# Alloa Secondary Plan Area

## Community Energy and Emissions Plan

**Town of Caledon, ON**

Prepared for: Alloa Landowners Group

Project No.: PR-24-061

Document Revision: 4.2

Pratus Group Inc.

**May 22, 2025**

Pratus

# Issuance Approval

| Prepared by: | Reviewed by: | Approved by: |
|---|---|---|
| Christopher Mohabir, P.Eng. | Eric Dunford, M.Sc., MBA | Oleksandra Onisko, P.Eng. |
| Zaid Khan, M.Eng. | | |
| Simonne Varela, M.Eng. | | |

# Document Revision History

| Rev | Date | Description | Prepared By | Reviewed By | Approved By |
|---|---|---|---|---|---|
| A | June 24, 2024 | Version 1.1 | Christopher Mohabir, Zaid Khan | Eric Dunford | Oleksandra Onisko |
| B | July 3, 2024 | Version 1.1 | Zaid Khan, Simonne Varela | Eric Dunford | Oleksandra Onisko |
| C | December 02, 2024 | Version 2.1 | Zaid Khan, Simonne Varela | Eric Dunford | Oleksandra Onisko |
| D | March 28,2025 | Version 3.1 | Christopher Mohabir, Zaid Khan | Eric Dunford | Oleksandra Onisko |
| E | April 2, 2025 | Version 4.1 | Christopher Mohabir, Zaid Khan | Eric Dunford | Oleksandra Onisko |
| F | May 22, 2025 | Version 4.2 | Zaid Khan, Simonne Varela | Eric Dunford | Oleksandra Onisko |

# Limitations

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

# Table of Contents



# 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:

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

The proposed Alloa Secondary Plan Area (inclusive of both Phase 1 and Phase 2) is expected to consist of 724 hectares of land, with 359 hectares allotted for the development of new buildings. The Plan Area is primarily low-rise residential with areas of denser development. The proposed building mix of the planned community includes freehold townhouses, detached homes, mixed used and medium density condominiums 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 were 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**

The **Baseline Scenario** establishes the expected energy consumption based on the proposed development meeting the prevailing energy standards in the Town of Caledon. The **Near Net Zero Scenario** was then constructed by evaluating a variety of potential additional low-carbon design strategies and technologies, both at building and district scales. Strategies were selected based on their capacity to achieve energy conservation and emissions reduction strategies, ultimately identifying a prospective pathway to a lower-carbon development approach within the Secondary Plan Area.

**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 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 | Three 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 | Three 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% |

### 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% | |

**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 2017 requirements. Note that no changes are expected as a result of migration to the 2020 iteration of the Ontario Building Code as there are no significant changes to energy requirements proposed between the code versions. The energy requirements of the Town of Caledon's pilot Green Development Standards exceed the provincial code, meaning that the Baseline Scenario represents energy conservation and emissions reduction in comparison to the Ontario Building Code (both 2017 and 2020).

*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 [$kgCO_2e/m^2$]** | 25 | 10 | 1 | 96% | 85% |

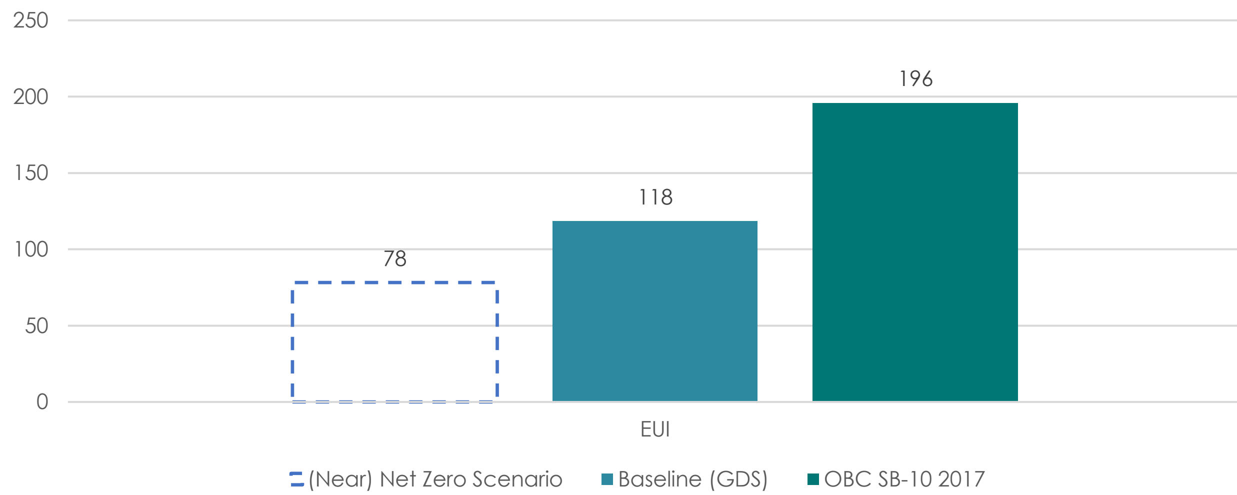



***Figure 1: Estimated EUI Reduction Potential Reduction Potential Comparion to OBC and Baseline Scenario***

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 to demonstrate the full potential of each system.

Additional energy and emissions reductions within the Secondary Plan Area could only be achieved by adopting more compact and higher-density development forms, as well as increasing on-site renewable energy installations. However, this is not currently feasible under the proposed development plan, as the existing Near Net Zero scenario already maximizes the potential for on-site renewable energy generation resources. 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.

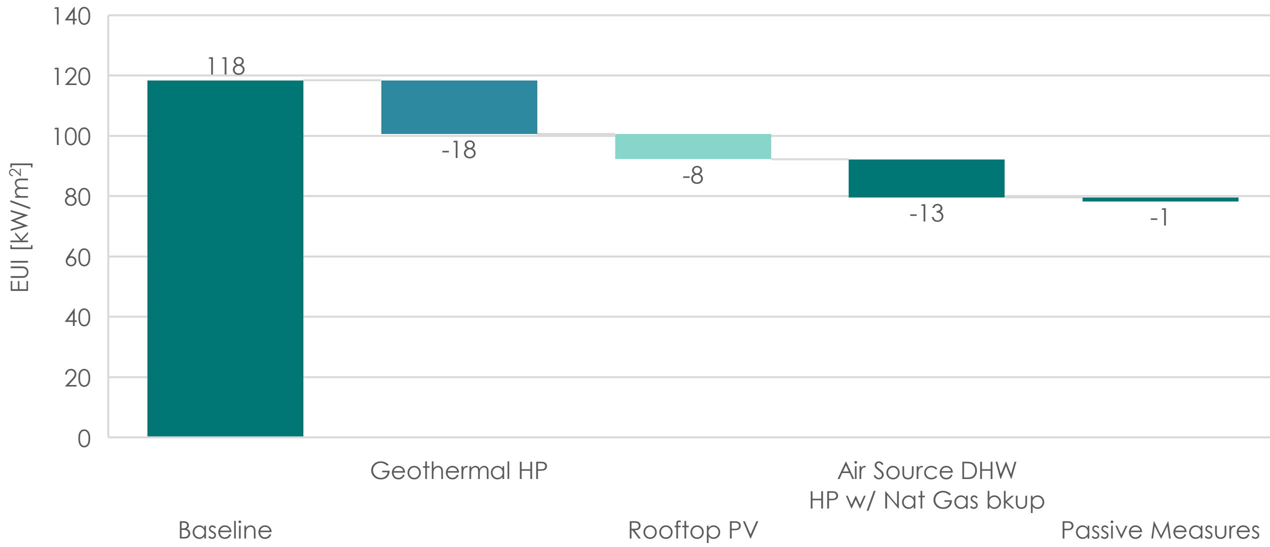



*Figure 2: Energy Use Intensity Reduction Roadmap Demonstrating EUI Reduction Potential*

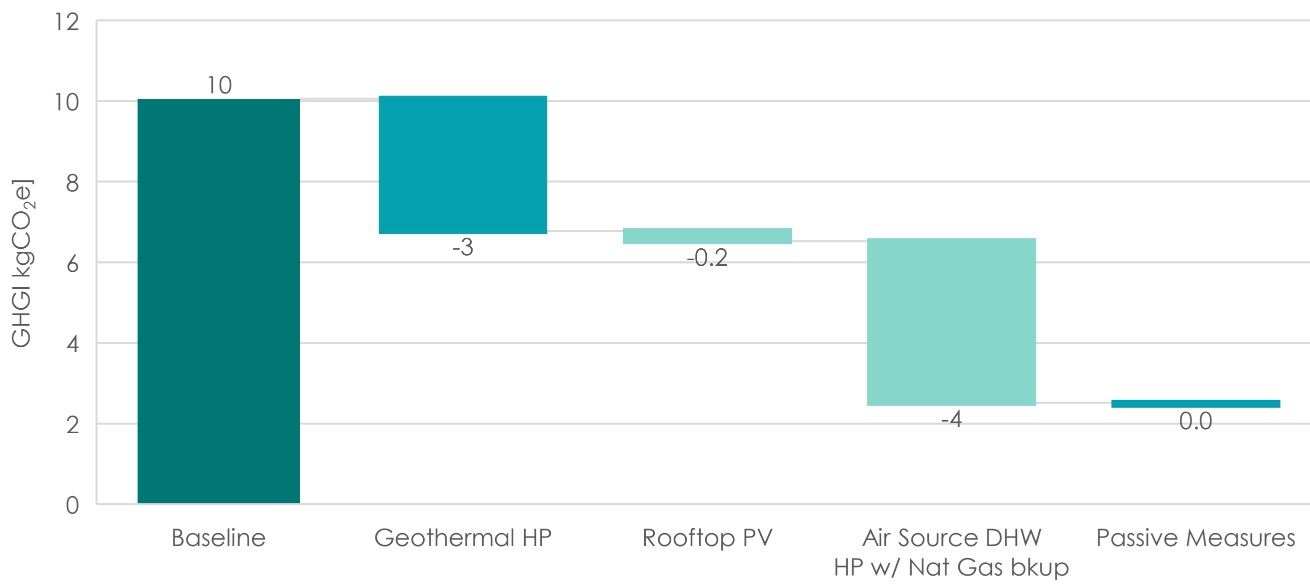



*Figure 3: Greenhouse Gas Intensity Reduction Roadmap demonstrating GHGI reduction potential*

**Transportation Systems Assessed**

The GDS requires that all single-family residential dwellings, 50% of multi-unit residential buildings and 20% of all other types of dwellings, be equipped with the required infrastructure to be EV charger ready. To understand the electrical demand the Secondary Plan Area can experience associated with transportation upgrades, the following cases were considered to describe the potential energy demand associated with various scenarios in which EV chargers are installed and utilized within the Secondary Plan area:

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

**Transportation Case 1** was used as the baseline in this analysis for comparison with other scenarios. The estimated overall energy demand associated with the different scenarios for EV adoption is summarized in **Table 4**. The potential electricity demand posed by the electric vehicle charging scenarios is substantial and would require engagement with utility providers to determine feasibility.

*Table 4: Estimated EV Charger Demand*

| Scenarios Assessed | Level 2 EV Chargers | | Level 2 EV Chargers Demand [kW] | Total Carbon Emissions [$kgCO_2e$] | Est. Increase in Energy Consumption |
|---|---|---|---|---|---|
| | Residential | Non-Residential | | | |
| **Transportation Case 1** | 2,185 | 295 | 14,682 | 734 | |
| **Transportation Case 2** | 4,369 | 295 | 28,774 | 1,439 | 2x |
| **Transportation Case 3** | 8,739 | 295 | 56,959 | 2,848 | 4x |
| **Transportation Case 4** | 8,739 | 1,474 | 59,318 | 2,966 | 5x |

Average costs for EV charging stations, installation and infrastructure amount to approximately $1,200 per Level 2 charger based on discussions from major supplies in Canada (ChargePoint, Switch Energy, & Flo). Approximately 35% and 15% of these costs are associated with charging station equipment and installation for residential and non-residential building types, respectively, which are to be borne by individual owners in Caledon, as shown in **Figure 4**. The remainder of these costs are associated with conduits and electrical cable installation expected to be borne by the developer.

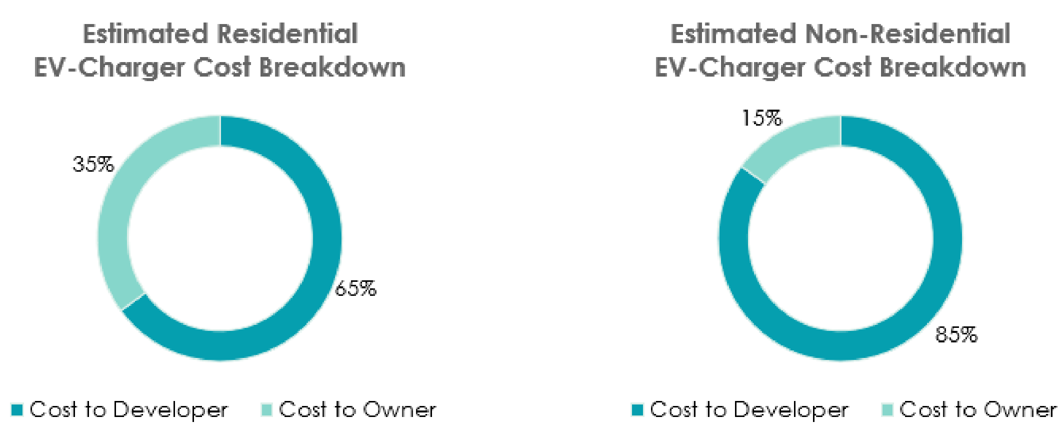



*Figure 4: Expected Breakdown of the Average Cost of EV Charger Components*

To quantify expected costs for making buildings EV charging-ready, $780 for Level 2 residential chargers, $1,020 for Level 2 non-residential was assumed. Based on the GDS requirements to make buildings EV-Charger ready, this results in a total of **$7,116,970**. Suppliers have communicated that there is a factor of economies of scale for installation that is not reflected in this value. The true cost will vary between suppliers and would be determined at the time of procurement. Further analysis must be conducted on the anticipated installation of the EV chargers, which is beyond the scope of this study.

Service upgrades are not required to make single-family homes EV charger ready, but high-rise multi-unit residential and non-residential spaces will likely require higher capacity transformers and sub-stations due to the shift to electrification. This will depend on the anticipated usage of the site and require further coordination during the design development stage. The increased electricity demand posed by the proposed electric vehicle charging scenarios cannot feasibly be met through on-site generation within the Secondary Plan Area and was therefore excluded from the Near Net Zero Scenario.

