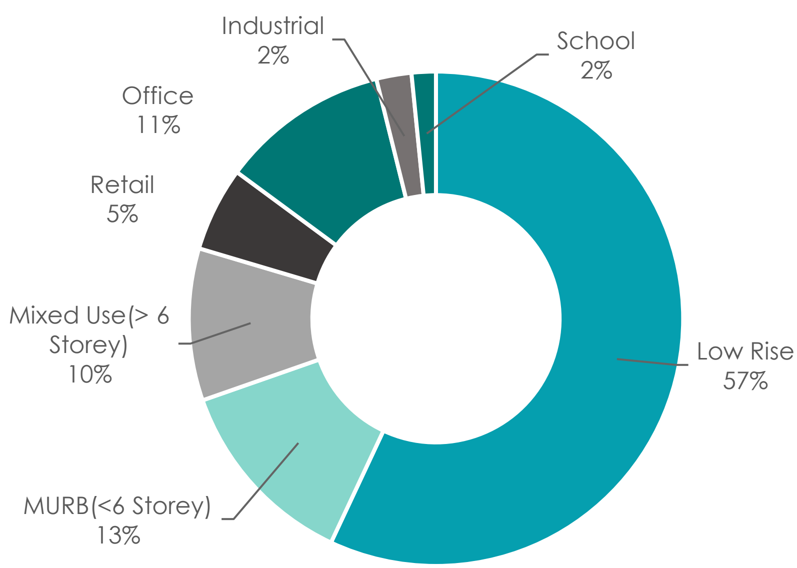

Figure 6: Alloa Secondary Plan Area Building Type Breakdown (GFA)

The total commercial footprint area as per stats provided is around 12.49 ha. It was assumed that the commercial area will ultimately be equally divided between office and retail spaces, with each occupying 6.245 hectares for the purposes of modeling energy consumption for these building types.

A similar approach was followed for the employment area. The total employment area of 94.09 hectares was divided equally into office, retail, and industrial spaces, with each type occupying approximately 31.36 hectares of footprint area.

2.2. CEERP and Net Zero Targets

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

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

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

2.3. Caledon Green Development Standard

The Town of Caledon has developed guidance for low-carbon building construction under its proposed Town of Caledon Green Development Standard (GDS). The Town of Caledon's GDS establishes a suite of long-term, low-carbon goals and strategies to reduce local greenhouse gas emissions and improve the community's health, grow the economy, and improve social equity.

The GDS establishes sustainable design requirements for new private and city-owned developments in Caledon for the first time. The GDS consists of tiers of performance measures with supporting guidelines that promote sustainable site and building designs. The GDS currently establishes Tier 1 as a 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 have been widely adopted by major jurisdictions across Canada (including the cities of Toronto, Ottawa, Vancouver, etc.) and have 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 5**.

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

Building Type	Energy and Carbon Performance Measures			EV Charging Requirements*
	TEUI [kWh/m²/yr.]	TEDI [kWh/m²/yr.]	GHGI [kgCO₂e/m²/yr.]	
Low Rise Residential (<3 storeys)	1. Design and Construct to a minimum: Tier 3 energy performance under NECB or recognized labelling program equivalent to ENERGY STAR for New Homes version 13.1 rev02 2. Reduce operational GHG by 20% OR 3. Design and construct to the current OBC and install hybrid heating systems			Minimum one charging space per dwelling unit.
Multi-unit Residential (>6 storeys)	15	135	50	Minimum 50% of parking spaces are EV-Ready.
Multi-unit Residential (≤6 storeys)	15	130	40	
Commercial Office	15	130	30	Total of 20% parking spaces are EV-Ready. Minimum 5% of spaces to be equipped with EV Supply Equipment (EVSE).
Commercial Retail	10	120	40	
Industrial	15	130	60	

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

2.4. District Energy Systems

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

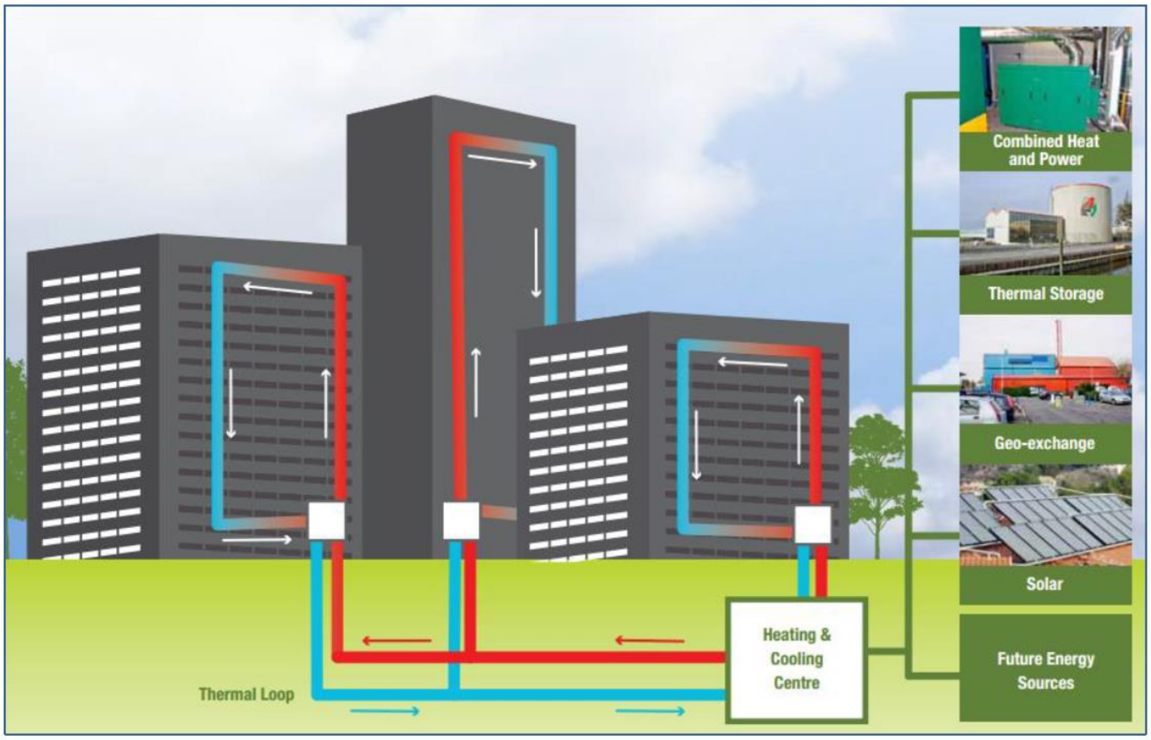

Figure 7 – Illustration of the function of a District Energy System (City of Toronto, 2016a)

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 Alloa Secondary Plan Area were estimated using a simulation-based approach which included:

1. Establishing baseline energy consumption requirements
2. Simulating potential energy conservation and emissions reduction measures
3. Analysis and interpretation of modeling results

This provided insight into how the buildings in the proposed Secondary Plan Area were responding to energy conservation and emissions reduction measures.

Potential energy conservation measures were chosen based on the 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 location and site orientation dependent and can vary across the Secondary Plan Area.

To reduce the variability in the analysis and directly evaluate the energy consumption and carbon emission results for each building archetype, the study initially focused on studying active energy conservation measures such as alternate HVAC systems, and then studied on-site renewable energy. 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 1compliant building (the Baseline Scenario). As a result, GHG and energy reductions are compared directly against the GDS Tier 1 baseline 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, which namely consists of enclosure upgrades, have 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, play 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 (Table 5 in Section 2.3)
- **Near Net Zero Scenario** – A potential pathway to near net zero energy and emissions

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

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

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

3.1.1. 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 focus on 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 B**.

Table 6 summarizes the technologies that were assessed as part of the development of this study. The technologies include various heat pump system options, where heat pumps are systems that extract or reject heat from one source (air, water, geothermal, etc.) and transfer it to building spaces that require it in the heating or cooling seasons, respectively. This technology saves energy as heat is transferred rather than generated in conventional heating systems. Other technologies that were studied included domestic hot water (DHW) source options in which efficient and low-carbon HVAC options were suggested to serve DHW loads from buildings; a change from traditional natural-gas sources.

Table 6 - Low-Carbon Building Technologies Assessed

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

3.2. Transportation Systems

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

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

Transportation Case 1 used the Town of Caledon GDS as a baseline which assumes a minimum number of EV chargers required based on dwelling type and population, as per **Table 5**. 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 Alloa Secondary Plan Area development is 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

DESs are significant in scale, complex to implement, and rely on interconnections and supporting infrastructure to function effectively. The current secondary plan area, lot layouts, street grids, and associated infrastructure limits the ability of the site to support prospective community energy systems. DES systems are evaluated based on factors including spatial feasibility and infrastructure constraints. This CEERP aimed to capture the maximum potential of each system being analyzed and assumed that the DESs being analyzed will service the entire site and achieve a 100% adoption rate.

Potential district energy systems considered for the Alloa Secondary Plan Area are outlined in **Table 7**:

Table 7 - Overview of the types of energy delivered by DES

DES 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	Electrical or thermal energy production using process waste and/or biofuels.
PV Array (District Level)	Composite panels that convert solar energy into electricity to be used on site or exported to the grid.
Water Source Exchange System	Acts as a heating source during the winter season and heat sink during the summer season.
Sewage Waste Heat Recovery	Makes use of water source heat pumps (that rely on electricity) to harness heat from sanitary water flows (i.e., the water body acts as both a heat source and heat sink). **Note that no electrical energy is produced from this system.*

3.3.1. Policy Barriers

When considering DES within the Plan Area, the Alloa secondary Plan presents some challenges for implementation. While the current site has ample space available to consider DES options, the following policy barriers exist that make it a less feasible option:

- **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 reduces the potential land available to support energy generation capacity. These public land sites are the most attractive for borehole drilling due to the relatively open space provided and surface space available. Energy transfer stations can be integrated into the private sector lands, however, there may be restrictions based on competing needs for private development which are likely to present cost and implementation barriers. It may be necessary for the Town of Caledon to purchase sections of privately owned land to deploy DES.
- **Right of Way (ROW) and Utility Design:** The implementation of potential DES 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 DES solutions 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.

Additionally, the quantity of detached dwellings require extensive infrastructure for DES, leading to additional costs. Typically, a DES is suited to serve multifamily complexes and large institutional facilities. While infrastructure costs are generally addressed within the scope of this study, pricing is limited to capital costs and maintenance costs of equipment only and does not account for additional costs the DES provider may incorporate into their cost structure.

4. Results

The relative energy and carbon emissions performance of the archetypes modeled for this CEERP are illustrated in **Table 8.** For the purpose of this study, the **Near Net Zero Scenario** energy system improvements were implemented across all building archetypes.

Table 8 - 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	Apartments	Constant volume corridor MUA and constant volume in suite ventilators served by condensing boiler and chiller	Installation of Solar photovoltaic systems, geothermal heat pump system for HVAC, and upgradation of domestic hot water to ASHPs with natural gas back up from 100% gas and passive measures	32%	72%
	Townhouses	3 season ASHP with natural gas backup		37%	82%
	Stacked Townhomes & Apartments	Constant volume corridor MUA and constant volume in suite ventilators served by condensing boiler and chiller		39%	84%
	Detached Homes	3 season ASHP with natural gas backup		32%	72%
Commercial	Commercial - Offices	FCUs/DOAS system served by condensing boiler and chiller		26%	71%
	Commercial - Retail	FCUs/DOAS system served by condensing boiler and chiller		38%	78%
Educational	Schools	RTUs served by natural gas and DX cooling		44%	84%
Employment	Office	FCUs/DOAS system served by condensing boiler and chiller		26%	71%
	Retail	FCUs/DOAS system served by condensing boiler and chiller		38%	78%
	Industrial	Packaged gas-fired/DX cooling RTUs with gas unit heaters		70%	93%

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	-25%	-25%

4.1. Energy and Carbon

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

The 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 ECMs were 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 C**.

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.

The most impactful energy reduction measure for the entire site is the use of Solar PV panels with an estimated 34% savings over the baseline. This measure is followed by both heat pumps-based space heating measures and DHW measures, as they have comparable performances. Overall, the geothermal heat pump option is the most efficient measure with an estimated potential for15% in energy savings.

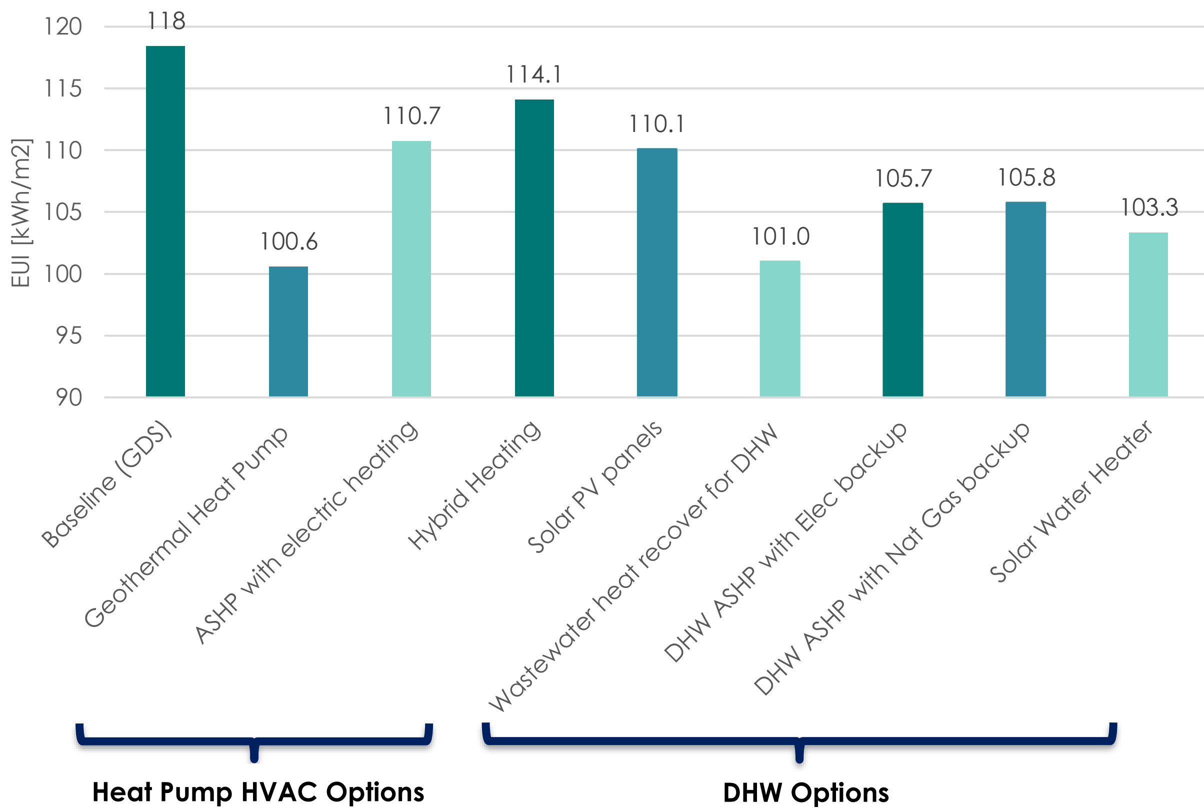

Figure 8 - Energy Use Intensity Results for Each HVAC System Assessed

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 Domestic Hot Water (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 45% of the greenhouse gas (GHG) emissions in the **Baseline Scenario**. This reliance provides substantial potential for GHG reduction through DHW measures.

In contrast, measures focused on heating have a lesser impact on the Greenhouse Gas Intensity (GHGI) 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 use of three-season air heat pumps in low-rise residential areas per the GDS. As low-rise residential buildings constitute approximately 70% of the site area, low-carbon space heating was already assumed for the majority of the Plan Area. Consequently, there is less room for improvement in GHGI through heating measures.

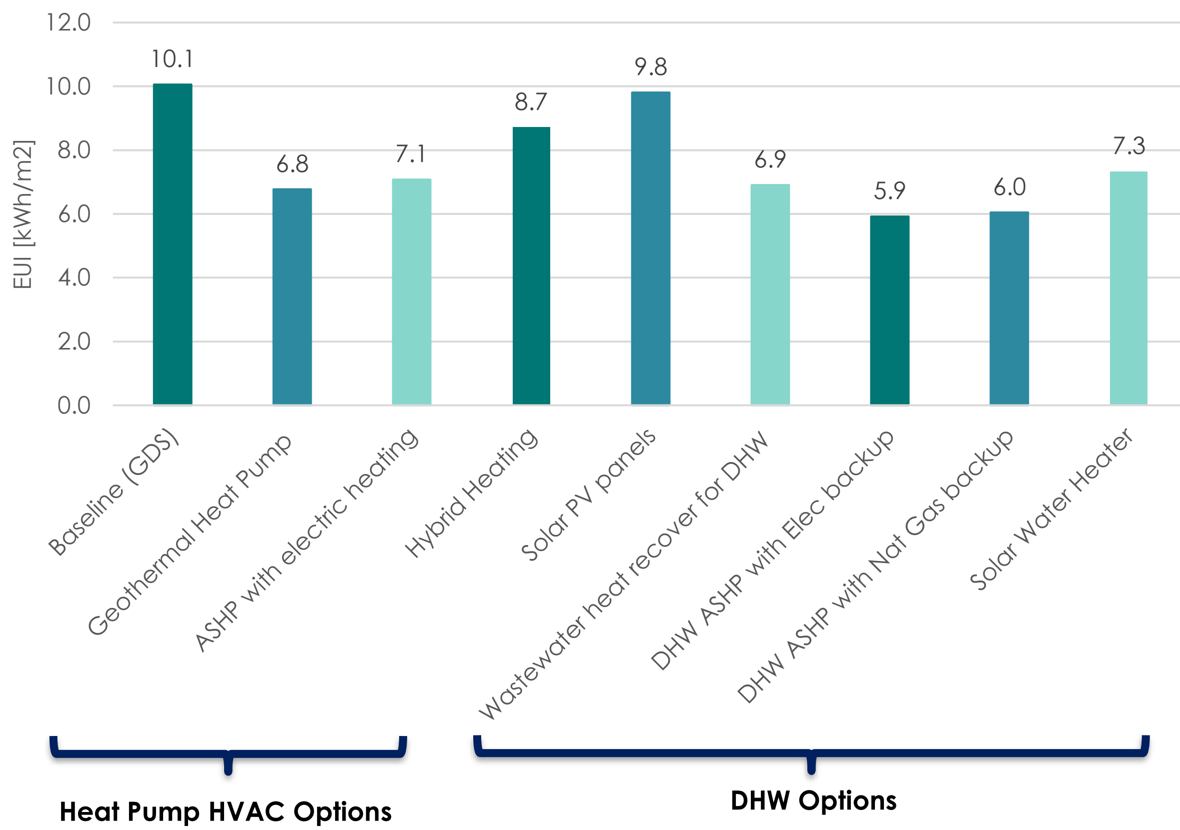

Figure 9 - Greenhouse Gas Use Intensity Results for Each HVAC System Assessed

4.2. Cost

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

Equation 1, as outlined in **Figure 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 9** below.

Equation 1 - Total Cost

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

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*

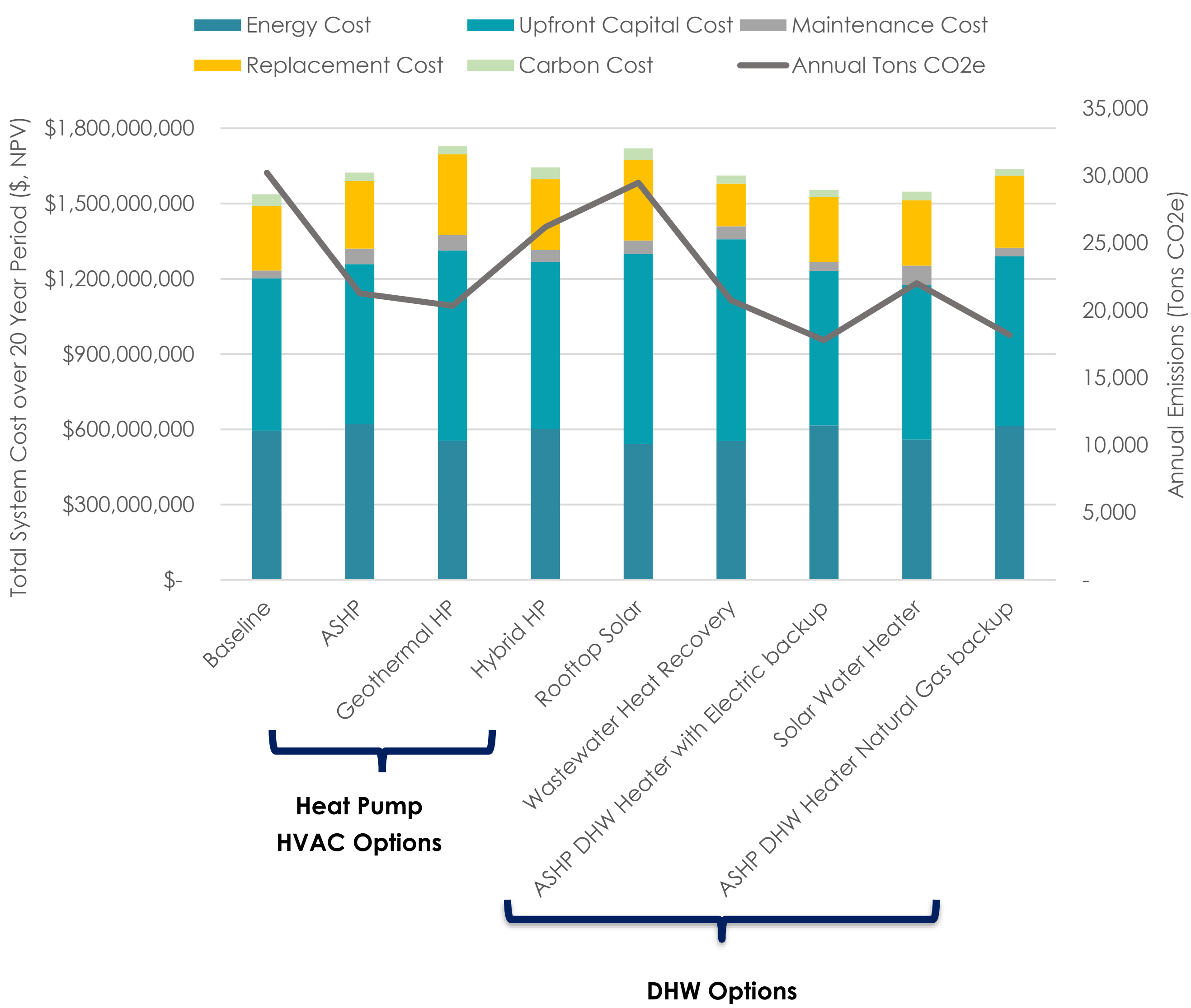

Figure 10: Total System Cost over 20 Year Period (NPV) of Each System Assessed Along with Annual CO_2e Associated with Each Measure

20-year costs are broken down by their respective cost components. While HVAC systems tend to have higher upfront and replacement costs than PV and DHW systems, their associated annual emissions are notably much lower. Note that upfront costs for the two potential DES i.e. sewage (wastewater) heat recovery and the geothermal solution are limited to equipment capital costs and borehole drilling/cistern installation, maintenance costs of this equipment and replacement cots and does not account for additional costs the DES provider may incorporate into their cost structure. 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 9**.