**Site Development Statistics**

Note that changes were made to the site development statistics after the initial analyses were completed as a result of planning updates made in response to further discussions between the Town and the Landowners Group. The changes generally reflect a reduction in the gross floor area for mixed-use buildings over 6 storeys, and a small increase in the gross floor area for retail use. The resuliting impacts on the baseline and net zero scenario are summarized in **Table 5**.

*Table 5: Comparison of Impact to Baseline and Net Zero Scenarios Based on Revised Site Statistics*

| Metric | Original Baseline | Revised Baseline Scenario | Original Net Zero | Revised Net Zero Scenario |
|---|---|---|---|---|
| **Energy Use Intensity (EUI)** | 118.4 | 117.7 (-0.6%) | 78.2 | 77.9 (-0.3%) |
| **GHG Intensity (GHGI)** | 10.1 | 9.8 (-3.0%) | 2.34 | 2.35 (+0.4%) |

Due to the minimal impacts associated with updated site statistics, it is the opinion of Pratus Group that the analyses and overall findings of the study are not materially affected by the changes to the site development statistics at present time. A more detailed analysis of this impact is outlined in **Section 4.2**.

**Community Energy System Viability**

Approximately 48% of the site consists of a mid to high density development style that could be conducive to district-scale energy (DES) generation. A sub-area of the site was identified for DES feasibility analysis based on density and building type. The sub-area centered on medium to high density developments along Mayfield and Chinguacousy Roads. Analyses conducted suggest that a district geothermal system could be feasible in this location. Solar PV and wastewater heat recovery were evaluated to be infeasible.

## 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.
- 20-year net present value (NPV) total cost of implementing the strategies described in the Near Net Zero Scenario is estimated at $1.9B 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.
- Approximately 48% of the site consists of a development style that could technically support district-scale energy generation. A sub-area focused on the south and eastern portions of the site along Mayfield and Chinguacousy Roads was assessed as a potential area that could host a district geothermal system. It was noted by the Landowners that this development will occur in a staged pattern over time however, which may impact the feasibility of such a system.
- Building-scale equivalents of the district-scale 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 per the requirements of the pilot Green Development Standard's requirements for site plan application.

# 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 5**. 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 6**. 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.

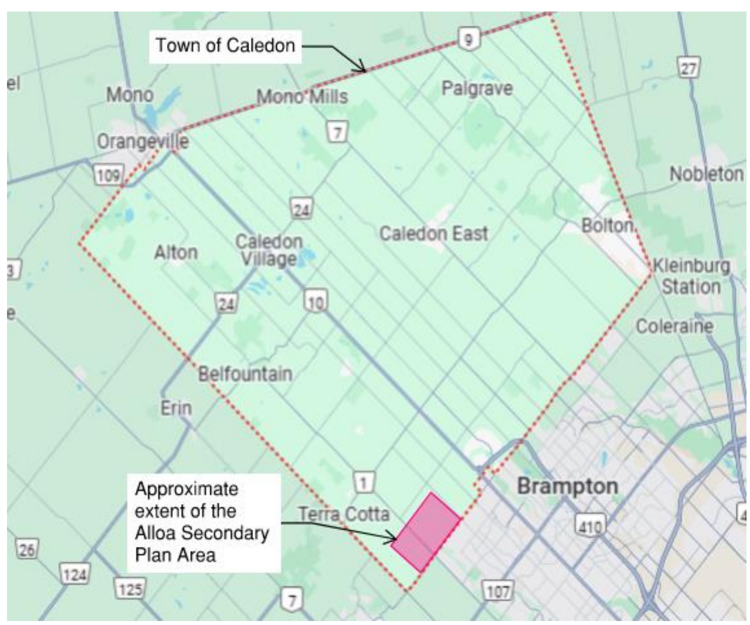



*Figure 5: Approximate Extent of the Alloa Secondary Plan Area in the Town of Caledon*

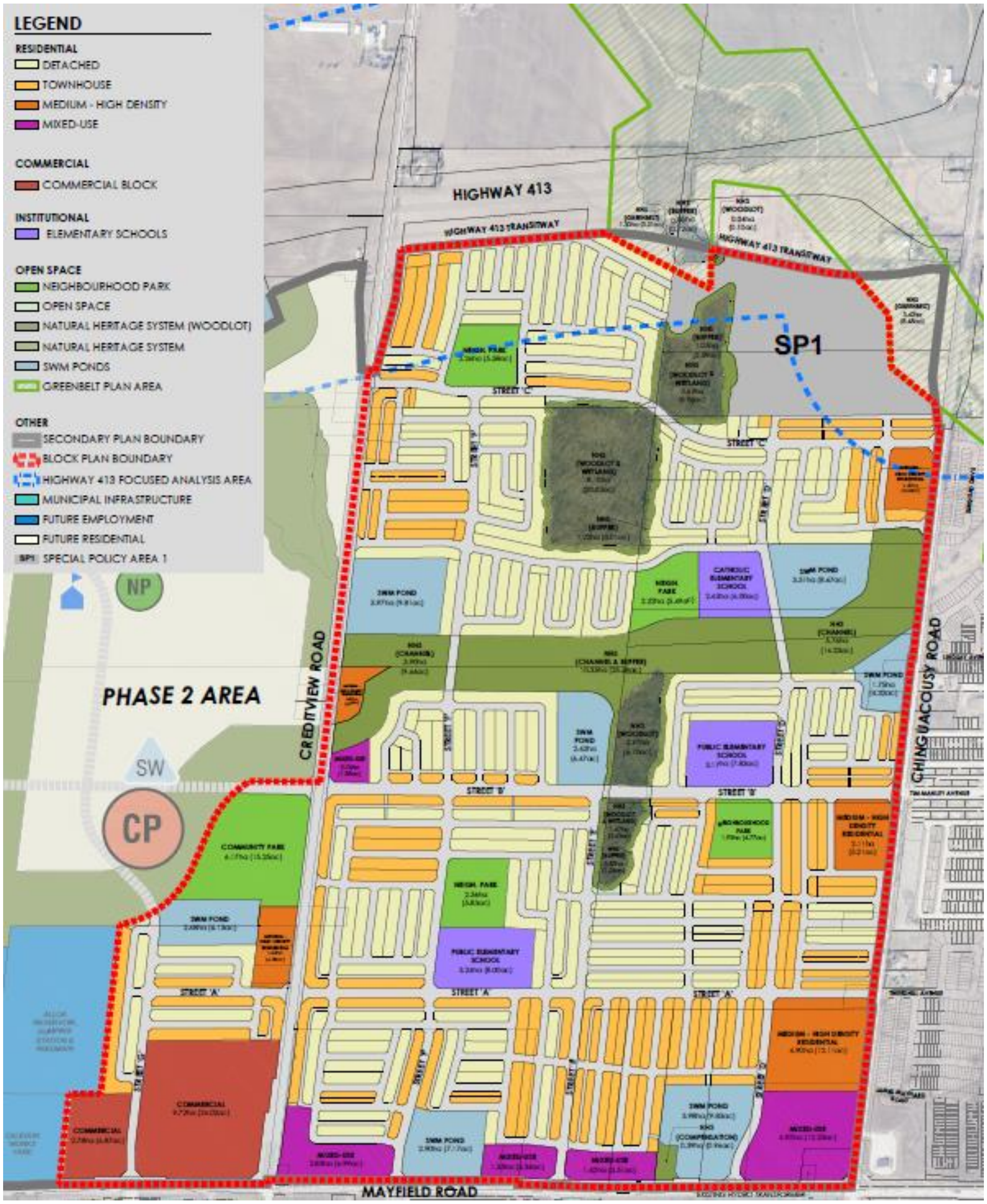



*Figure 6: Proposed Conceptual Land Use Plan for the Alloa Secondary Plan Tertiary Plan Phase 1, April 1 2025 (Glen Schnarr & Associates Inc., 2025)*

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. This Phase is the subject of this report.

Phase 2 of the Secondary Plan Area will also primarily consist of low-density residential development. Phase 2 also includes significant employment lands, though the nature of the activities that will be supported within these employment lands is not yet defined.

### 2.1.1. Demographics, Site Statistics and Building Types

The Alloa Secondary Plan Area will include a land area of approximately 714 hectares of land (including both Phase 1 and Phase 2) with a mix of land uses. 351 hectares of the total land area is expected to ultimately be developed into new buildings.

Of the total 714 hectares of land, 363 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 – 167.76 ha
- Roads (estimated at 30% of the net community area) – 135.23 ha
- Stormwater management facilities – 32.21 ha
- Neighbourhood parks – 18.00 ha
- Community parks – 6.00 ha
- Community Centre – 3.5 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 2,890,039 $m^2$.

#### *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 6** for reference. **Figure 7** shows a breakdown of the types of building within the Secondary Plan Area development.

*Table 6: Alloa Secondary Plan Area Building Type Descriptions*

**Residential Building Types – Total 222.9 ha / 11,200 units**

**Low Rise (3 storeys or less)**

Low Density Residential – Detached – 114.8 ha / 3,443 Units

Medium Density Townhomes – 67.8 ha / 4,069 Units

**MURB (<6 storeys)**

Medium Density Stacked Townhomes and Apartments

– 26.08 ha / 2,608 Units

**MURB (> 6 storeys)**

Mixed Use Apartments – 5.4 ha / 1,087 Units

**Non-Residential Building Types - Total 135.8ha**

**Schools**


Elementary and High School Buildings

- 23.8 ha

**Industrial**

Manufacturing plants, storage and warehouse buildings

Employment Area – 31.4 ha

**Retail**


Local commercial and open-air retail

Commercial Area – 11.7 ha

Employment area – 31.4 ha

**Office**

Workspaces (i.e., administrative, managerial, etc.)

Commercial Area – 6.2 ha

Employment Area – 31.4 ha

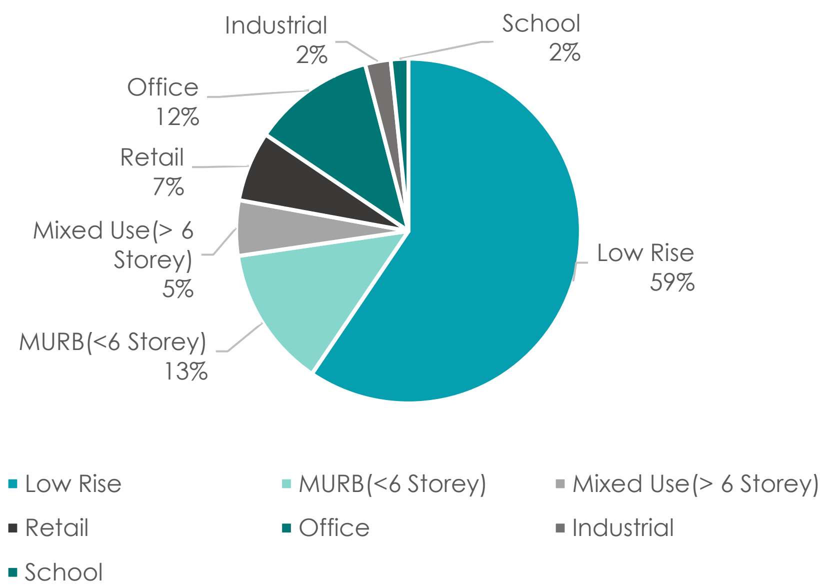



*Figure 7: Alloa Secondary Plan Area Building Type Breakdown (by GFA)*

The total commercial footprint area is 12.49 ha. For the purposes of modeling, Pratus Group assumed that the commercial area would be evenly divided between commercial office and retail uses, with each occupying 6.245 hectares of land area. Input from the planning consultant after the analyses was conducted confirmed that an additional 5.49 ha of commercial area was extracted from the mixed-use land area, increasing the total quantity of commercial area to 17.9 ha. It was assumed that the commercial portion of the mixed-use area will predominantly be retail use, as mixed-use developments typically feature retail at street level. The total retail area was therefore considered to be 11.7 ha.

A similar approach was followed for the employment area. For the purposes of this analysis, the total employment area of 94.09 hectares was divided equally into office, retail, and industrial spaces, with each type occupying an assumed 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 for the community (Town of Caledon, 2021). The Town subsequently developed the Resilient Caledon Community Climate Change Action 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 Pilot Green Development Standard

The Town of Caledon has developed guidance for low-carbon building construction under its pilot 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.

The current targets for Caledon's GDS are outlined in **Table 7**.

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

<table>
<tr><th rowspan="2">Building Type</th><th colspan="3">Energy and Carbon Performance Measures</th><th rowspan="2">EV Charging Requirements*</th></tr>
<tr><th>TEUI [kWh/m$^2$/yr.]</th><th>TEDI [kWh/m$^2$/yr.]</th><th>GHGI [kgCO$_{2e}$/m$^2$/yr.]</th></tr>
<tr><td>Low Rise Residential (<3 storeys)</td><td colspan="3"><ul><li>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</li><li>Reduce operational GHG by 20% OR</li><li>Design and construct to the current OBC and install hybrid heating systems</li></ul></td><td>Minimum one charging space per dwelling unit.</td></tr>
<tr><td>Multi-unit Residential (>6 storeys)</td><td>15</td><td>135</td><td>50</td><td rowspan="2">Minimum 50% of parking spaces are EV-Ready.</td></tr>
<tr><td>Multi-unit Residential (≤6 storeys)</td><td>15</td><td>130</td><td>40</td></tr>
<tr><td>Commercial Office</td><td>15</td><td>130</td><td>30</td><td rowspan="3">Total of 20% parking spaces are EV-ready. Minimum 5% of spaces to be equipped with EV Supply Equipment (EVSE).</td></tr>
<tr><td>Commercial Retail</td><td>10</td><td>120</td><td>40</td></tr>
<tr><td>Industrial</td><td>15</td><td>130</td><td>60</td></tr>
</table>

**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 is explored within this study. An example schematic of a typical DES is shown in **Figure 8**.