Table 9: HVAC System Class D Estimate Cost Analysis

HVAC Option	System Type	Cost Analysis	Est. 20-Year NPV Cost (Scenario 1)	Incremental Cost of Near Net Zero Condition (Scenario 2)
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.	$ 1,536,559,000	
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.	$ 1,622,892,000	$ 86,333,000
Geothermal HP	Heat Pump	Largest impact on GHG emissions at incremental cost over the Baseline Scenario. 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.	$ 1,727,971,000	$ 191,412,000
Hybrid HP	Heat Pump	Moderate impact on GHG emissions reduction at reduced incremental cost over the Baseline Scenario. On-site kW demand is a non-factor for this system type.	$ 1,643,612,000	$ 107,053,000

Renewables	System Type	Cost Analysis	Est. 20-Year NPV Cost	Incremental Cost of Near Net Zero Condition (Scenario 2
Rooftop Solar	Electricity Production	Negligible impact on GHG with significant additional cost.	$ 1,720,574,000	$184,015,000
DHW Option	**System Type**	**Cost Analysis**	**Est. 20-Year NPV Cost**	**Incremental Cost of Near Net Zero Condition (Scenario 2**
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.	$ 1,611,905,000	$ 75,346,000
ASHP DHW Heater w/ Electrical backup	DHW Heating	Notable impact on GHG emissions. The inclusion of electrical backup heating system gives furthermore GHG savings as compared to option with natural gas backup	$1,554,613,000	$18,054,000
Solar Water Heater	DHW Heating	Reduced GHG benefits as other DHW upgrades at costs relatively comparable to an ASHP Heater.	$1,547,479,000	$10,920,000
ASHP DHW Heater w/ Natural Gas backup	DHW Heating	Notable impact on GHG emissions. The inclusion of natural gas backup heating systems mitigates on site kW impacts.	$1,638,956,000	$102,397,000

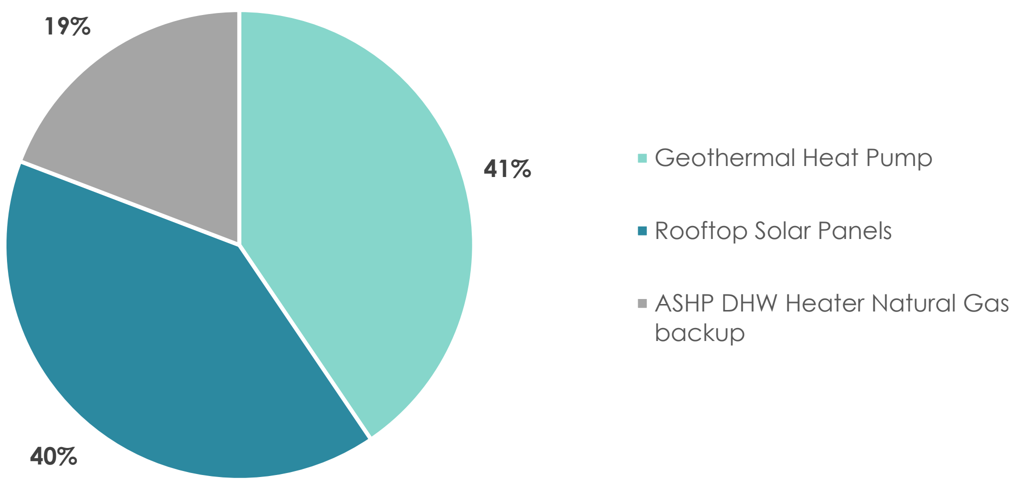

Figure 11: Total Incremental Upfront Capital Cost Distribution of Each Proposed Measure

The implementation of the ECMs in net zero scenario include 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 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 $374M, or 62% more (refer to **Figure 12**).

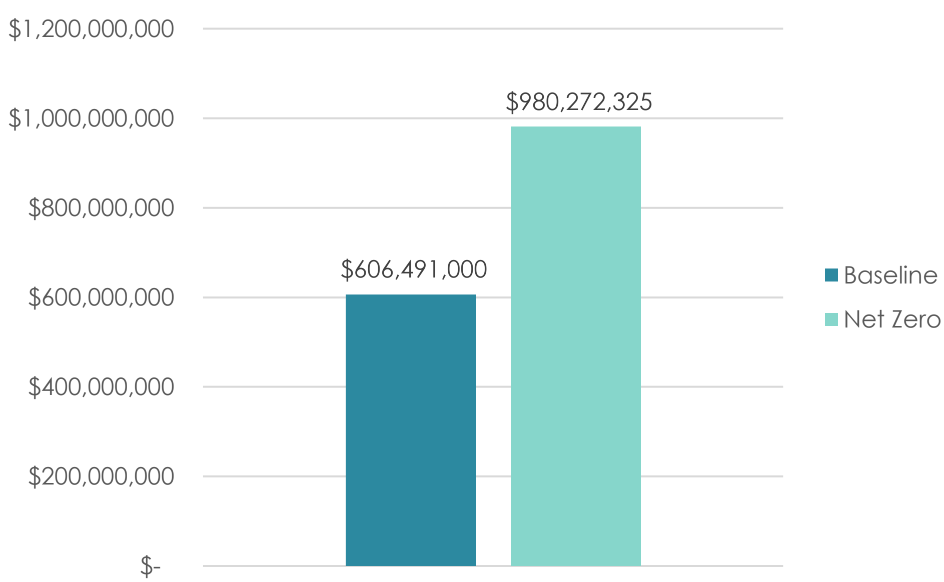

Figure 12: Total Incremental Upfront Capital Cost vs. Baseline Scenario

4.3. Traffic Vehicles & EV Charging

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

The overall energy demand estimated to provide EV chargers within the Alloa Secondary Plan Area is summarized in **Table 10**.

Table 10: 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	27,528	181,684	3,708	231,751	413,434	20,672	**$287,088,469**
Case 2 – 100% EV Chargers	34,170	225,524	5,172	323,261	548,785	27,439	**$396,222,201**

**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 Alloa 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 **25%** over **Transportation Case 1**.

4.4. Roadmap to Near Net Zero Discussion

Table 11 and **Table 12** 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 11 : 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		
118	-18	-8	-13	-1	-40	78
% of individual reduction	15%	7%	11%	1%	34%	

Table 12: 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 [$kgCO_2e$ /m²]
	Geothermal Heat Pump	Solar Rooftop PV	Air Source DHW HP with Gas Backup	Passive Measures		
10	-3.3	-1.2	-4	-0.04	-8.5	1.5
% of individual reduction	33%	12%	40%	0%	85%	

Table 13 and **Figure 13** summarizes 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 13: 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]	196	118	78	60%	34%
GHGI [kgCO2e/m²]	25	10	1	96%	85%

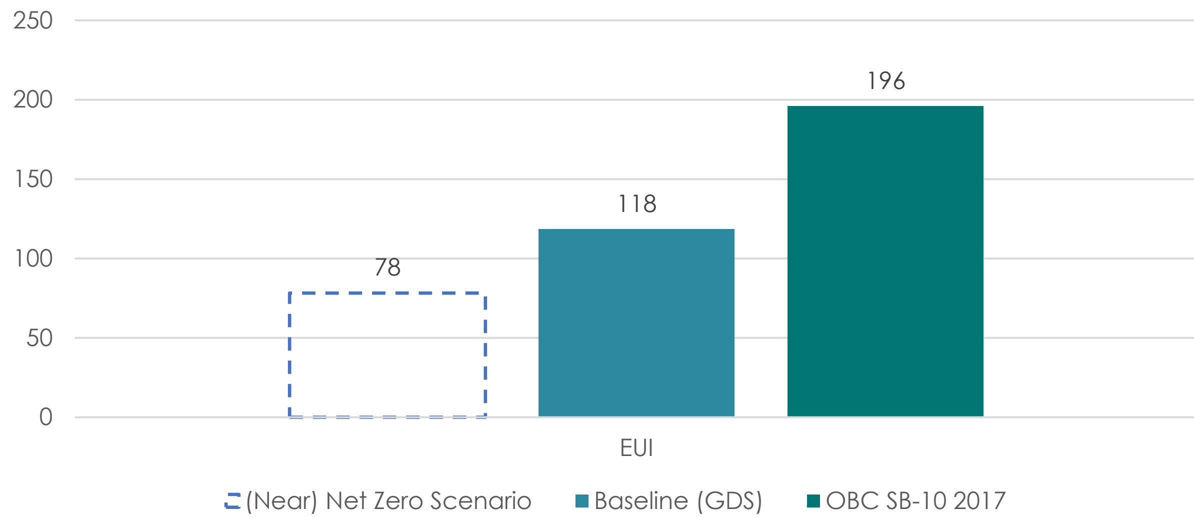

Figure 13: Estimated EUI Reduction Potential Reduction Potential Comparion to OBC and Baseline Scenario

The **Near Net Zero Scenario** is meant to provide a potential pathway to near net zero carbon emissions for the Alloa Secondary Plan Area, is visually presented in **Figure 14** and **Figure 15** showing how each strategy considered viable reduces the energy and carbon emission demand.