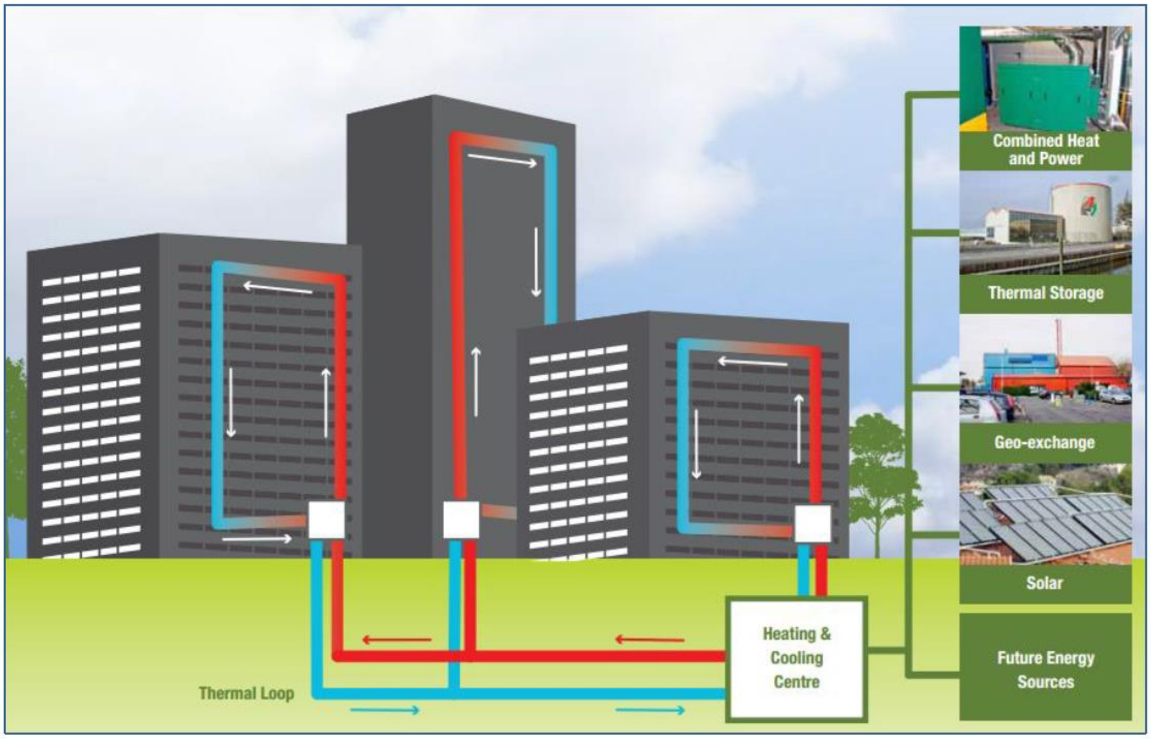



***Figure 8 – Illustration of the function of a District Energy System*** (City of Toronto, 2016a)

# 3. Methodology and Assumptions

## 3.1. Building Energy Systems

Energy and operational GHG emissions for the individual archetypes and the entirety of the buildings proposed in the Alloa 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 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 consist 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 8** summarizes the technologies that were assessed as part of the development of this study. The technologies include various heat pump system options, where heat pumps are systems that extract or reject heat from one source (air, water, geothermal, etc.) and transfer it to building spaces that require it in the heating or cooling seasons, respectively. This technology saves energy as heat is transferred rather than generated in conventional heating systems. Other technologies that were studied included domestic hot water (DHW) source options in which efficient and low-carbon HVAC options were suggested to serve DHW loads from buildings; a change from traditional natural-gas sources.

*Table 8 - Low-Carbon Building Technologies Assessed*

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

The GDS requires that at minimum all single-family residential dwellings, 50% of multi-unit residential buildings (MURBs) and 20% of all non-residential spaces are equipped to be EV charger ready. 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. **Table 9** summarizes the number of parking spaces required to be EV charger ready for the Alloa Secondary Plan Area.

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

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

| Building Type | | Caledon GDS EV Charger-Ready Requirement | # of Level 2 Parking Spaces | Total Parking Spaces (Assumed) |
|---|---|---|---|---|
| **Residential** | Low Rise Residential (<3 storeys) | Minimum one charging space per dwelling unit | 7,512 | 8,739 |
| | Medium Density Stacked Townhomes and Apartments (<6 storeys) | Minimum 50% of parking spaces are EV-Ready. | 943 | |
| | Multi-unit Residential (>6 storeys) | | 284 | |
| **Non-Residential** | Commercial | 20% of parking spaces are EV-ready | 266 | 1,474 |
| | Schools | | 1 | |
| | Employment | | 1,207 | |

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

*Table 10 - Transportation Scenarios Assessed*

| Transportation Analysis Case | Number of Residential Chargers Utilized | % of Residential Chargers Utilized | Number of Non-Residential Chargers Utilized | % of Non-Residential Chargers Utilized |
|---|---|---|---|---|
| **Transportation Case 1** | 2,185 | 25% | 295 | 20% |
| **Transportation Case 2** | 4,369 | 50% | 295 | 20% |
| **Transportation Case 3** | 8,739 | 100% | 295 | 20% |
| **Transportation Case 4** | 8,739 | 100% | 1,474 | 100% |

**Transportation Case 1 and Case 2** represent scenarios in which 25% and 50% of residential dwellings install and utilize EV chargers, along with the minimum required 20% of all other spaces, as per the GDS, in the

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

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 11**:

*Table 11 - 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).<br>**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).<br>**Note that no electrical energy is produced from this system.* |

### 3.3.1. Sub-Area Analysis

**Section 2.1** of the report describes the land use concept for the Alloa Secondary Plan Area. Analyzing density distribution throughout the entire site was conducted to evaluate the feasibility of prospective District Energy System (DES) implementation. To assess feasibility from a density perspective, the plan area was categorized based on the density of the building archetypes, as outlined in **Table 12**. The findings from this analysis inform the feasibility assessment of the DES, which is discussed in detail in **Section 4.**

*Table 12 - Overview of the Sub-Areas within the Secondary Plan Area*

| Sub-Area | Building Archetypes & Square Footage | Total Dense Areas |
|---|---|---|
| **Low Density Archetypes (DES Infeasible)** | Detached homes: 10,372,468 $ft^2$<br>Major Commercial: 1,144,304 $ft^2$<br>Employment area: 5,197,008 $ft^2$ | 16,713,780 $ft^2$ |
| **Medium-High Density Archetypes (Potential for DES)** | Med-High Density Townhouse: 7,297,432 $ft^2$<br>Mixed Use Apartment: 1,608,217 $ft^2$<br>Medium Density (Stacked Townhomes, Apartments): 3,928,691 $ft^2$<br>Schools: 512,176 $ft^2$ | 13,346,516 $ft^2$ |

As shown, approximately 44% of the Secondary Plan Area consists of medium-high density development patterns. These areas were considered for potential DES implementation.

### 3.3.2. Policy and Planning Considerations

The following policy and planning considerations are relevant to the deployment of a potential district / community-scale energy system:

- **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.
- **School Board Construction Practices:** The Town of Caledon and the local school boards (Peel District School Board and Dufferin Peel Catholic District School Board) may not permit drilling of geothermal boreholes or installation of solar photovoltaic energy systems on parklands or school properties. 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.
- **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.
- **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. The Landowners Group noted that the timeline for development of the multi-unit buildings within the Secondary Plan Area will likely occur over the span of several years. This may permit the completion of more

comprehensive studies but would also potentially restrict the viability of the system due to the staged construction approach.

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

# 4. Results

The relative energy and carbon emissions performance of the archetypes modeled for this CEERP are illustrated in **Table 13.** For this study, the Near Net Zero Scenario energy system improvements were implemented across all building archetypes.

*Table 13 - Energy and Carbon Emission Reduction Savings from Near Net Zero Designs*

| Category | Archetype | Baseline Design | 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% |

## 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 9** 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.

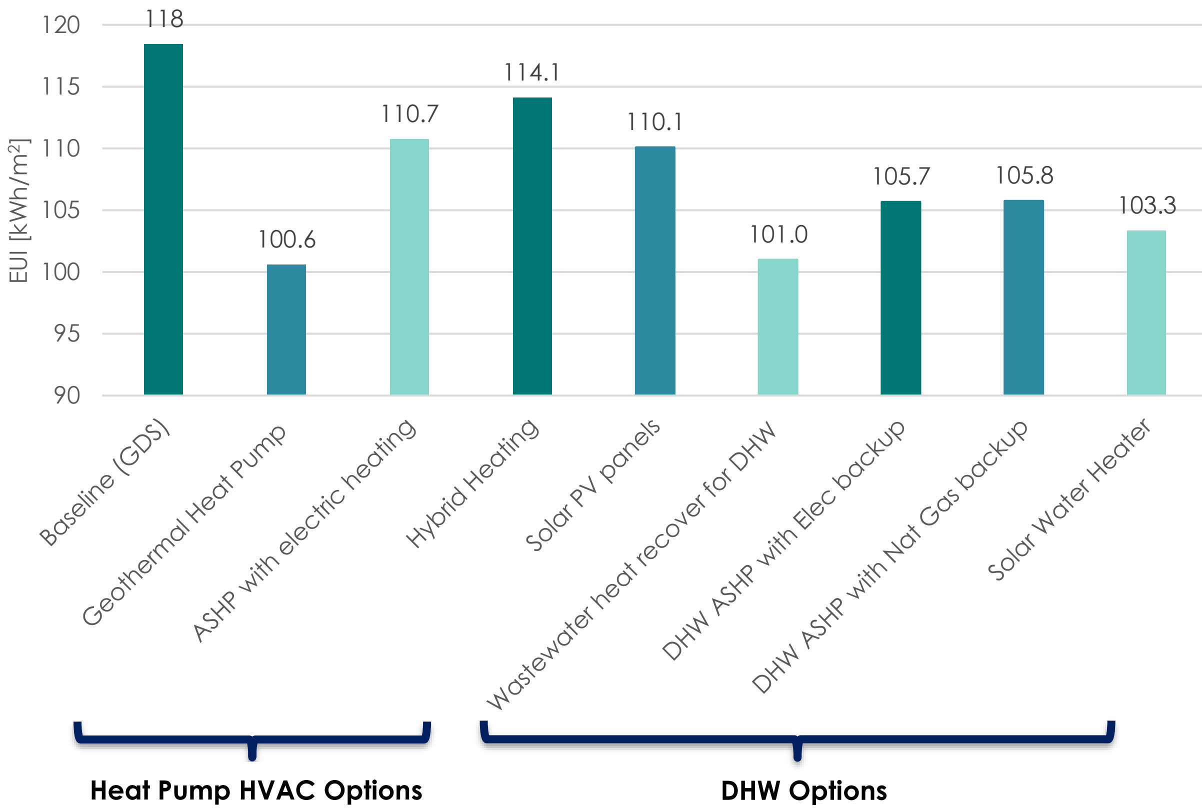



*Figure 9 - Energy Use Intensity Results for Each HVAC System Assessed*

### 4.1.2. Carbon

**Figure 10** below illustrates the greenhouse gas intensities (GHGI) of the Baseline Scenario design and various other energy conservation and greenhouse gas reduction measures. Similar to the energy results, space heating and DHW are the primary contributors to greenhouse gas emissions of the proposed community development. Therefore, energy conservation measures targeting heating and DHW were applied to determine the most feasible strategies for reducing emissions and energy use.

The most impactful emission reduction measure assessed for the entire site is the use of 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.

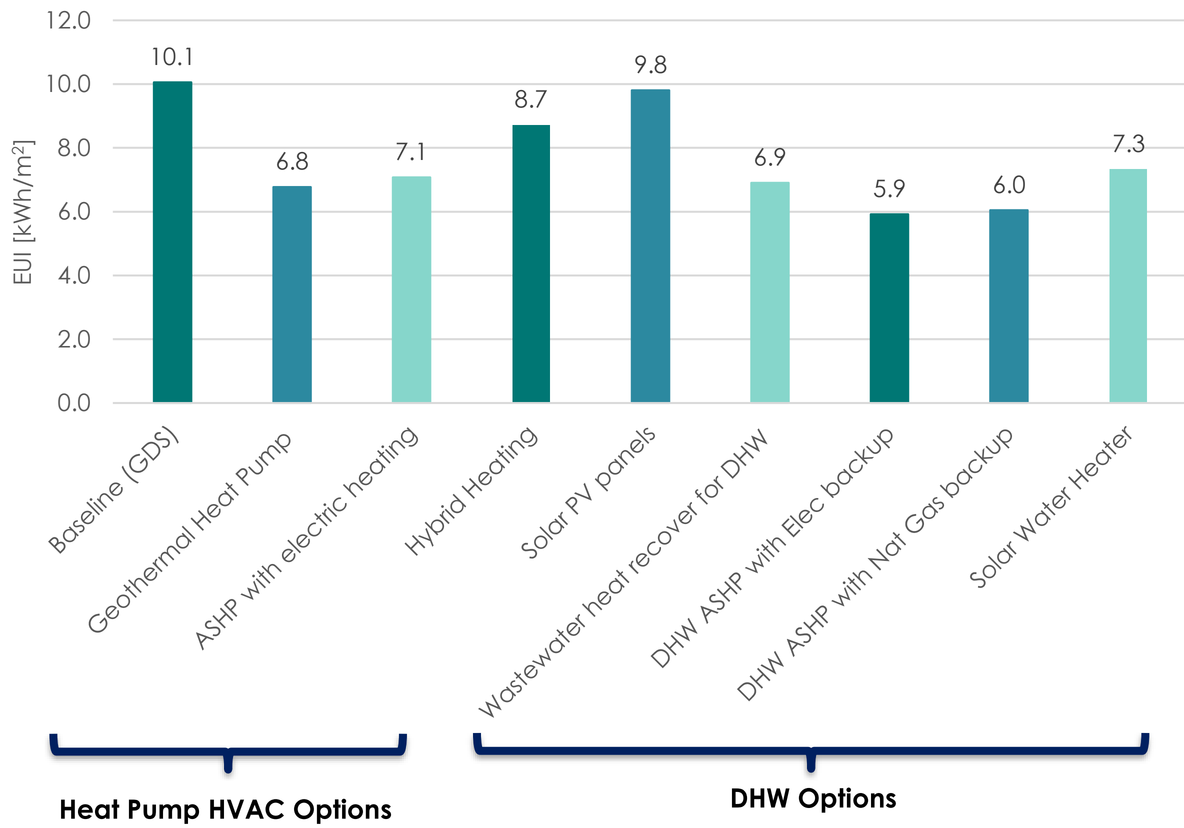



*Figure 10 - Greenhouse Gas Use Intensity Results for Each HVAC System Assessed*

## 4.2. Impact of Updated Development Statistics on Energy and GHG Performance

Energy and emissions analyses were conducted based on documentation provided by the planning consultant. After the analyses were completed, some changes to the proposed development were made as an outcome to ongoing discussions between the Town of Caledon and the Landowners Group. Revised site development statistics communicated by the planning consultant in March 2025 are summarized in **Table 14**. As shown, the revised statistics reflect requests to provide additional parkland area, municipal facilities, and varying other adjustments.

*Table 14: Summary of Changes to Site Development Statistics*

| Revision | Change |
|---|---|
| Community Park Expansion | Expanded to 6 hectares based on Town feedback |
| Community Area Reduction | Adjusted for lands removed from the Secondary Plan and added to Highway 413 Corridor |
| New Community Centre Area | Included 3.5 hectares for a planned facility |
| Mixed-Use Land Adjustment | Reduced by 50% to reflect commercial-only areas |

| Revision | Change |
|---|---|
| Medium-High Density Rate Change | Lowered from 200 uph to 100 uph to better align with townhouse development |
| Reduction in Number of Total Dwelling Units | Decreased from 14,000 to ~11,200 |

The revised site development statistics present minor fluctuations to the Plan Area's expected energy and GHG performance. A comparison of energy and GHG performance between the plan and site statistics used to conduct the original analysis and the revised site statistics is provided in **Table 15.**

*Table 15: Comparison of Impact to Baseline and Net Zero Scenarios Based on Revised Site Statistics*

| Metric | Original Baseline | Revised Baseline Scenario | Original Net Zero | Revised Net Zero Scenario |
|---|---|---|---|---|
| **Energy Use Intensity (EUI)** | 118.4 | 117.7 (-0.6%) | 78.2 | 77.9 (-0.3%) |
| **GHG Intensity (GHGI)** | 10.1 | 9.8 (-3.0%) | 2.34 | 2.35 (+0.4%) |

The expected energy and GHG performance for the Secondary Plan Area based on the revised site statistics improves slightly primarily due to a Mixed-Use Land adjustment. The baseline EUI and GHGI were assessed to decrease by 0.6% and 3%, respectively. This change is the result of the reduction of the mixed-use lot size by 50% and the reallocation of space to commercial-only areas. Since mixed-use buildings typically have a higher EUI and GHGI than commercial retail buildings, this shift consequently lowers the overall projected energy use and emissions of the site, as shown in **Table 15.** As the Net Zero Scenario references the Baseline Scenario, the change in site statistics also impacts the expected energy and emissions performance of this scenario.

It is the opinion of Pratus Group that the changes to the proposed development are immaterial to the analyses conducted. The data and trends reported are representative of the expected future development, noting that details on building typologies and design are still limited at this stage of planning. It is also possible that further changes may be made to the site statistics as the planning process progresses. Therefore, updates were not made to the analyses documented in this report.

## 4.3. 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 11** below. Total costs were used to evaluate relative costs between alternate system types over an extended period.

***Equation 1 - Total Cost***

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

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* |

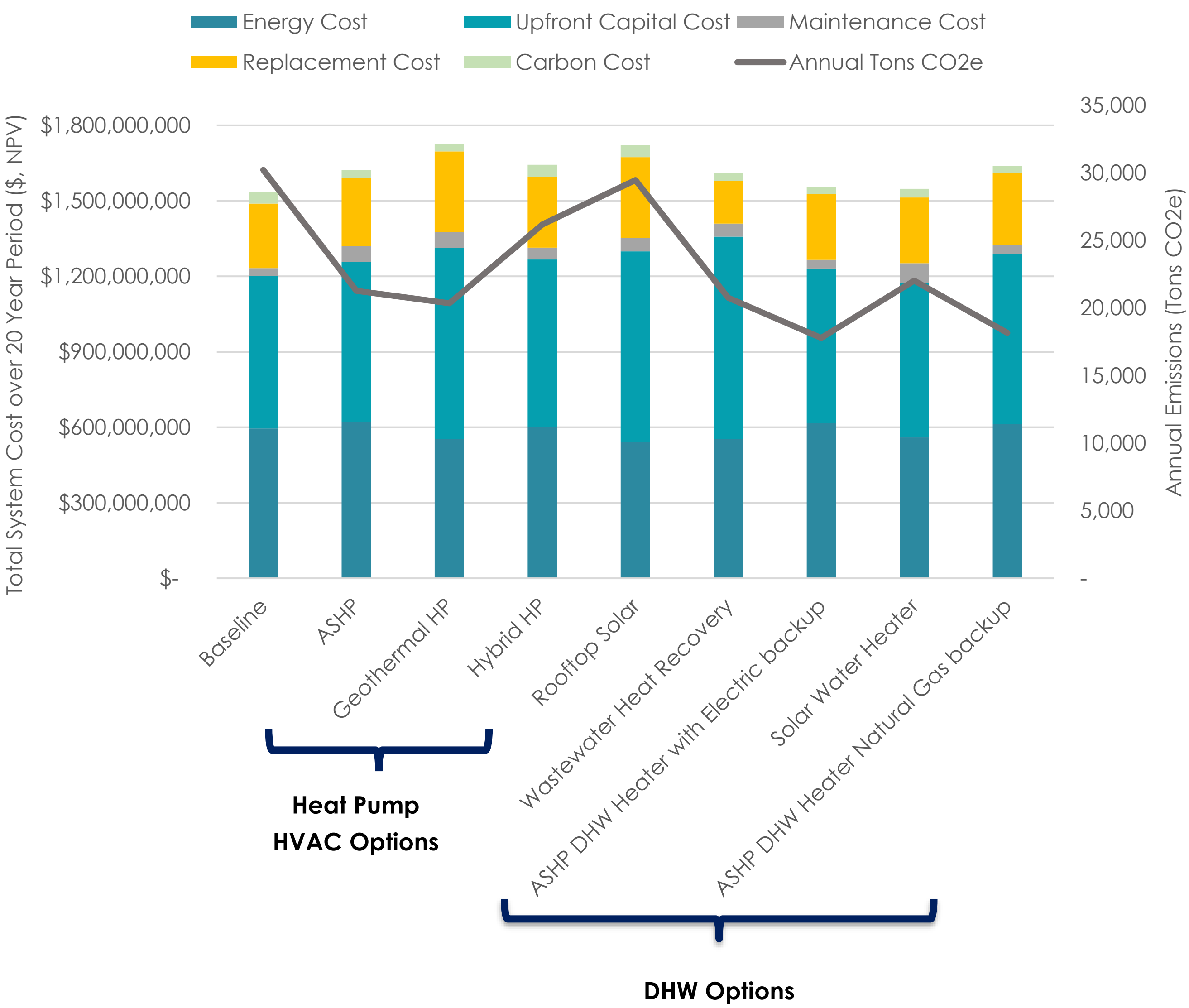


*Figure 11: Total System Cost over 20 Year Period (NPV) of Each System Assessed Along with Annual $CO_2e$ Associated with Each Measure*

20-year costs are broken down by their respective cost components. 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 not be any 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 16**.

*Table 16: 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 |

| HVAC Option | System Type | Cost Analysis | Est. 20-Year NPV Cost (Scenario 1) | Incremental Cost of Near Net Zero Condition (Scenario 2) |
|---|---|---|---|---|
| **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 |

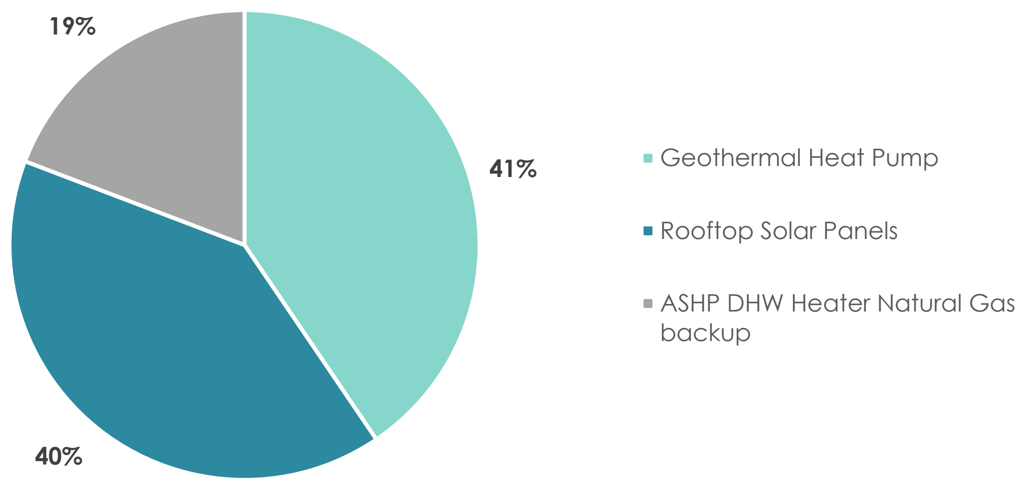



*Figure 12: Total Incremental Upfront Capital Cost Distribution of Each Proposed Measure*

The implementation of the ECMs in 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 12** illustrates the incremental upfront capital cost distribution for each measure in the Near 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 13**).

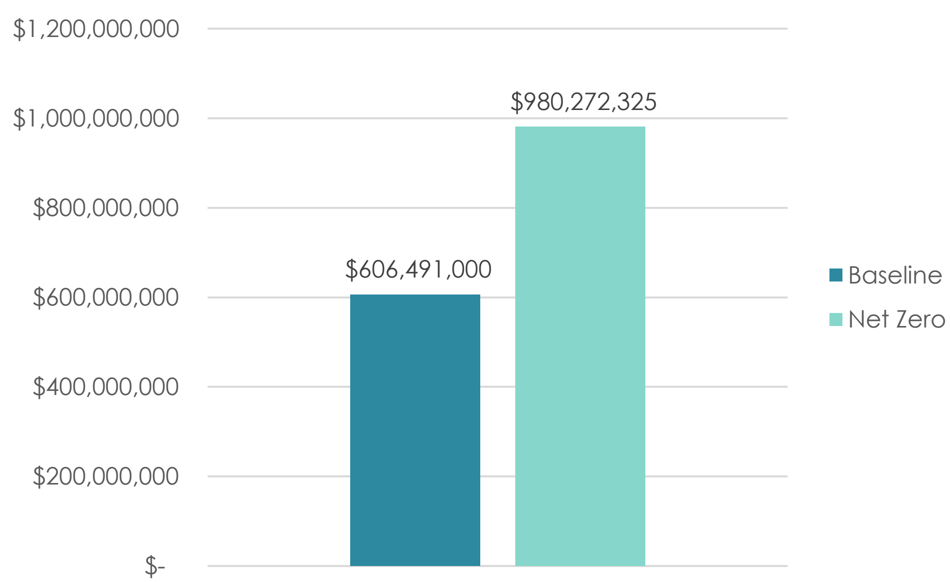



*Figure 13: Total Incremental Upfront Capital Cost vs. Baseline Scenario*

## 4.4. 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. Level 2 chargers are assumed to have an electrical demand of 6.6 kW per charging station for single family homes. All other dwellings (MURBs, commercial and school buildings) require an energy management system to be installed which limits the peak demand. Level 2 chargers in these spaces were assumed to have an average electrical demand of 2 kW.

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

The results of the analyses conducted demonstrate that EVs and their associated infrastructure requirements are expected to impose significant electricity demand. The estimated overall energy demand associated with the scenarios modelled is summarized in **Table 16**.

*Table 16: Estimated EV Charger Demand*

| Scenarios Assessed | Level 2 EV Chargers | | Level 2 EV Chargers Demand [kW] | Total Carbon Emissions [kg$CO_2$e] | Increase in Energy Consumption |
|---|---|---|---|---|---|
| | Residential | Non-Residential | | | |
| **Transportation Case 1** | 2,185 | 295 | 14,682 | 734 | |
| **Transportation Case 2** | 4,369 | 295 | 28,774 | 1,439 | 2x |
| **Transportation Case 3** | 8,739 | 295 | 56,959 | 2,848 | 4x |
| **Transportation Case 4** | 8,739 | 1,474 | 59,318 | 2,966 | 5x |

Cost estimates for the EV charging stations were based on average costs of $1,200 per charger for Level 2 chargers. These costs include charging station equipment, conduits, electrical cable runs and installation. These average costs were obtained from major supplies in Canada (ChargePoint, Switch Energy, & Flo). Approximately 35% and 15% of these costs are associated with charging station equipment and installation for residential and non-residential spaces, which the GDS indicates are to be borne by individual owners, as shown in **Figure 14**. The remainder of these costs are associated with the conduits, and electric cable installation which are incurred to the developer. The remainder of costs, incurred by the developer, equates to $780 for level 2 residential chargers, $1,020 for level 2 non-residential chargers.

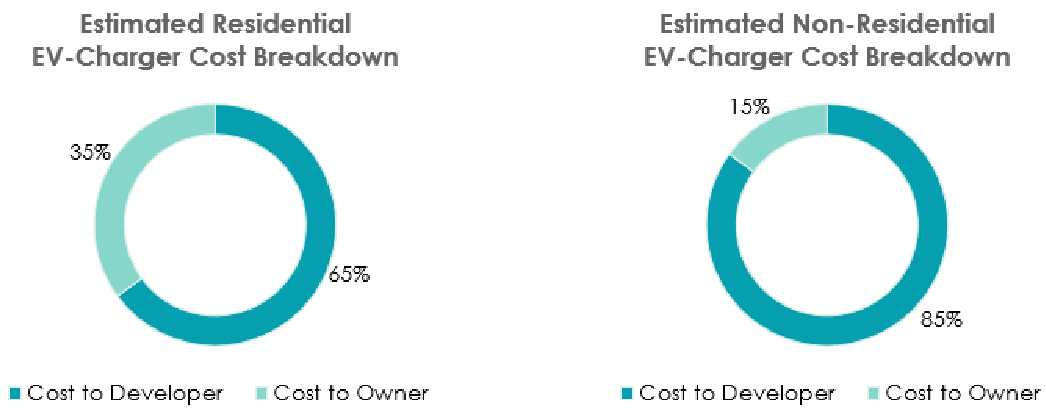



*Figure 14: Breakdown of Average cost of EV Chargers*

Based on the GDS requirements to make buildings EV-Charger ready, this results in a total of **$7,116,970**. Major suppliers have suggested that there is a factor of economies of scale that exists when chargers are installed in larger quantities. This value varies between suppliers and would be determined at the time of procurement as it is based on market demand. Networking opportunities also exist in which chargers are connected to a central plant to reduce the energy required to operate the individual chargers.

Costs for electrical infrastructure upgrades (such as higher capacity transformers and sub-stations) were excluded from these calculations as further analysis will need to be conducted on anticipated usage of the EV chargers and transportation uses which is beyond the scope of this study. While service upgrades are not required to make single-family homes EV charger ready, medium and medium/high density residential and non-residential spaces will likely require higher capacity transformers and sub-stations due to the electrification of building and transportation services. This depends on the anticipated usage at the site and can be coordinated with a service provider during the design development stage.

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

In terms of emissions, **Transportation Case 4** would fully eliminate Scope 3 tailpipe emissions from the proposed community, however, **Transportation Case 4** also increases the energy demand and carbon emissions by 304% or 5x over **Transportation Case 1**.

## 4.5. District Energy Analysis

Success factors for DES include:

- A consistent base load for both electricity and heat, supported by a diverse mix of energy profiles (residential, commercial, industrial, retail, and institutional) to enable year-round operation.
- High density and compact spatial configurations for buildings to minimize pipework infrastructure requirements, costs, and to reduce heat losses by minimizing transmission distances.
- Access to low-carbon energy source(s).