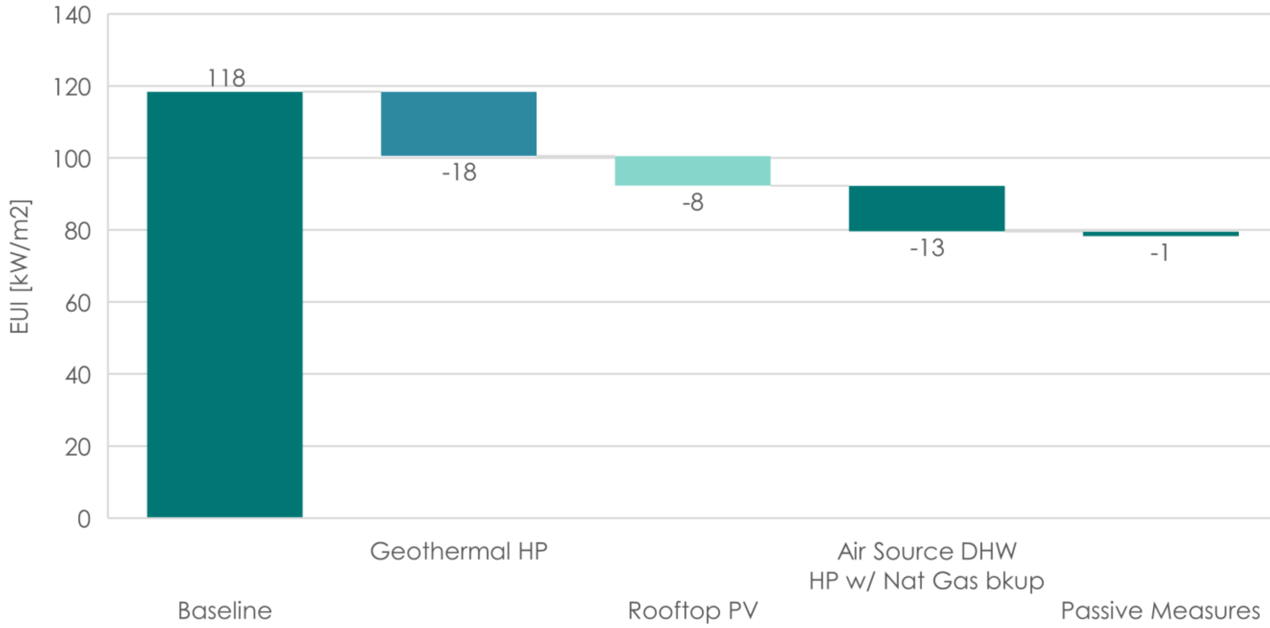

Figure 14: Energy Use Intensity Reduction Roadmap demonstrating EUI reduction potential

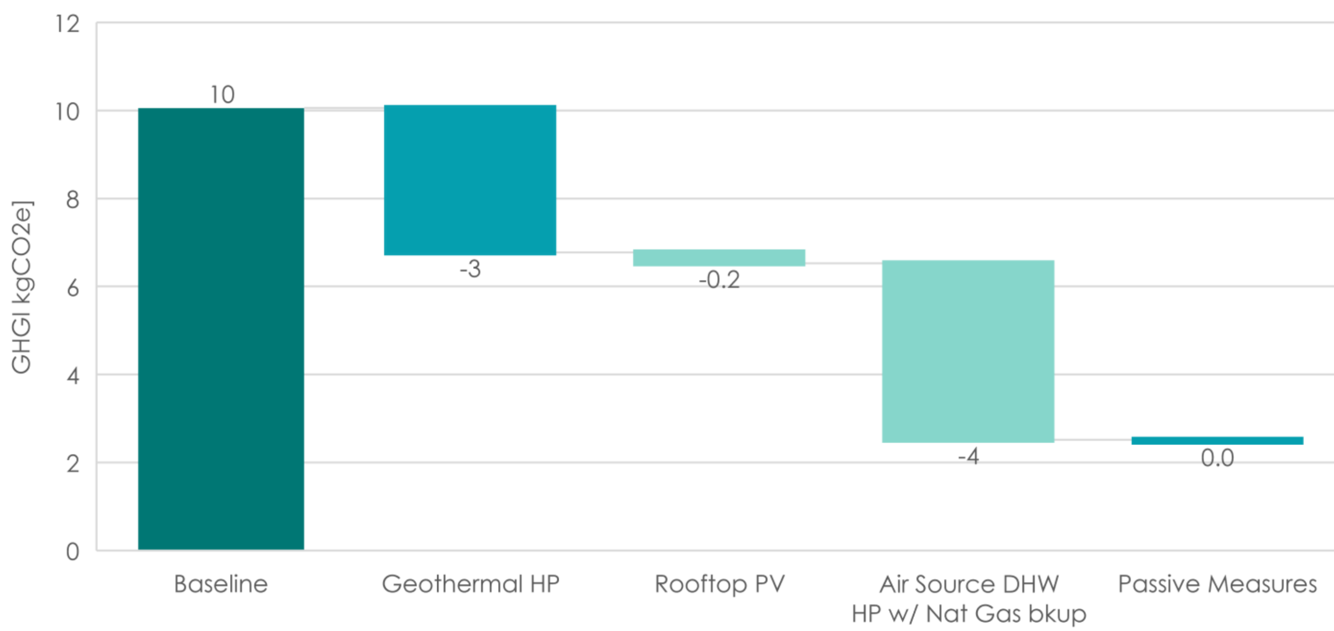

Figure 15: Greenhouse gas Intensity Reduction Roadmap demonstrating GHGI reduction potential

Therefore, the **Near Net Zero Scenario** as modeled achieves an EUI of 45 kWh/m^2 and a GHGI of 1kgCO_2e/m^2. This represents 62% savings in EUI and 90% in GHGI over the **Baseline Scenario**.

The 20 Year NPV total cost of implementing the strategies in this scenario is expected to be **$1.9 billion**, based on the Class D cost estimate conducted, in **Section 4.2.** The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$373.8 million**. Passive measures are not reflected in this cost estimate as they are site dependent and will vary throughout the implementation process.

Table 14 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 14: 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	$1,727,971,000	$151,802,000
Solar Rooftop PV	$1,720,574,000	$151,800,000
Air Source DHW HP w/gas backup	$1,638,956,000	$70,176,000
Near Net Zero Scenario Total Cost	**$1,861,953,316**	**$373,778,000**

4.5. 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.

4.5.1. 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).

4.5.2. 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	163,500
Geothermal HX	163,500
Air Source HP	235,500
Hybrid HP	170,000

4.5.3. 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.

5. Implementation

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

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

Actions	Timeline	Relevant Documents	Responsibility
1: Building-Scale Measures			
Confirm energy and emissions performance targets for all building typologies defined by the Tier 1 requirements of the final published Town of Caledon Green Development Standard.	Green Development Standard	Site Plan	Town of Caledon
Engage with renewable energy providers (solar and geothermal) and utility companies to confirm design requirements for building-scale systems and financial models available for operating these systems.	N/A	Site Plan	Building Developers
2: Electric Vehicle Infrastructure			
Confirm total required electric vehicle charging capacity and infrastructure requirements by building type based on the Caledon Green Development Standard and integrate infrastructure requirements outlined within the Standard.	Green Development Standard Architectural & Urban Design Guideline	Site Plan	Town of Caledon Hydro One Networks Inc.
Confirm service capacity and cost through service providers based on expected total electrical demand requirements for the Secondary Plan Area for electric vehicles based on the standards and requirements communicated by the Town of Caledon.	N/A	Official Plan Amendment	Town of Caledon Hydro One Networks Inc.

6. Conclusion

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

In terms of transportation systems, EVs and their associated infrastructure requirements are expected to impose a significant electricity demand - approximately 413.4 MW for **Transportation Case 1** and 548.8 MW for **Transportation Case 2,** representing additional capital cost requirements of approximately $287.1 million for **Transportation Case 1** and $396.2 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**.

The **Near Net Zero Scenario** achieves an EUI of 78 kWh/m^2 and a GHGI of 1 kg CO_2e/m^2. This represents 34% reduction in EUI and 90% reduction in GHGI over the baseline scenario.

The 20 Year NPV total cost of implementing the strategies in this scenario is expected to be **$1.9 billion**, based on the Class D cost estimate conducted. The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$373.8 million**.

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

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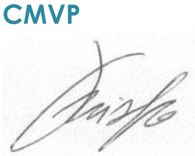

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Appendix A. Site Plan and Statistics

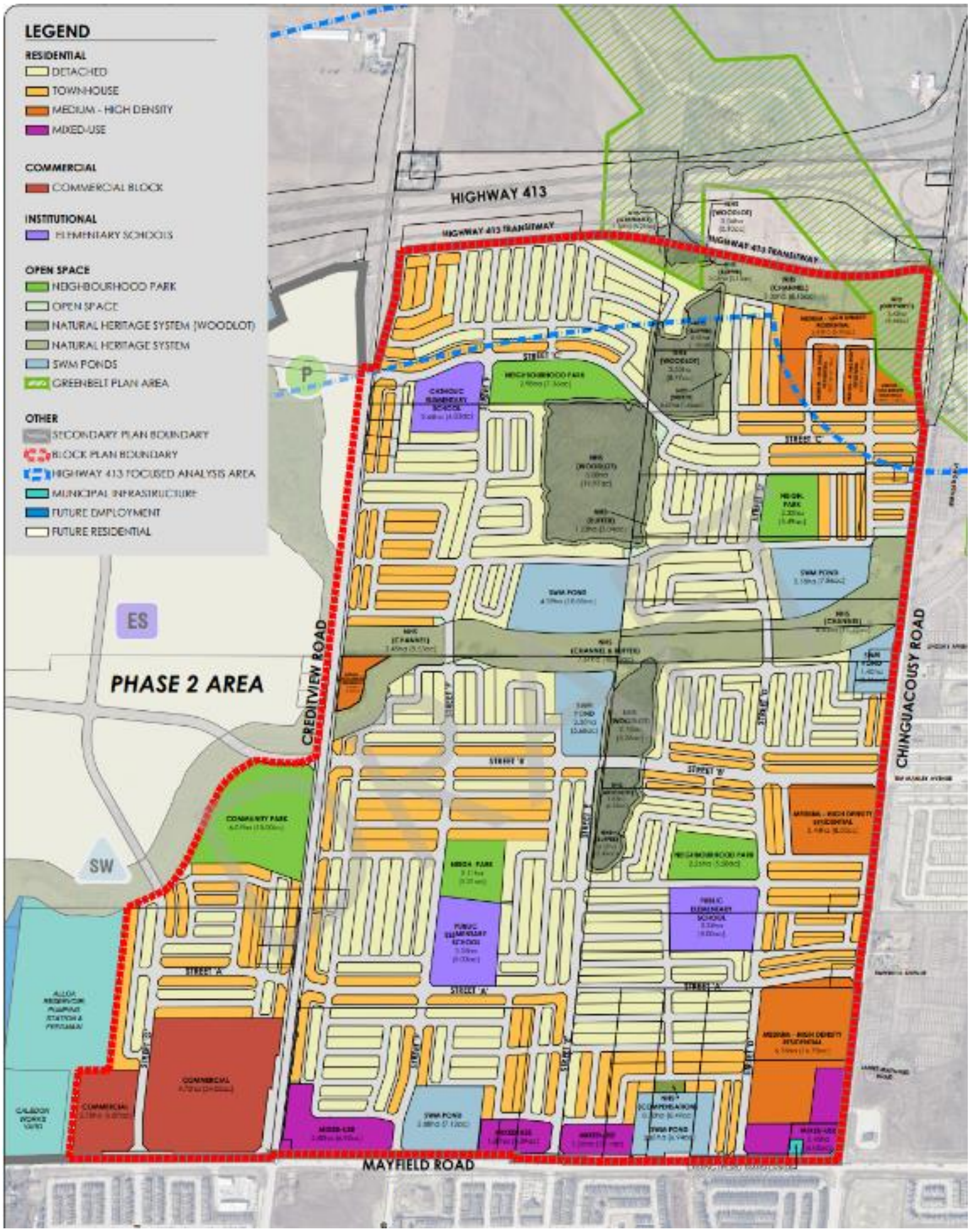

Figure A-1 – Proposed Conceptual Plan of the Alloa Secondary Plan Phase (Glen Schnarr & Associates Inc., 2024a)