Direct discussions held with DES providers identified that DES systems are typically viable for denser developments in excess of approximately one million square feet.

The proposed Secondary Plan Area was reviewed to identify potential suitable spatial configurations that would support the feasibility of the DES in sub-areas of the site.

**Mixed-Use Apartments:** Project site statistics indicate that mixed-use apartments represent the highest density archetype in the Alloa Secondary Plan Area, with a density of 200 units per hectare. Therefore, the mixed-use apartment archetypes, along with the adjacent medium-density townhomes, were considered the most suitable development type for a DES.

**Commercial:** Discussions with the Landowners Group confirmed that the commercial property west of Creditview Road and north of Mayfield Road is expected to consist of open-air retail with big box retail store locations. This style of development is not well-suited to DES. It was understood that other commercial areas along the north side of Mayfield Road will be present in mixed-use developments.

**Employment Area:** Phase 2 of the Alloa Secondary Plan Area incorporates significant land dedicated to Prestige Employment Area. It was understood that some areas of the Phase 2 land will host municipal facilities. The nature of the Prestige Employment Area is subject to ongoing discussion and negotiation, and therefore it was unclear whether this area will be well-suited to a DES. Per feedback from the Landowners Group, this area would be useful to revisit in future to assess potential for DES once more information is confirmed on the expected development of this sub-area.

Based on the concept of the development area, a sub-area of the site was selected to evaluate potential DES implementation. **Figure 15** below illustrates the specific area of the site plan that was analyzed.

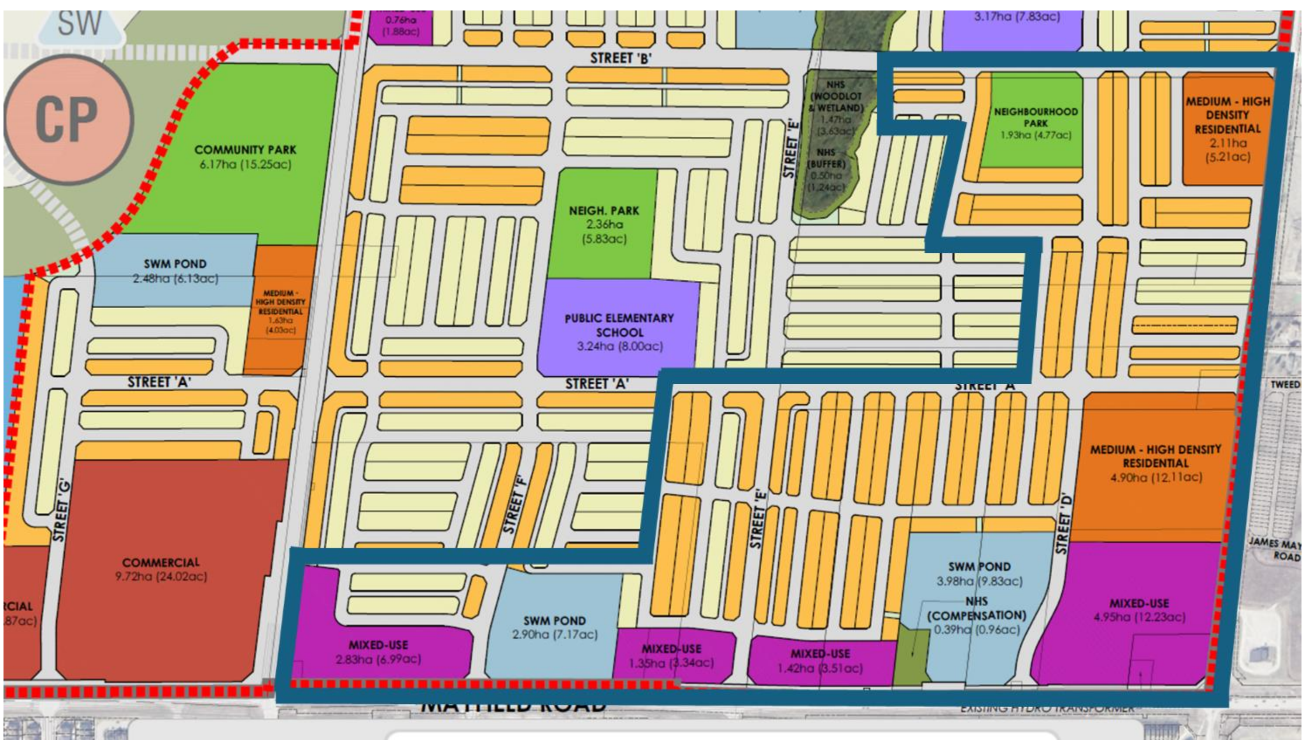



*Figure 15: Sub-Area Where DES Evaluated as Potentially Feasible*

The highlighted area above meets all the criteria for the feasibility of the District Energy System (DES), both technically and economically. This area includes the following archetypes:

- **Mixed-use apartments**: 200 units/ha
- **Medium-high density residential** (stacked townhomes and apartments): 150 units/ha
- **Medium-density townhomes**: 60 units/ha

A DES system for this sub-area of the site would serve approximately 4.8M $ft^2$ of gross floor area, significantly exceeding the minimum recommended gross floor area of 1M $ft^2$. This sub-area accounts for around 15% of total site gross floor area.

### 4.5.1. Evaluation of District Energy Systems

In all cases evaluated below it was assumed that a proposed DES would service a dense area of development centered on medium to high density developments along Mayfield and Chinguacousy Roads. This configuration would enable compact development of the DES network and a reduced service area (in terms of physical size).

#### *4.5.1.1. Geothermal District Energy Systems*

The medium density archetypes' peak heating and cooling load for the proposed DES is estimated to be 5230 kBTU/hr and 3700 kBTU/hr, respectively. This means that the site energy demand will be dominated by heating loads.

To meet this demand, approximately 1,580 boreholes drilled to a depth of 850 feet would be required to meet the expected demand of the DES feasible site under consideration.

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 178,200 $ft^2$ . This equates to approximately 3.5% of the proposed DES sub-site under consideration, indicating that there would be limited space restrictions, and that the deployment of the system could 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. Detailed engineering and design would need to be conducted to confirm.

The approximate NPV cost of implementing this system would be $258,088,000.

#### *4.5.1.2. 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: 3,800 m² (~5% of park land use area)
- Elementary Schools: 650 m² (~1% of school land use area)

It should be noted that only the parks and schools located near the sub-area that was assessed as a potential host for DES were considered for solar PV in this feasibility assessment. A district solar PV system installed in parks and schools near the proposed sub-area would allow for approximately 5,000 m² of panel area, which is equivalent to mounting panels on roughly 5% of all available roof area across the entire DES sub-site under consideration. The additional space allocation towards Solar PV only translates to an EUI reduction of ~1%. This style of system was therefore evaluated to be unfeasible 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 $242,519,000.

#### *4.5.1.3. Sewage (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 16** below.

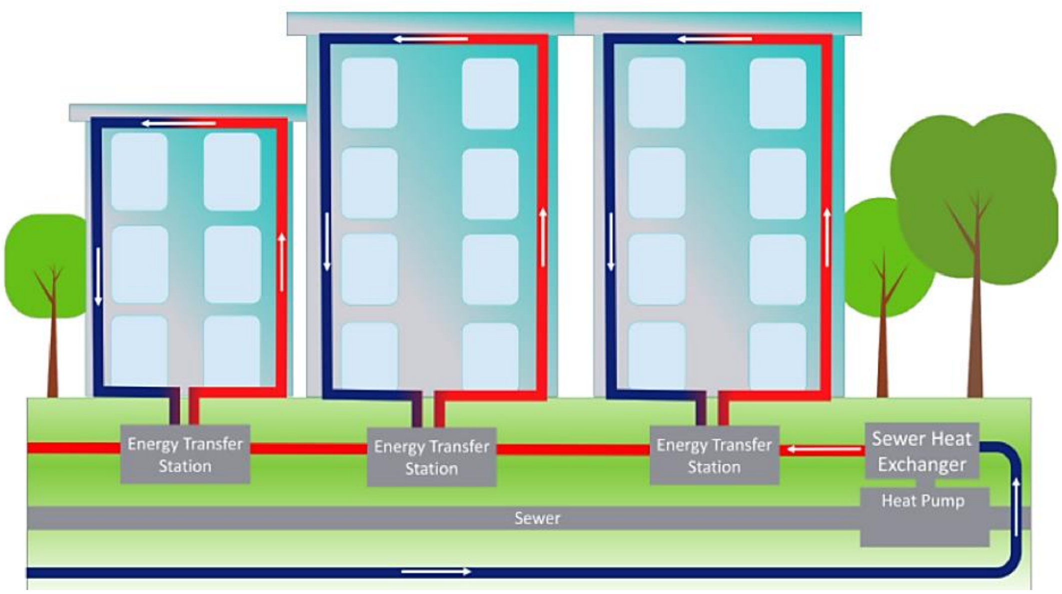



*Figure 16: DES Schematic of Wastewater Heat Recovery (City of Toronto, 2017)*

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 sub-area, 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 sub-area's DHW load demand was estimated to be approximately **451M gallons/ year.** The overall analysis summary is summarized in **Table 17** below.

*Table 17: Estimated Wastewater Generation vs Estimated Wastewater Required for the Host Sub-Area*

| Wastewater Factor | Modeled Flow Rates |
|---|---|
| **Total wastewater generated** | 141,802,500 gallons/year |
| **Total wastewater required** | 451,320,799 gallons/year |

The quantity of wastewater that is expected to be generated in this subarea is therefore insufficient to meet the volume required to meet the modeled DHW demand.

The approximate NPV cost of implementing this system for the medium density dwellings in the neighborhood Centre would be $240,752,206.

### 4.5.1.4. DES Result Summary

**Table 18** summarizes the evaluation of DES viability results for the sub-area studied.

*Table 18: DES Viability*

| System | Infrastructure Required (Enbridge, 2024) | Considerations | Estimated Cost (Sub-Area) |
|---|---|---|---|
| **Geothermal Pumps System** | 1,580 boreholes and 178,265 $ft^2$ land area | • Typically sized to serve heating and cooling loads and optionally for DHW<br>• Space constraints must be studied (i.e., borehole field sizes/locations)<br>• Soil conditions<br>• Metering/financing considerations for owners/operators | $258,088,000 |
| **PV Array (District Level)** | 102,174 $m^2$ of roof area; 5,000 $m^2$ of space in parks and school roofs | • Low energy generation potential<br>• Location of PV arrays and racks are limited to publicly owned property<br>• Metering/financing considerations for owners/operators | $242,519,000 |

| System | Infrastructure Required (Enbridge, 2024) | Considerations | Estimated Cost (Sub-Area) |
|---|---|---|---|
| **Sewage Waste Heat Recovery** | 16,567 $m^2$ land area | • Typically, can only serve DHW loads<br>• Access to available sanitary waste matter streams<br>• Metering/financing considerations for owners/operators | $240,752,000 |

## 4.6. Roadmap to Near Net Zero Discussion

**Table 19** and **Table 20** summarize the Near Net Zero Scenario, a potential lower carbon development pattern. This scenario incorporates strategies to achieve additional energy and carbon emission reductions beyond the Baseline Scenario. The percentage of individual reduction is calculated by using the individual measure reduction potential over the total reduction potential value.

*Table 19 : 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 20: 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 21** and **Figure 17** 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]** | 196 | 118 | 78 | 60% | 34% |
| **GHGI [kgCO2e/m²]** | 25 | 10 | 1 | 96% | 85% |

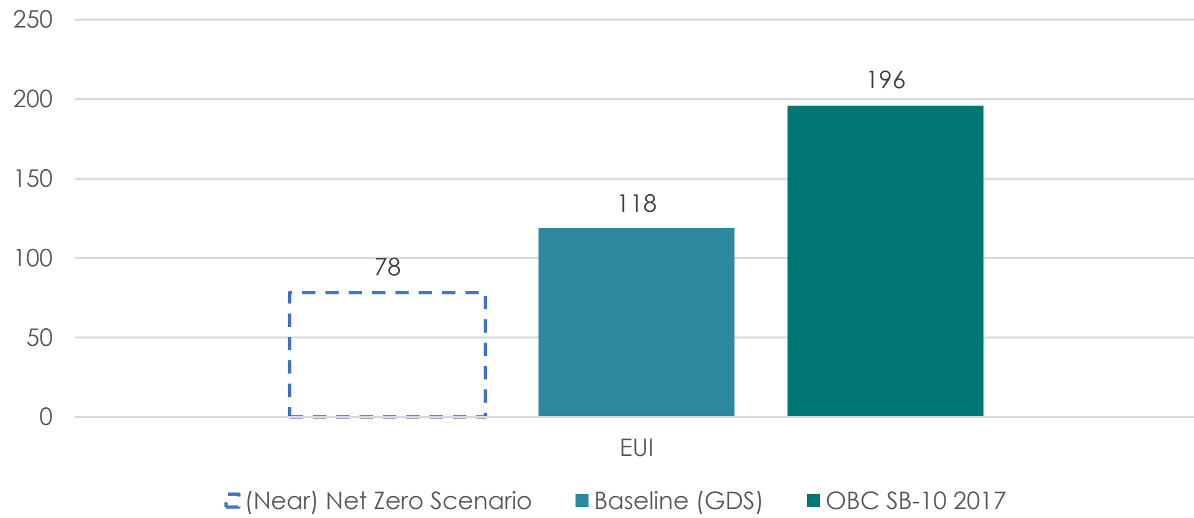



*Figure 17: Estimated EUI Reduction Potential Reduction Potential Comparion to OBC and Baseline Scenario*

The Near Net Zero Scenario is meant to provide a potential pathway to near net zero carbon emissions for the Alloa Secondary Plan Area. **Figure 18** and **Figure 19** present how the proposed strategies would further reduce energy and carbon emission demand.

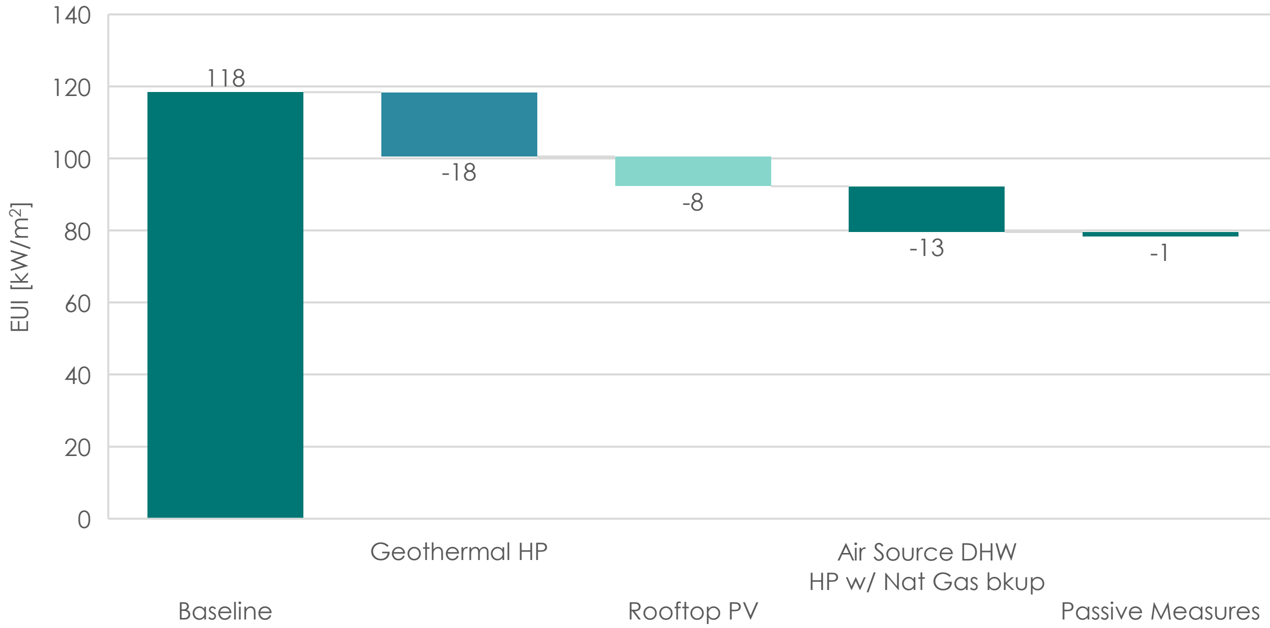



*Figure 18: Energy Use Intensity Reduction Roadmap demonstrating EUI reduction potential*

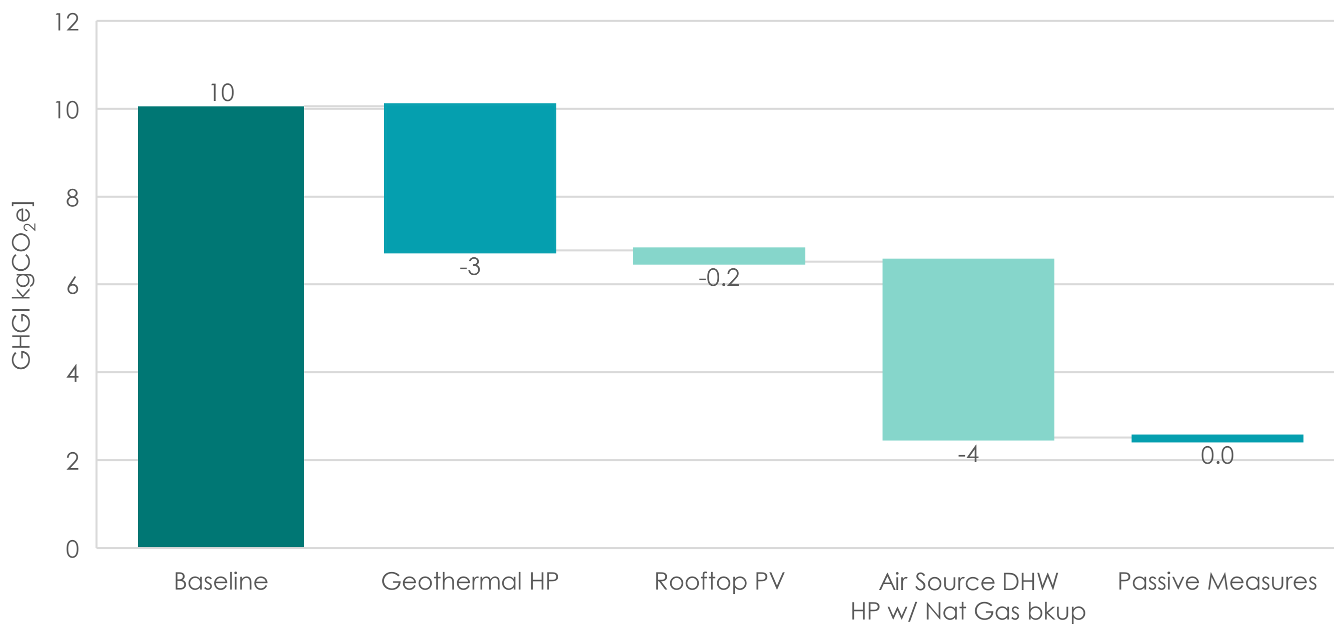



*Figure 19: Greenhouse gas Intensity Reduction Roadmap demonstrating GHGI reduction potential*

Therefore, the Near Net Zero Scenario as modeled achieves an EUI of 45 kWh/$m^2$ and a GHGI of 1kg$CO_2$e/$m^2$. 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 $1.9B, based on the Class D cost estimate conducted, in **Section 4.3.** The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately $373.8M. 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** | $1,727,971,000 | $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** |

## 4.7. 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.

### 4.7.1. 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).

### 4.7.2. 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 21** outlines estimated kW demand for the heating and cooling systems under consideration.

*Table 21: 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 |

### 4.7.3. 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

The Alloa Secondary Plan Area represents the creation of a significantly sized community. Effectively advancing energy efficiency and emissions reduction actions will require new communications and engagements between project stakeholders including the Town of Caledon, the Landowners, utility providers, and district energy system providers, among others.

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 22**.

*Table 22: Proposed Implementation Plan for Energy Conservation & Emissions Reduction Strategies*

| Actions | Relevant Documents | Timeline | Responsibility |
|---|---|---|---|
| **1: Building-Scale Measures** | | | |
| The Landowners Group shall engage with the Town of Caledon to confirm elements of the pilot Town of Caledon Green Development Standard that the Landowners Group will agree to integrate into policy requirements for the Secondary Plan Area. | Green Development Standard | Site Plan | Building Developers |
| Building developers are encouraged to integrate high-efficiency air-based and/or ground-based heat pumps for buildings that are not required to implement these systems under Tier 1 of the Green Development Standard. | Green Development Standard | Site Plan | Building Developers |
| The Town of Caledon is encouraged to explore and develop incentives for the integration of low-carbon energy systems (such as heat pumps) that go beyond the Green Development Standard requirements to reduce the capital cost to builders. | Green Development Standard | N/A | Town of Caledon |
| Building developers shall 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** | | | |
| Total electric demand for EV infrastructure should be confirmed with Hydro One to evaluate feasibility of EV charging at the level required should the majority of future owners in the Secondary Plan Area elect to install EV chargers. Hydro One will be approached to provide information to qualified users and operators to inform planning and design, with specific guidance required on transmission capacity. | N/A | Draft Plan | Town of Caledon<br><br>Hydro One Networks Inc. |
| The Landowners Group shall implement electric vehicle charging capacity and infrastructure requirements (by building type) based on agreed upon metrics from the pilot Green Development Standard with the Town of Caledon. | Green Development Standard<br><br>Architectural & Urban Design Guideline | Draft Plan | Building Developers |

| Actions | Relevant Documents | Timeline | Responsibility |
|---|---|---|---|
| **3: District-Scale Energy Systems** | | | |
| If requested and directed by the Town of Caledon, the Landowners Group will participate in further evaluation of district energy systems to further assess the feasibility of the district-level systems identified as potentially feasible for sub-areas of the site. | N/A | Draft Plan | Landowners Group<br><br>Town of Caledon |

# 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.

The results of the analyses conducted demonstrated EVs and their associated infrastructure requirements are expected to impose a significant electricity demand at their assumed usage. Average installation and material costs suggest that it would cost approximately $7.1 million to install electrical wiring and infrastructure at buildings to make EV-charger ready, as per the GDS minimum requirements.

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

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 **$1.9B**, based on the Class D cost estimate conducted. The incremental capital cost over the baseline for the Near Net Zero Scenario is approximately **$373.8M**.

Implementing the strategies outlined in the Near Net Zero Scenario will allow the Alloa Secondary Plan Area to surpass the Town of Caledon's overall greenhouse gas intensity (GHGI) reduction goal of 36% by 2030, which applies to both existing and new communities. Additionally, the Near Net Zero Scenario will support the achievement of the specific target for new developments to meet net-zero standards 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:**

**Christopher Mohabir, P.Eng.**

Building Performance Team Lead
chris.mohabir@pratusgroup.com

**Zaid Khan, M.Eng., EIT**

Building Performance Analyst
zaid.khan@pratusgroup.com

**Report Reviewed By:**

**Jay Doshi, MS, P.Eng., CEM**

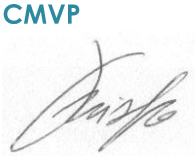
Building Performance Team Lead
jay.doshi@pratusgroup.com

**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

# 7. References

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

Canada, A. (2018). *Vision George Town Energy,Masterplan.* The Town of Halton Hills.

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

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

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

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

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

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

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

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

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

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

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

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

Glen Schnarr & Associates Inc. (2025). *Alloa Secondary Plan: Lane Use Plan.* Glen Schnarr & Associates Inc.

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

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

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

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

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

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

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

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

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

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

# Appendix A. Site Plan and Statistics

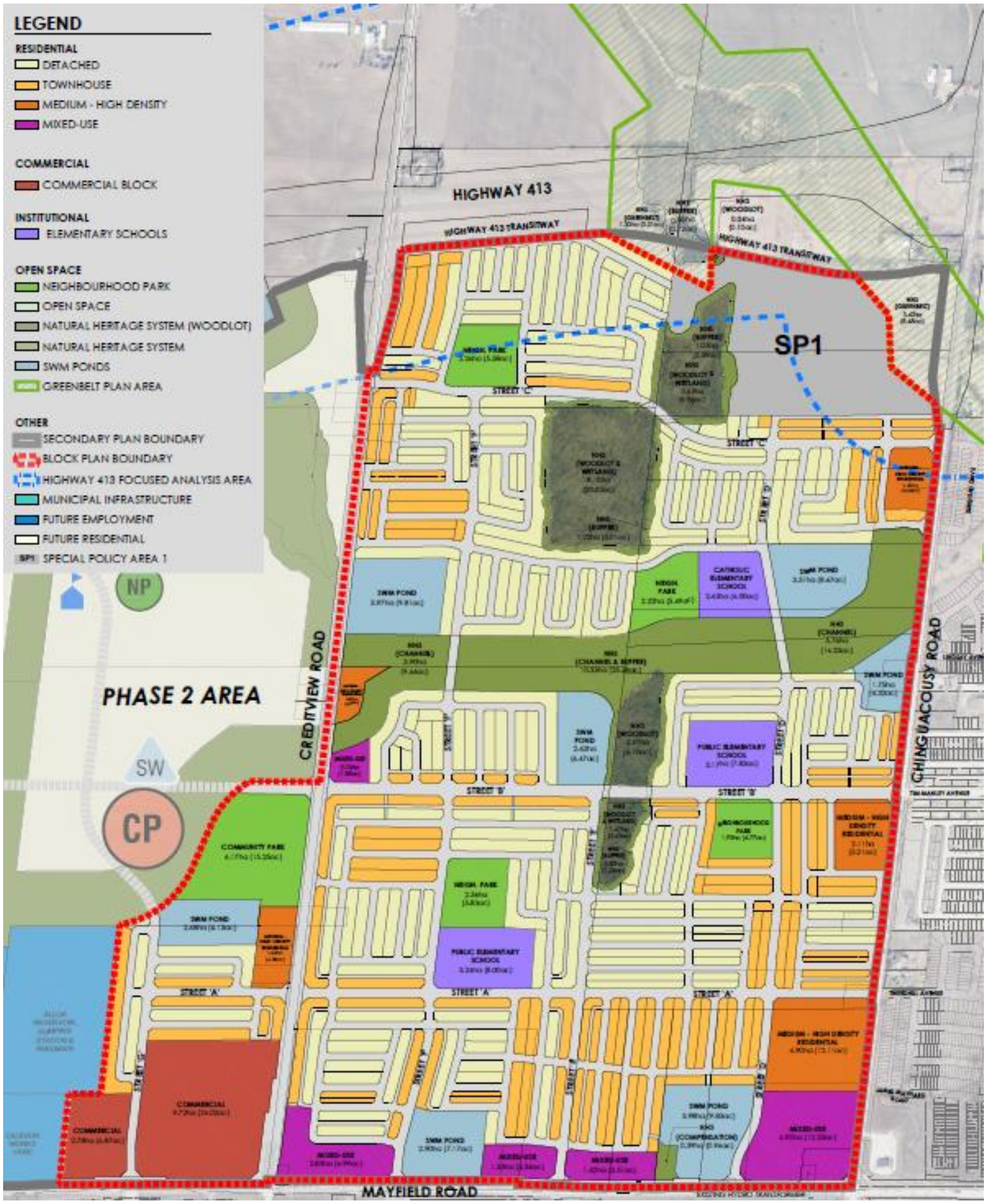



*Figure A-1 – Proposed Conceptual Land Use Plan for the Alloa Secondary Plan Tertiary Plan Phase 1, April 1 2025 (Glen Schnarr & Associates Inc., 2025)*

## 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 |

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

NOTES:

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

Prepared by GSAI (June 3, 2024)

*Figure A-2 – Preliminary Statistics from the Alloa Secondary Plan Used to Inform the Energy/Emissions Analysis (Glen Schnarr & Associates Inc., 2024)*

# 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.

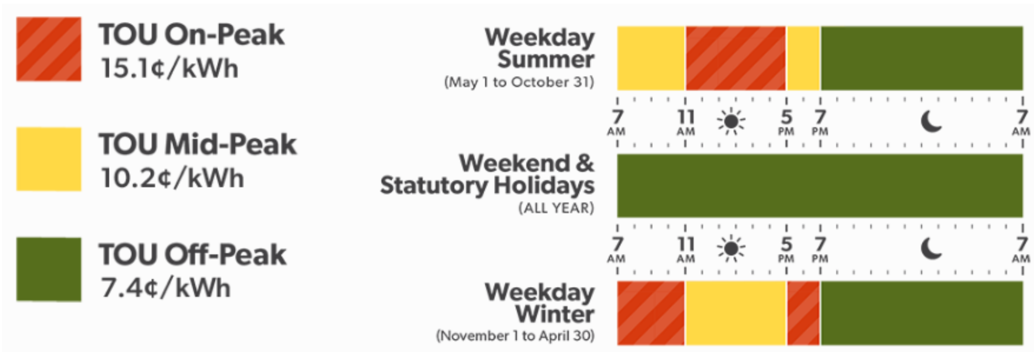



*Figure B-1 – Hydro One Time-of-Use Rates Effective until October 31, 2023 (Hydro One, 2023)*

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 $CO_2$e 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%).