Alloa Secondary Plan Development Statistics

TABLE 1

	AREA (ha)	AREA (ac)
Alloa Secondary Plan Community Area	724.38	1789.9
Deductions (As Per Growth Plan)		
Natural Heritage System	169.49	418.8
Employment Area	95.04	234.8
Net Community Area	459.85	1136.3
Target Community Area Population and Jobs (@ 67.5 P+J/ha)	31,040	

TABLE 2

	AREA (ha)	AREA (ac)
Alloa Secondary Plan Employment Area	95.04	234.8
Target Employment Area Jobs (@ 26 Jobs/ha)	2,471	

Total Alloa Secondary Plan Target Population and Jobs	33,511

TABLE 3

	AREA (ha)	AREA (ac)
Community Area Land Use Breakdown (incl. NHS)	629.34	1555.1
Natural Heritage System	169.49	418.8
Roads (30% of Net Community Area)	137.96	340.9
SWM Ponds (7.5% / 429.4ha Drainage Area)	32.21	79.6
Public Elementary Schools (3 schools @ 3.24 ha per school)	9.72	24.0
Catholic Elementary Schools (2 schools @ 2.43 ha per school)	4.86	12.0
Public Secondary School (1 school @ 6.47 ha)	6.47	16.0
Existing Alloa Public School (excl. NHS area)	2.75	6.8
Neighbourhood Parks (8 parks @ 2.5 ha per park)	20.00	49.4
Community Park	5.00	12.4
Commercial	12.49	30.9
Mixed Use	10.87	26.9
Net Residential Area	217.53	537.5

NOTES:

- NHS Area based on preliminary field work undertaken to date and is subject to further refinements
- Target Community Area Population and Jobs (67.5 P+J/ha) as per Region of Peel Official Plan
- Target Employment Area Jobs (26 Jobs/ha) as per Region of Peel Official Plan
- Road area percentage based on industry average for Greenfield Communities
- School Areas as per PDSB Requirements

TABLE 4

Residential Land Uses / Population	AREA (ha)	AREA (ac)	Units Per Hectare	No. of Units	PPU*	Pop.
Low Density Residential (@ 55% Net Res. Area) *(Detached and Semi-detached)*	119.64	295.6	30	3,589	3.64	13,065
Medium Density Residential (@ 32.5% Net Res. Area) *(Townhouses)*	70.70	174.7	60	4,242	3.3	13,998
Medium - High Density (@ 12.5% Net Res. Area) *(Stacked Townhouses, Apartments)*	27.19	67.2	150	4,079	2.07	8,443
Mixed Use *(Apartments)*	10.87	26.9	200	2,174	2.07	4,500
Total	228.40	564.4	-	14,083	-	40,005

NOTES:

*PPUs as per Draft 2024 Town of Caledon Development Charges Background Study

Proposed Unit Mix:
Low Density: 26%
Medium Density: 30%
Medium-High Density: 29%
Mixed Use Residential: 15%

TABLE 5

Population-Related Jobs	AREA (ha)	AREA (ac)	Lot Coverage	GFA (m^2)	Jobs per m^2*	No. of Jobs
Major Commercial	12.49	30.9	22.0%	27,478.0	50	550
Mixed Use	10.87	26.9	25.0%	27,175.0	50	544
Elementary Schools (6 schools @ 50 jobs per school)	-	-	-	-	-	300
Secondary School (1 school @ 100 jobs)	-	-	-	-	-	100
Total	23.36	57.72		54,653.0		1,493

NOTES:

*Jobs per m^2 as per Draft 2024 Town of Caledon Development Charges Background Study

TOTAL COMMUNITY AREA POPULATION AND JOBS	41,498
ALLOA SECONDARY PLAN COMMUNITY AREA DENSITY (P+J/ha)	90

Prepared by GSAI (June 3, 2024)

Figure A-2 – Proposed Statistics of the Alloa Secondary Plan (Glen Schnarr & Associates Inc., 2024b)

Appendix B. 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.

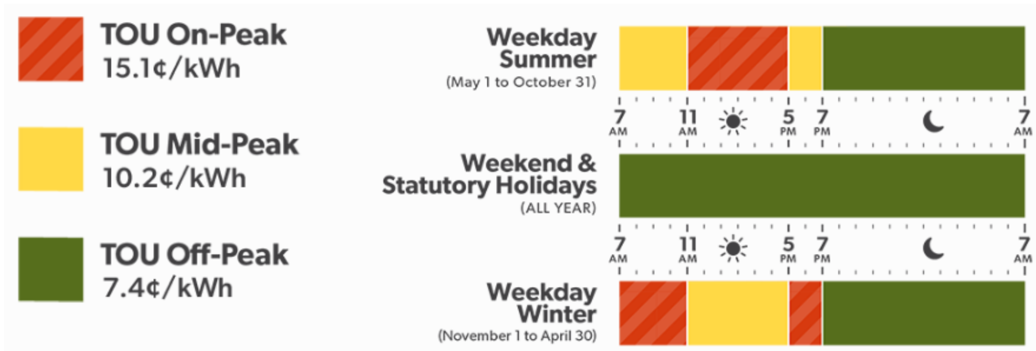

Figure B-1 – Hydro One Time-of-Use Rates Effective until October 31, 2023 (Hydro One, 2023)

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/m³)
First 30 m³	60.9364
Next 55 m³	60.2673
Next 85 m³	59.7433
Next 170 m³	59.3527

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

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

Energy

Low-Rise Residential

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

As discussed in the Carbon section, low rise residential is already served by heat pump-based HVAC system, which results in lesser scope of energy savings for space heating. Solar PV panels tend to give more energy savings, since the electric EUI is offset up to a considerable extent by electricity generation through solar PV. Other than that solar water heaters give the best performing results with around 13% energy savings.

One thing to note is higher DHW savings for this archetype, which is quite opposite to other archetypes. As discussed in the below sections, EUI savings are dominated by space heating focused heat pump measures. Hence, this contradiction in savings profile among low rise residential and other archetypes leads to a more balanced savings trend for the overall entire site. Low rise residential's DHW measure performance is able to compensate other archetypes space heating measure's performance due its larger share of the overall building site area (approximately 57%).

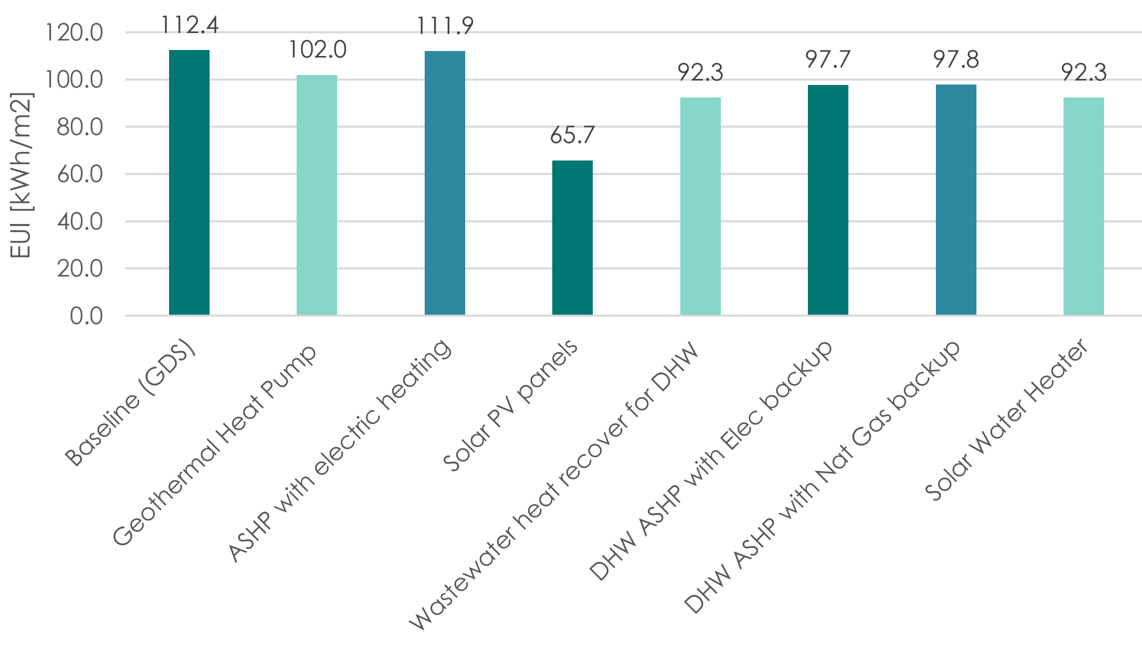

Figure D-1 – EUI Results for Low-Rise Residential

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 20% in energy savings.

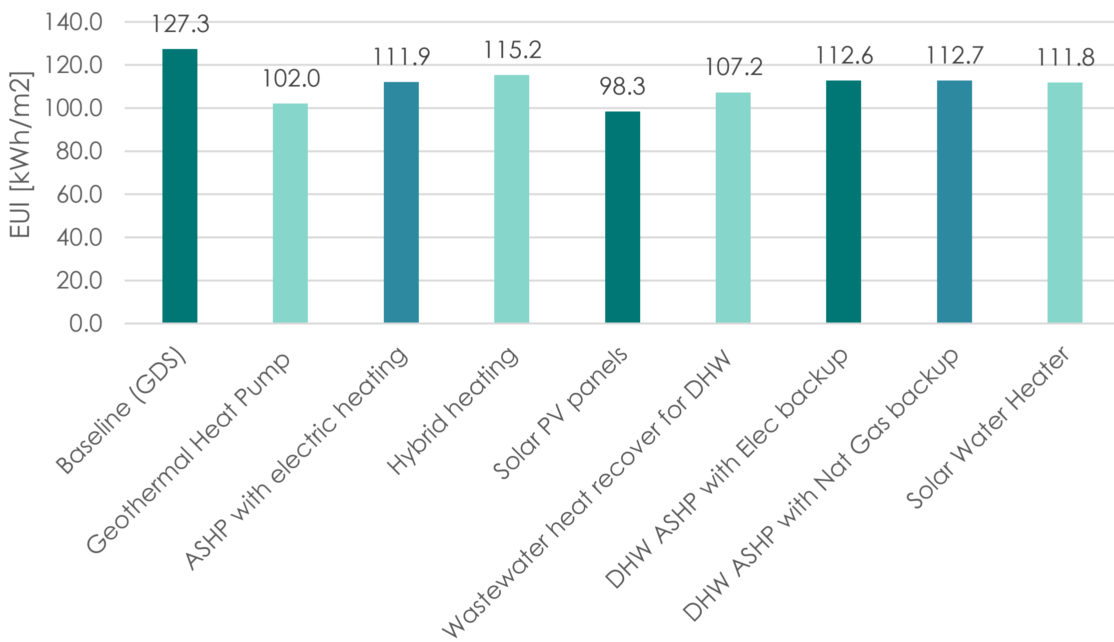

Figure D-2 – EUI Results for MURBs (<6 storeys)

MURBS>6 storeys

Mixed Use apartments fall under this archetype. Observations similar to MURBs(< 6 storeys) applies to this archetype. The savings through solar is even lesser for this archetype due to lesser available roof area. Geothermal is the best performing measure with an estimated 24% energy savings as shown in **Figure D-3** below

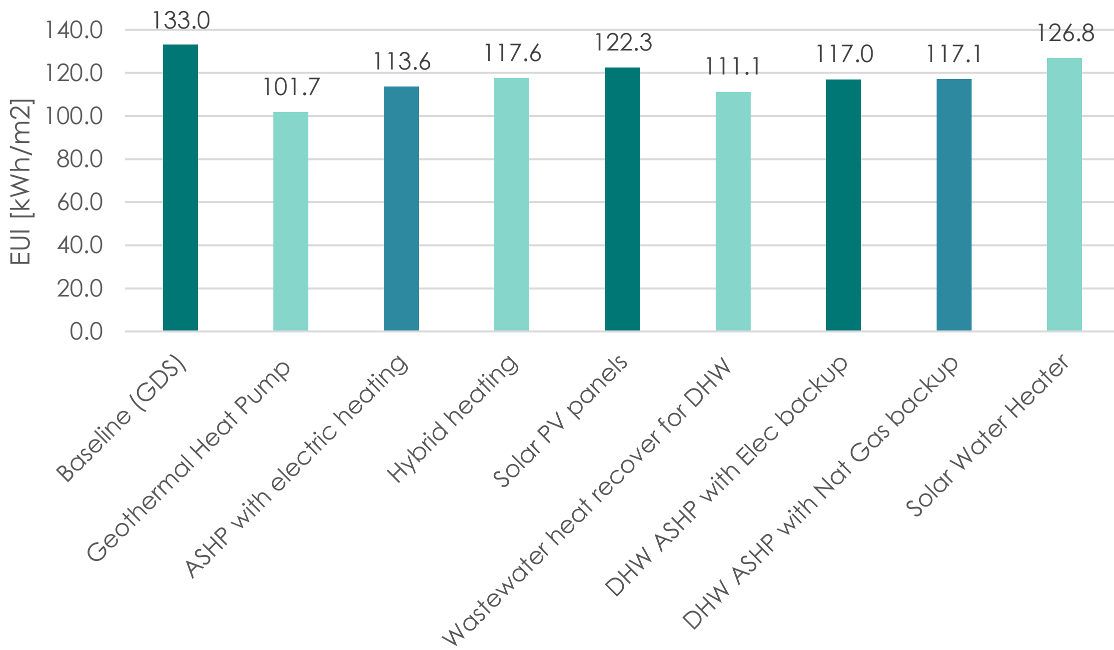

Figure D-3 – EUI Results for MURBs (>6 storeys)

Commercial Retail

The retail buildings in commercial and employment areas fall under this archetype category. Geothermal was the best performing measure with an estimated 25% energy savings as observed in **Figure D-4** below. Note that solar PVs are particularly attractive for this archetype due to large roof area available for PV panels, leading to increased electricity generation.

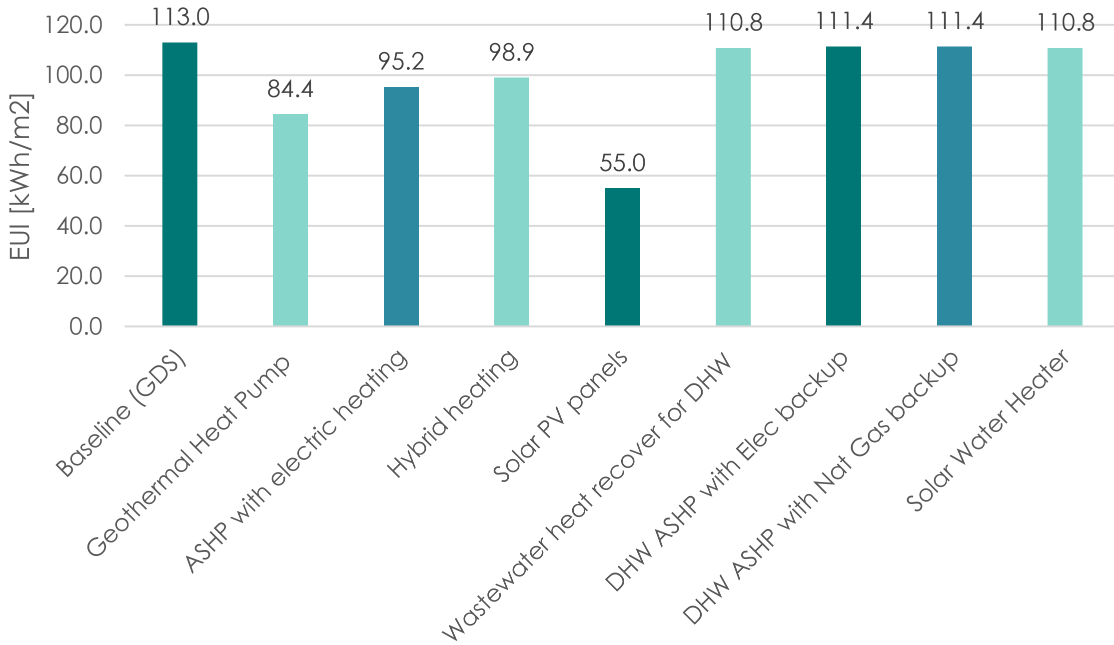

Figure D-4 – EUI Results for Commercial Retail

Commercial Office

The office buildings in employment and commercial areas fall under this archetype. Similar to the above archetypes the geothermal heat pump and the solar PV were the best performing measures as observed in **Figure D-5** below.

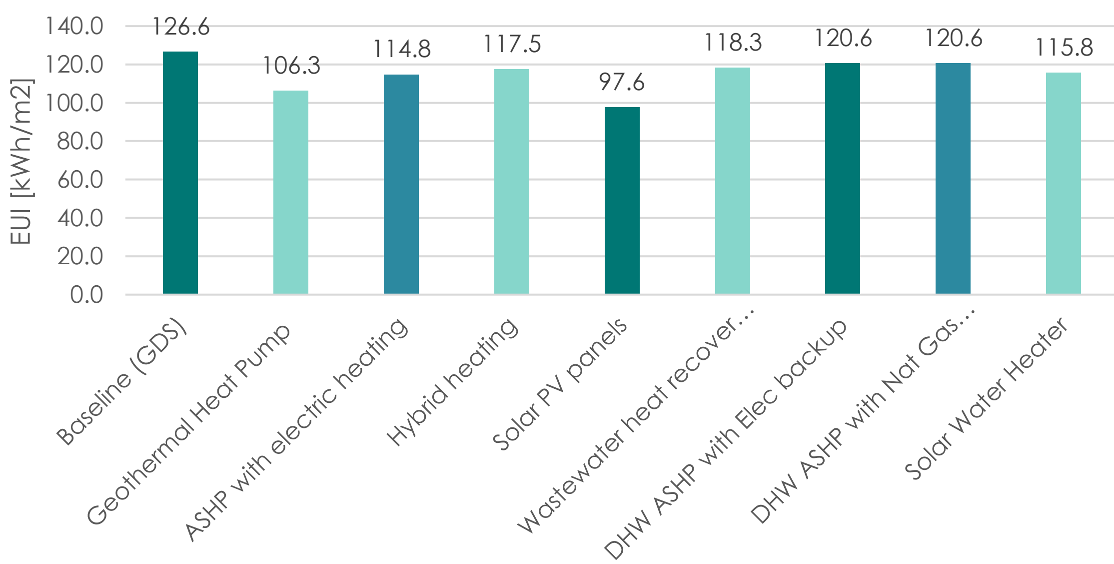

Figure D-5 – EUI Results for Commercial Office

Commercial Industrial

The industrial buildings in commercial and employment areas fall under this archetype. The space heating for this archetype contributes to around 63% of total EUI, which leads to more improved performance of heat pump measures for this archetype as observed in **Figure D-6** below. As a result, geothermal may create up to 46% in EUI savings for this archetype.

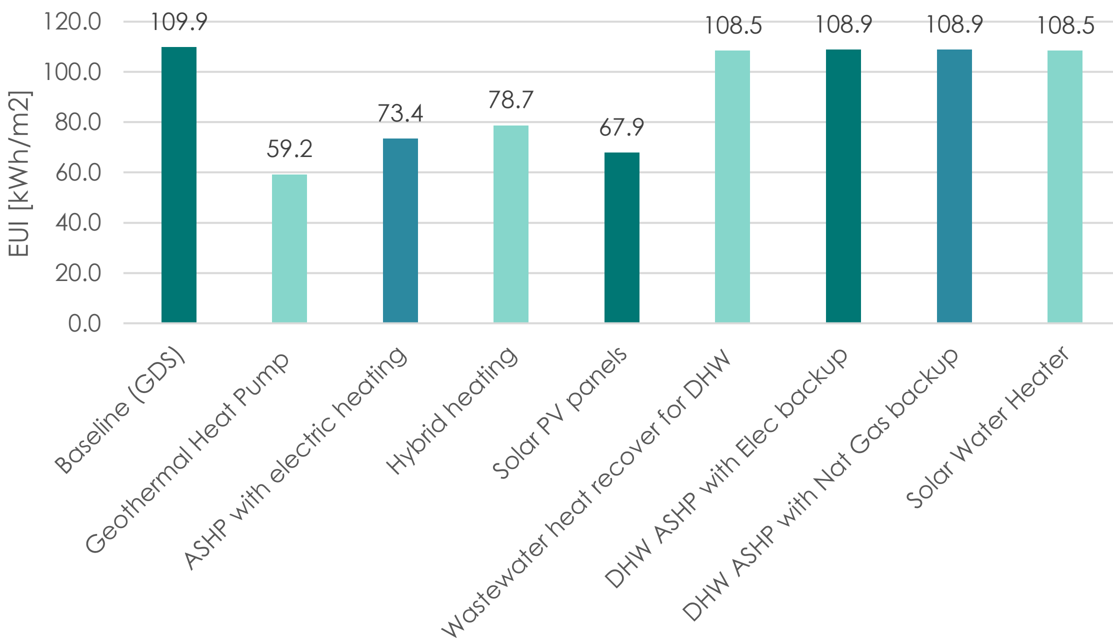

Figure D-6 – EUI Results for Commercial Industrial

Schools

The prospective performance of new schools in the Secondary Plan Area follows the same pattern as other archetypes, hence geothermal heat pump was the best performing measure with an estimated 29% energy savings potential as observed in **Figure D-7** below.