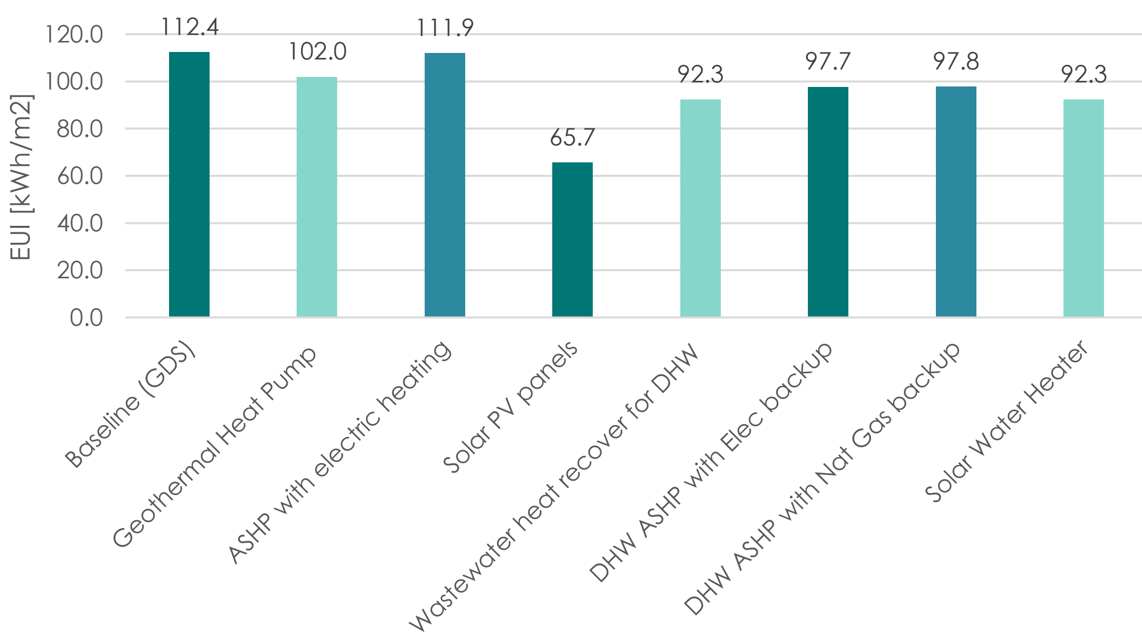



*Figure D-1 – EUI Results for Low-Rise Residential*

**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.

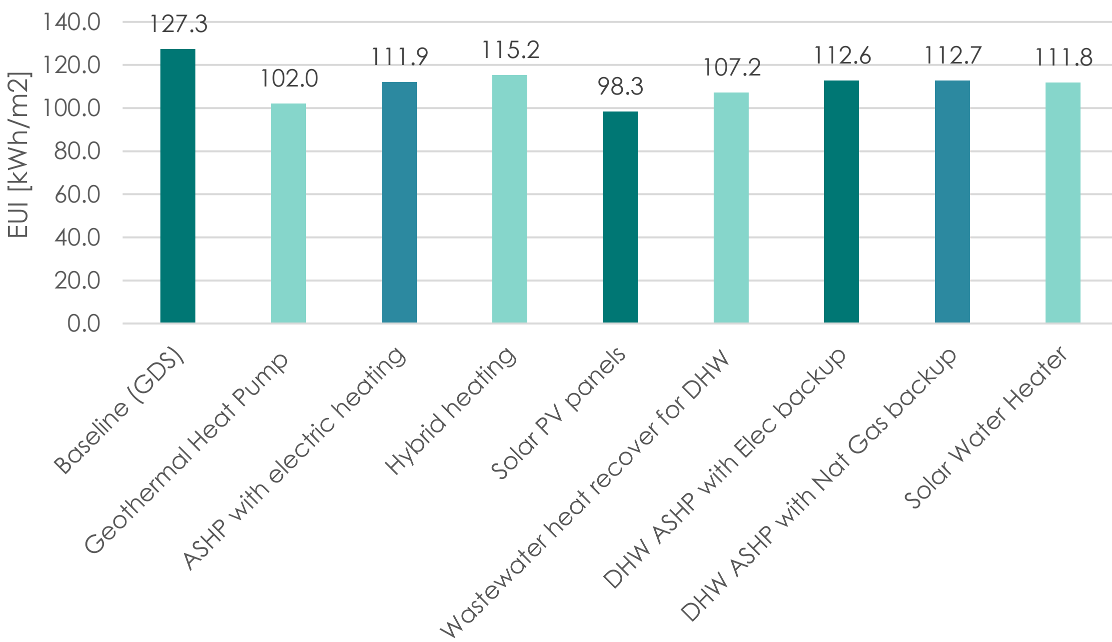



*Figure D-2 – EUI Results for MURBs (<6 storeys)*

**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

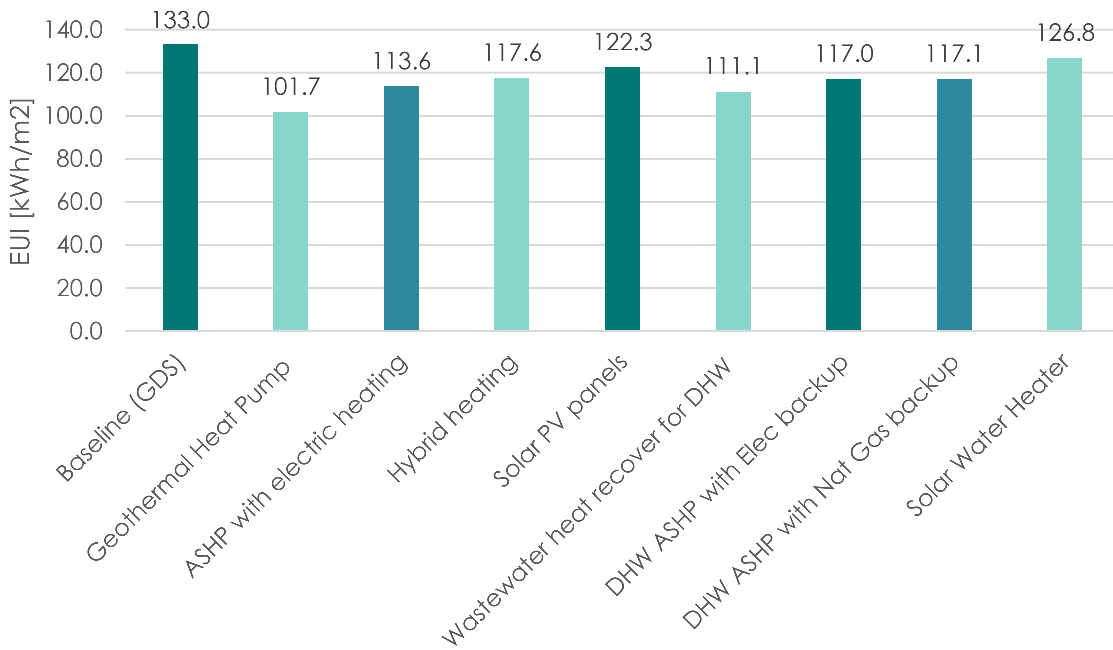



*Figure D-3 – EUI Results for MURBs (>6 storeys)*

**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.

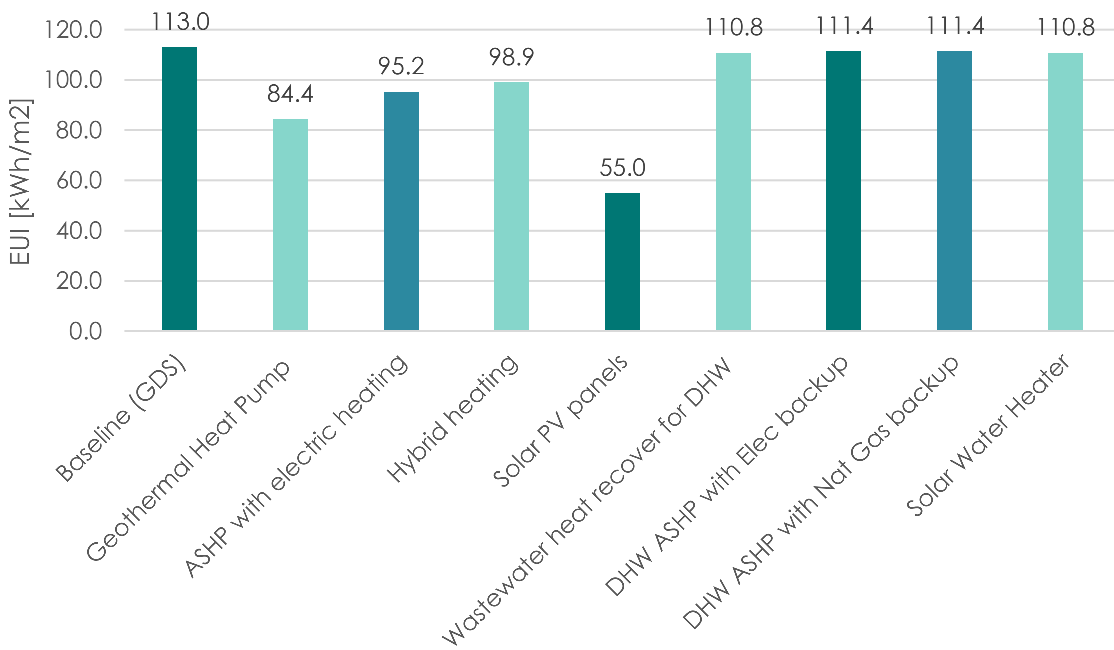



*Figure D-4 – EUI Results for Commercial Retail*

**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.

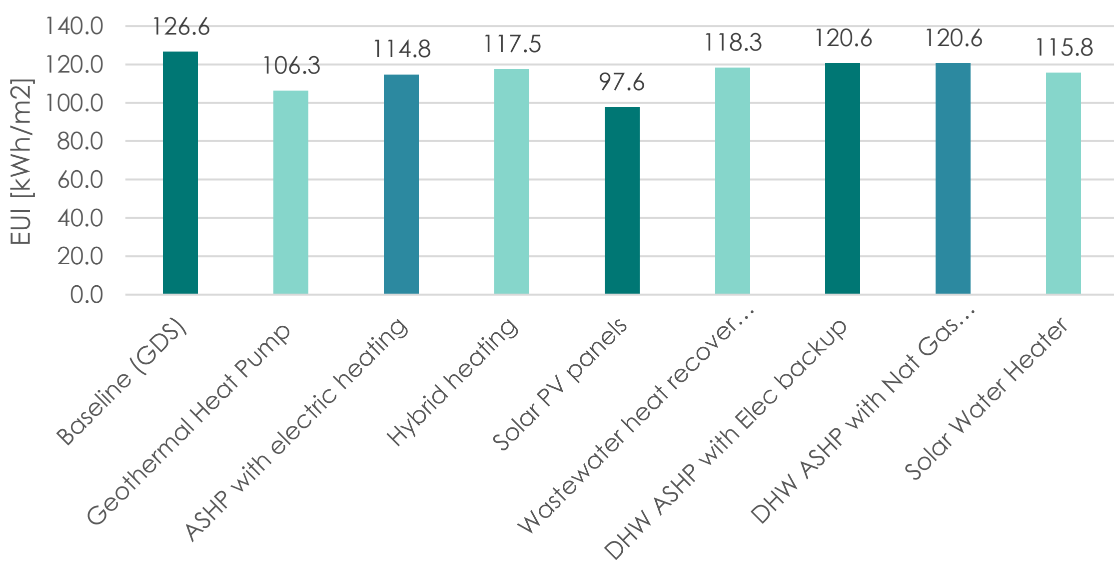



*Figure D-5 – EUI Results for Commercial Office*

**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.

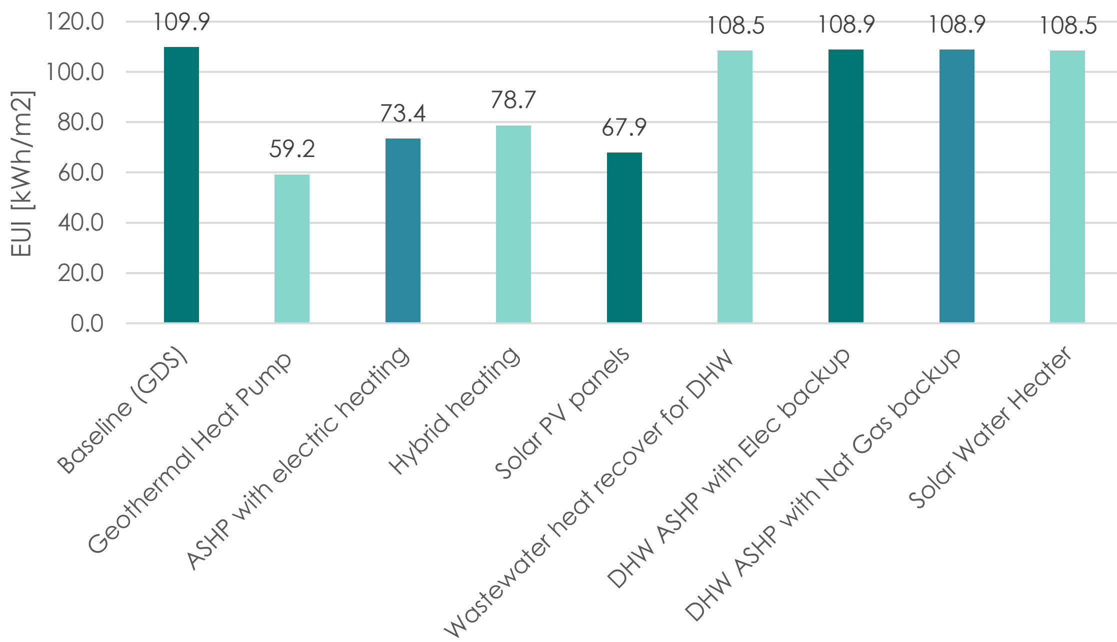



*Figure D-6 – EUI Results for Commercial Industrial*

**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.

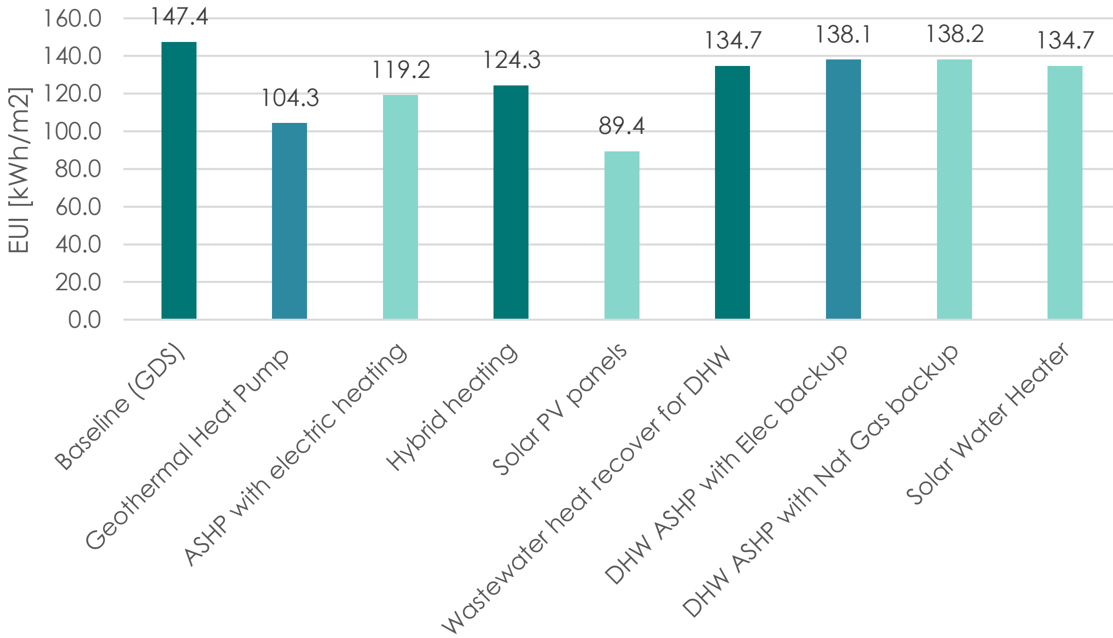



*Figure D-7 – EUI Results for Schools*