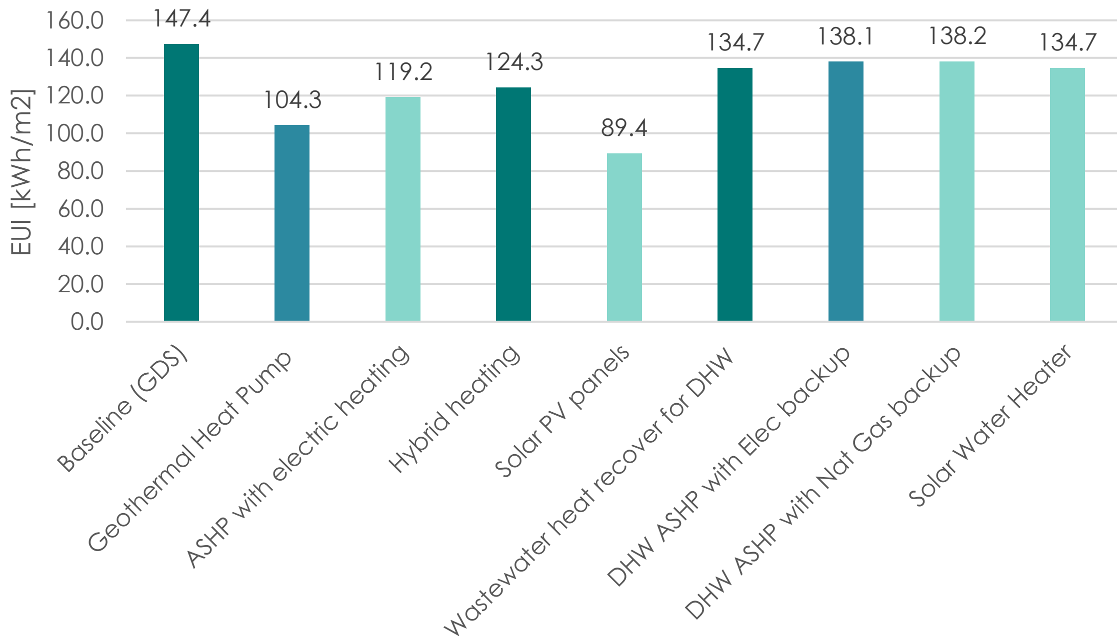

Figure D-7 – EUI Results for Schools

Carbon

Low-Rise Residential

Figure D-8 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 60% of the emissions. Consequently, Energy Conservation Measures (ECMs) that focus on DHW tend to have a higher impact on reducing GHGI. DHW with Electric backup offer most GHGI reduction potential with around 57% expected GHGI reduction.

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

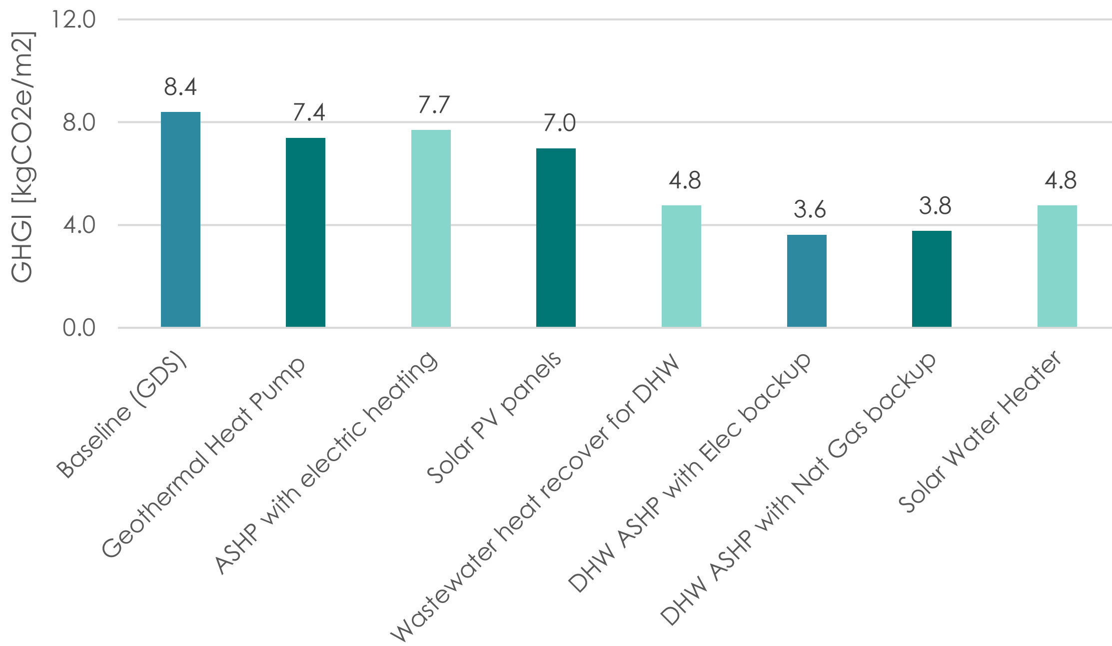

Figure D-8 – GHGI Results for Low Rise Residential

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-9** below. Unlike low-rise residential buildings, MURBs are served by mid-efficiency boiler plant-based HVAC systems. As a result, space heating constitutes around 45% of GHGI emissions in the baseline, which is less compared to the 38% 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 43% GHGI reduction potential.

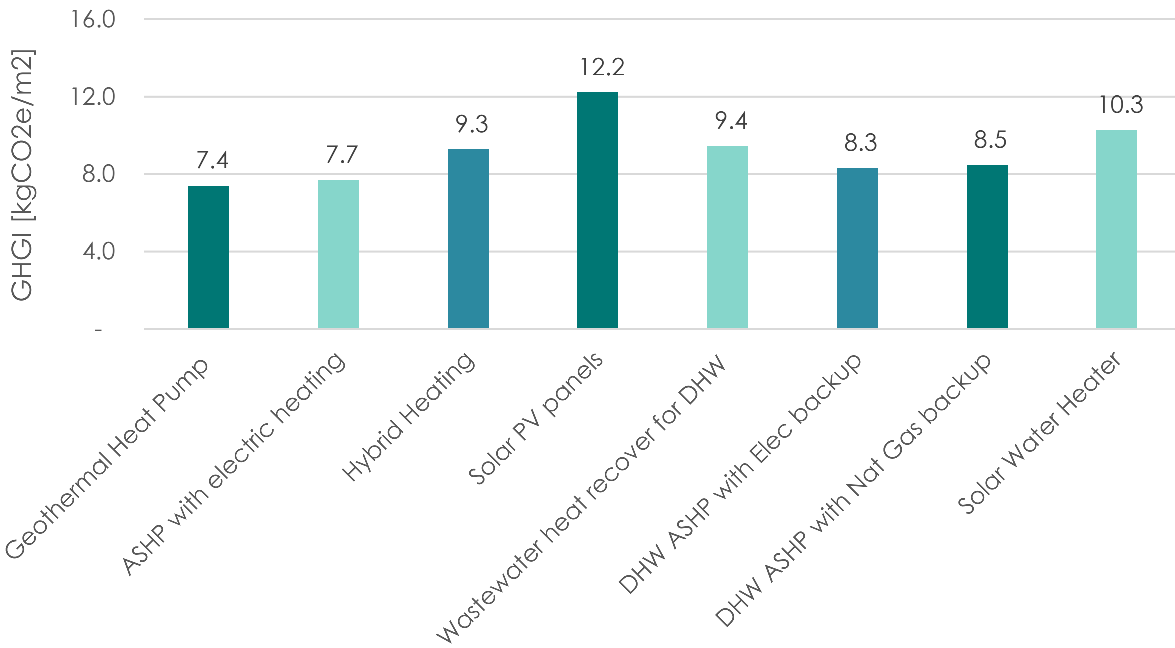

Figure D-9 – GHGI Results for MURBs (<6 storeys)

Mixed Use Apartments – MURBs (> 6storeys)

The conclusion drawn for multi-unit residential buildings (MURBs) under 6 storeys can also be applied to this archetype. Similar to MURBs, this archetype utilizes a natural gas-based HVAC heating system, which results in a greater reduction potential for heat pump-based heating measures. Geothermal heat pumps were evaluated to offer the greatest GHGI reduction potential, with approximately 48% GHGI savings as illustrated in **Figure D-10** below.

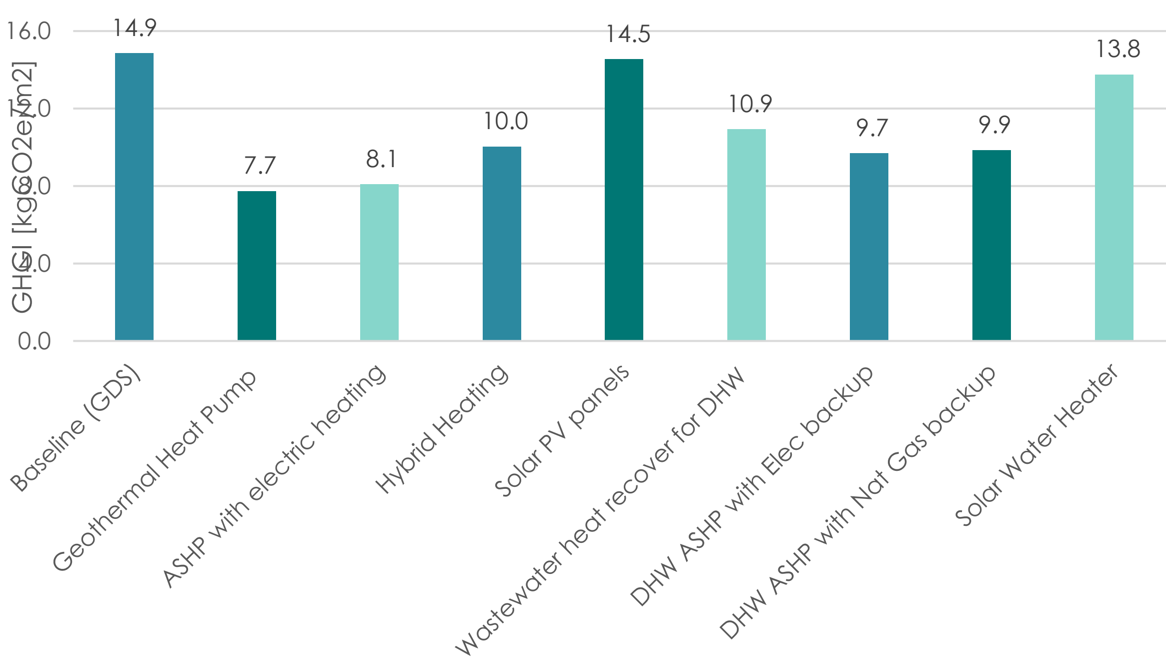

Figure D-10 – GHGI Results for MURBs (>6 storeys)

Commercial Retail

In this archetype, the contribution of domestic hot water (DHW) to the baseline GHGI is inherently very low, accounting for just 6% compared to the 54% contribution from heating. Consequently, heating measures tend to have a more significant impact on GHGI, as illustrated in **Figure D-11** below. Among these measures, geothermal heat pumps offered the greatest reduction potential, with an expected reduction of approximately 69%.

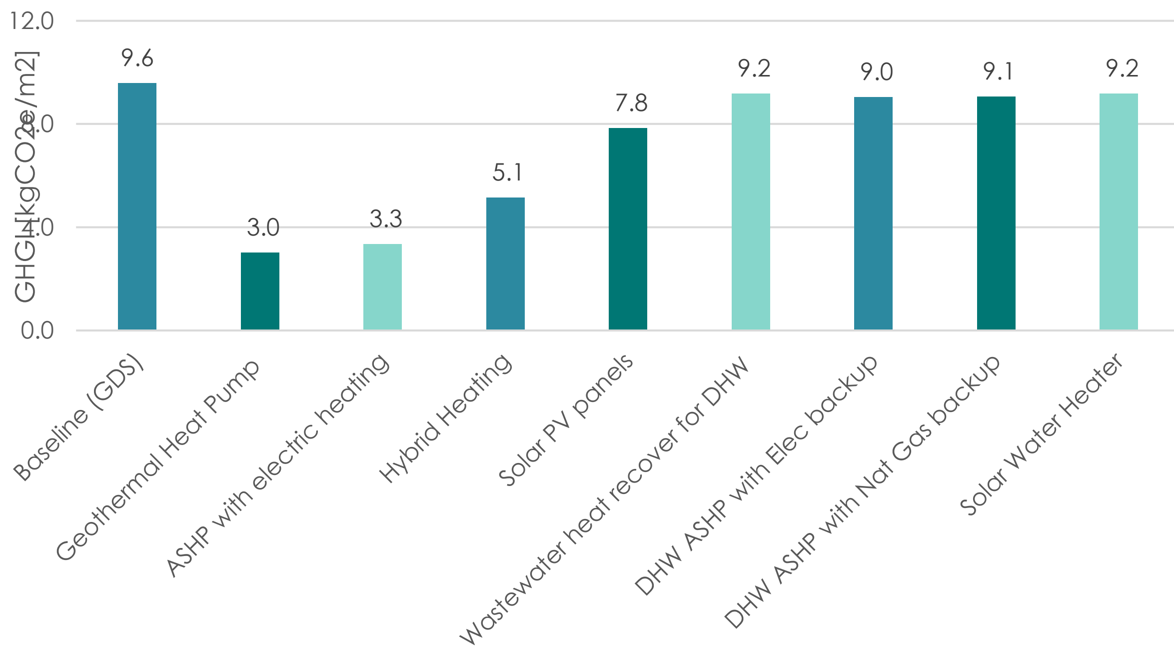

Figure D-11 – GHGI Results for Commerical Retail

Commercial Office

The observations for the commercial retail archetype apply similarly to the commercial office archetype. While the scale of heating measures are lower, DHW measures are slightly more effective compared to the commercial retail archetype, as shown in **Figure D-12** below. This is because DHW's contribution to GHGI is assumed to be higher in the baseline condition for the commercial office archetype, at around 22%, compared to only 6% in the Commercial Retail archetype.

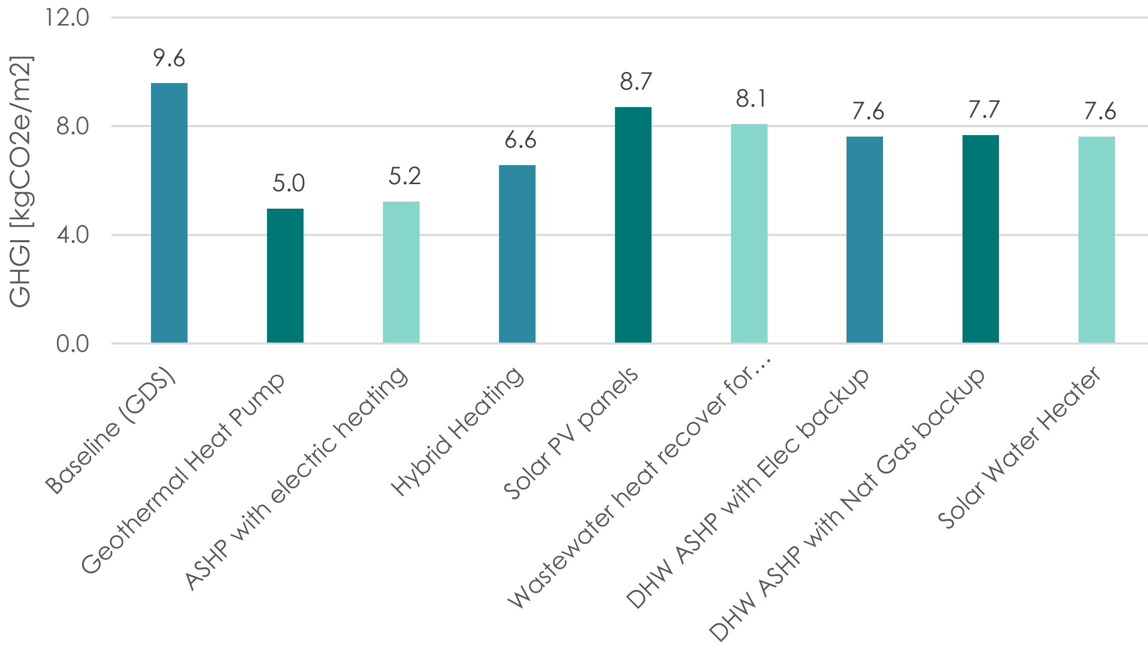

Figure D-12 – GHGI Results for Commercial Office

Commercial Industrial

As observed from **Figure D-13**, heat pump-based measures have a substantial impact on GHGI. In the baseline scenario, heating emissions account for a significant 92% of total greenhouse gas emissions, offering significant potential for improvement through heat pump-based measures. Geothermal heat pump heating could achieve an estimated 84% reduction in GHGI, which represents the highest reduction among all archetypes for any measure.

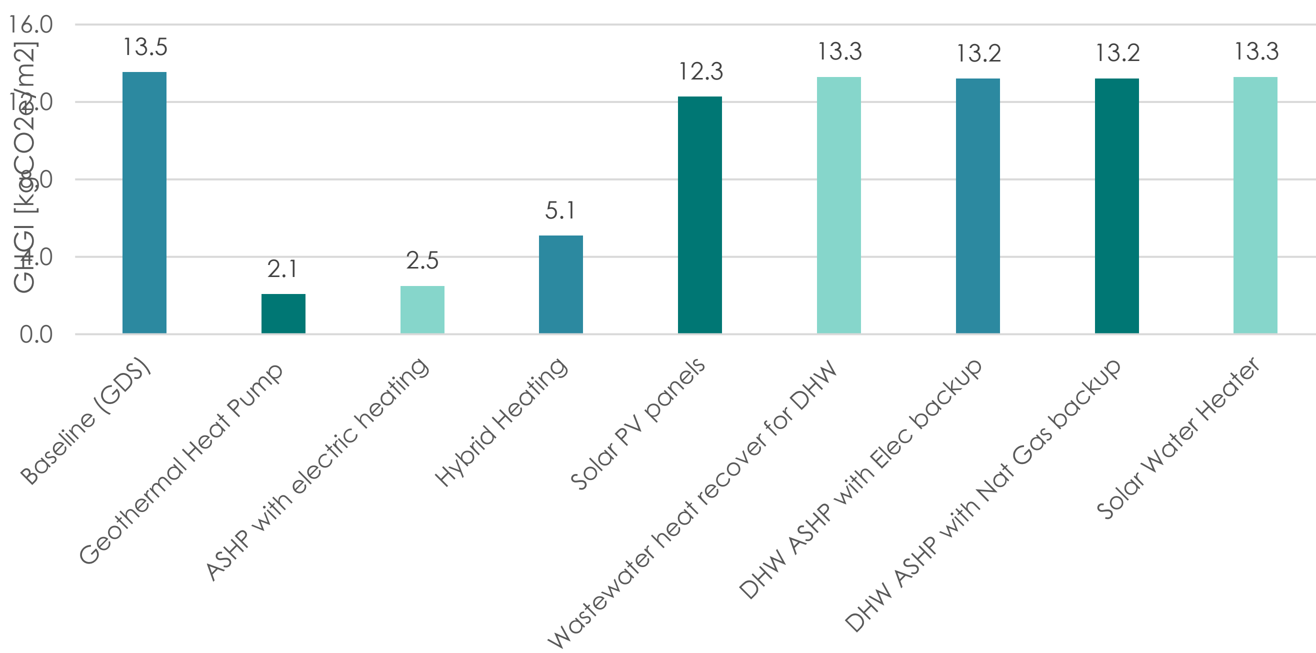

Figure D-13 – GHGI Results for Commerical Industrial

Schools

For reasons similar to the commercial office and retail archetypes, the school archetype offers greater scope for improvement through heat pump-based measures. Consequently, geothermal heat pumps could achieve an estimated 62% reduction in GHGI, as observed in **Figure D-14** below.

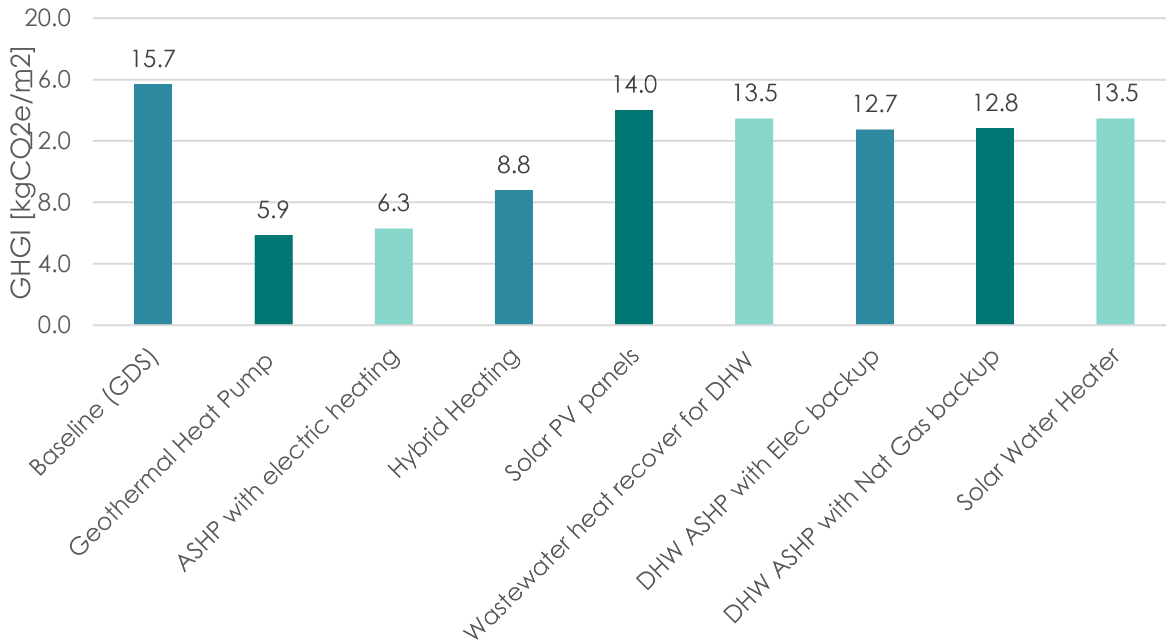

Figure D-14 – GHGI Results for Schools

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