## 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.

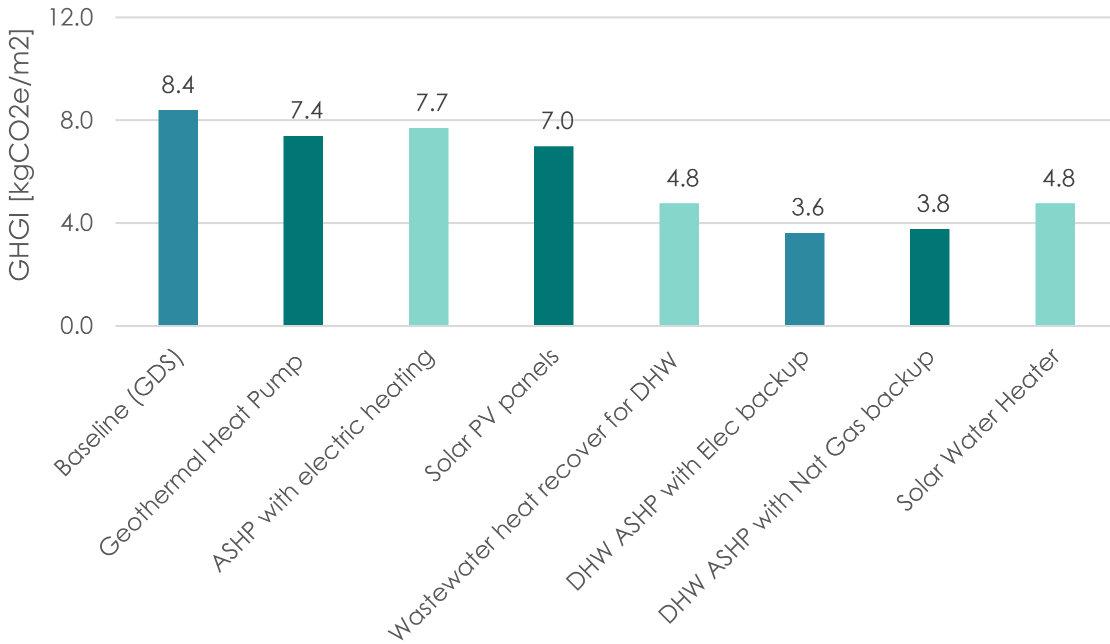



***Figure D-8 – GHGI Results for Low Rise Residential***

**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.

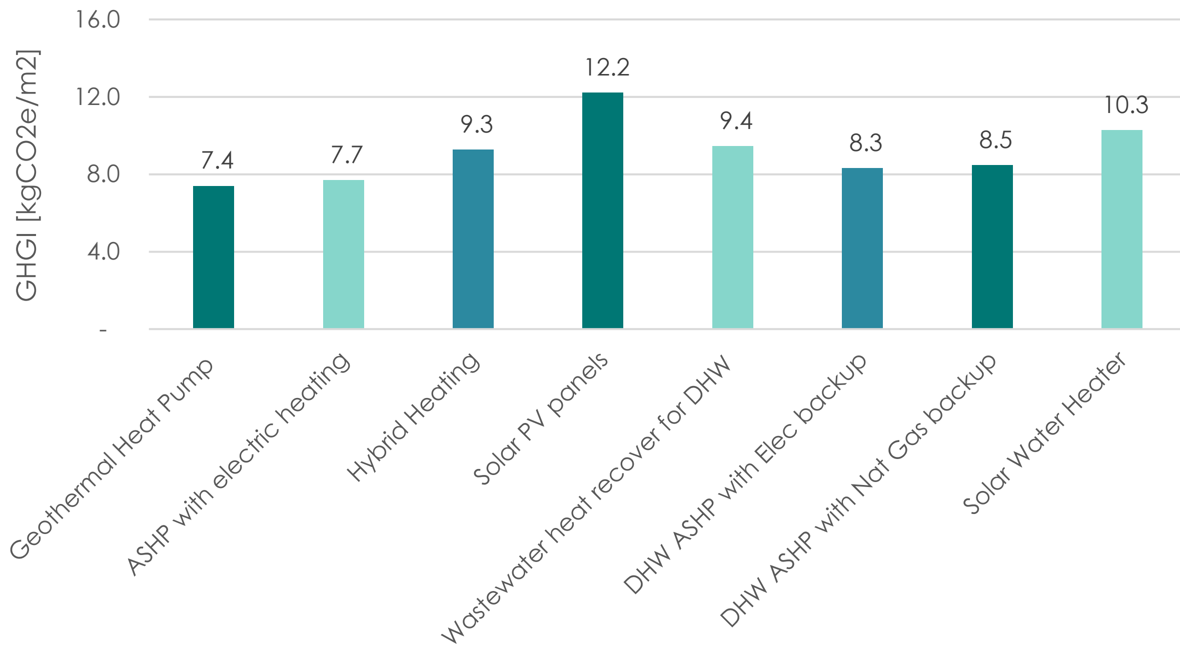



*Figure D-9 – GHGI Results for MURBs (<6 storeys)*

**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.

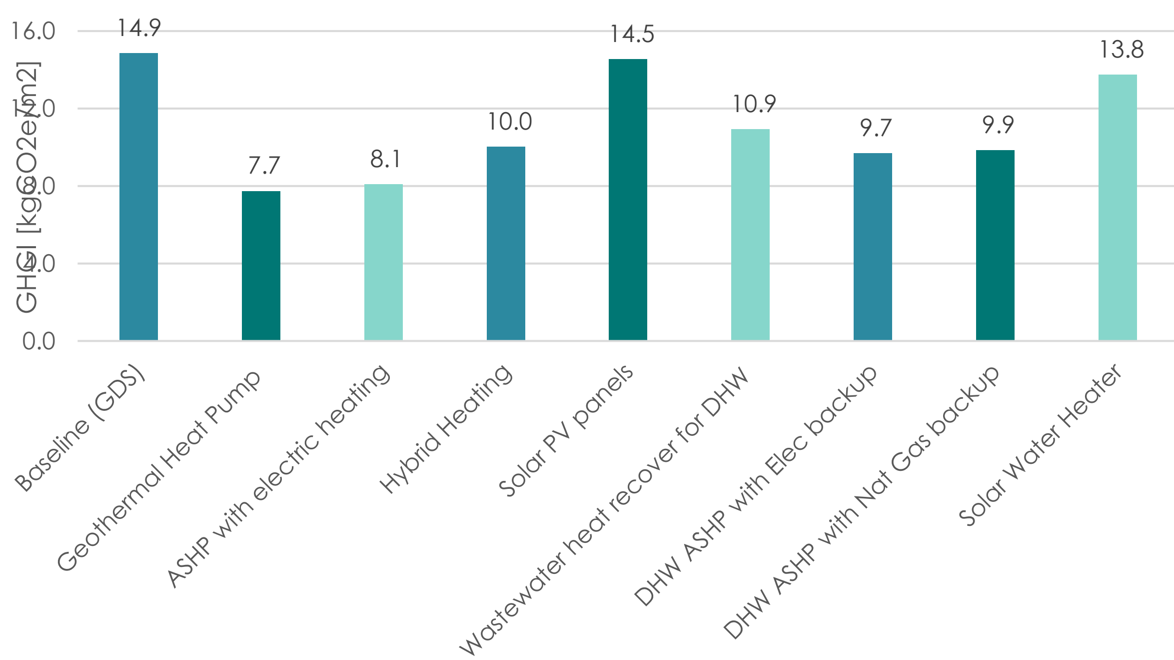


*Figure D-10 – GHGI Results for MURBs (>6 storeys)*

### 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%.

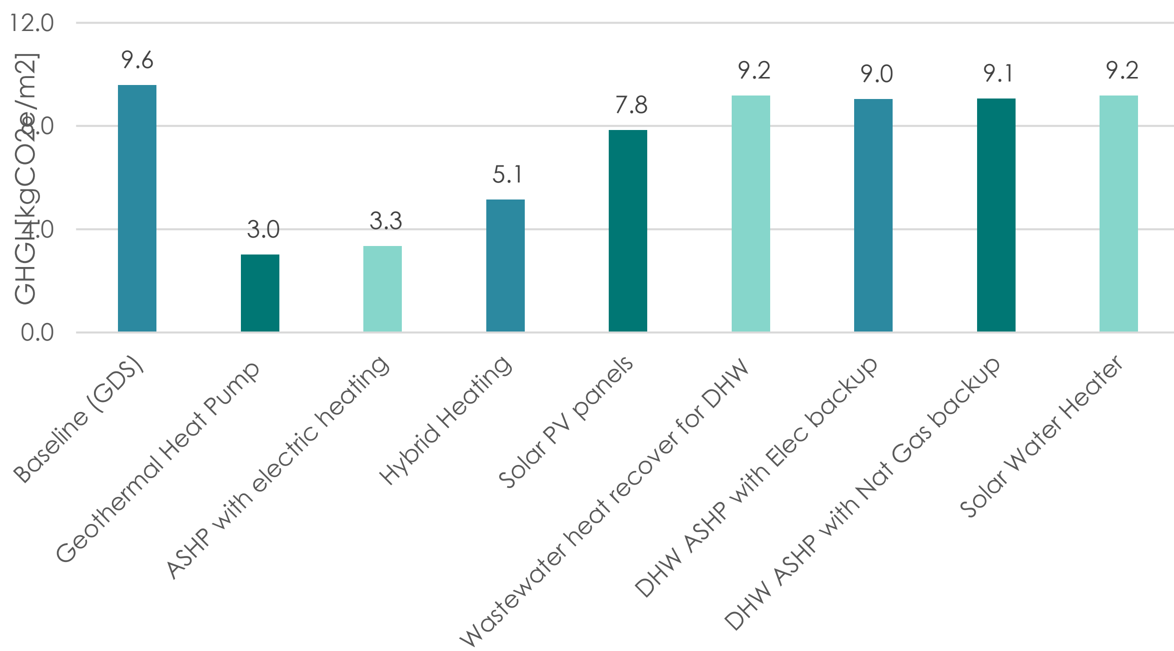



*Figure D-11 – GHGI Results for Commerical Retail*

### Commercial Office

The observations for the commercial retail archetype apply similarly to the commercial office archetype. While the scale of heating measures is 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.

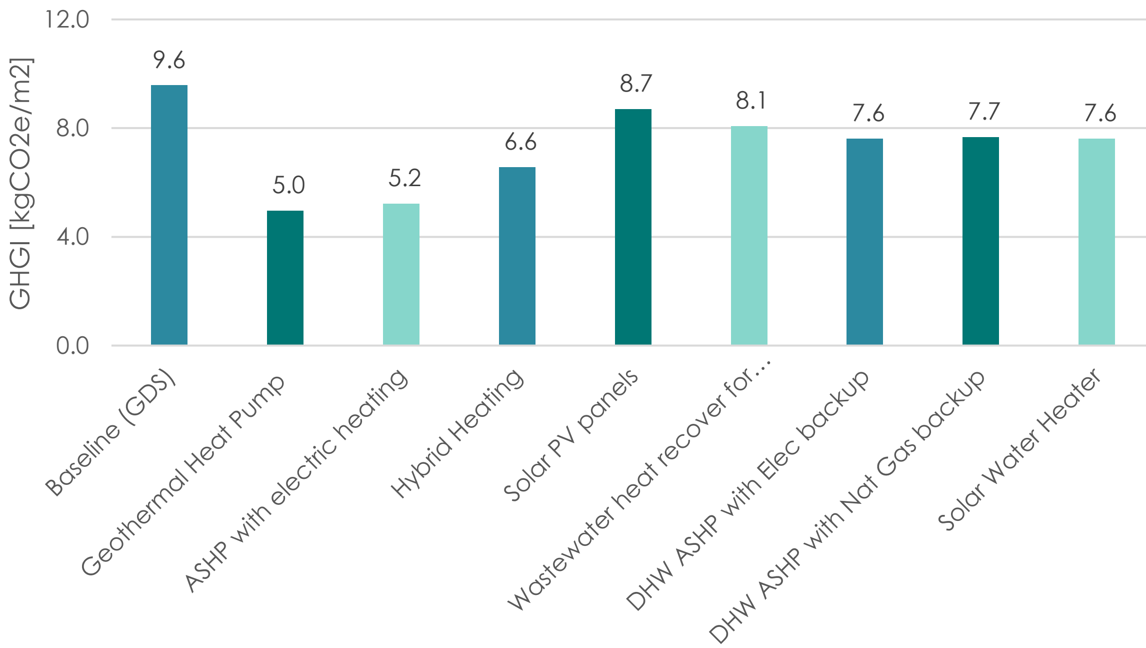



*Figure D-12 – GHGI Results for Commercial Office*

**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.

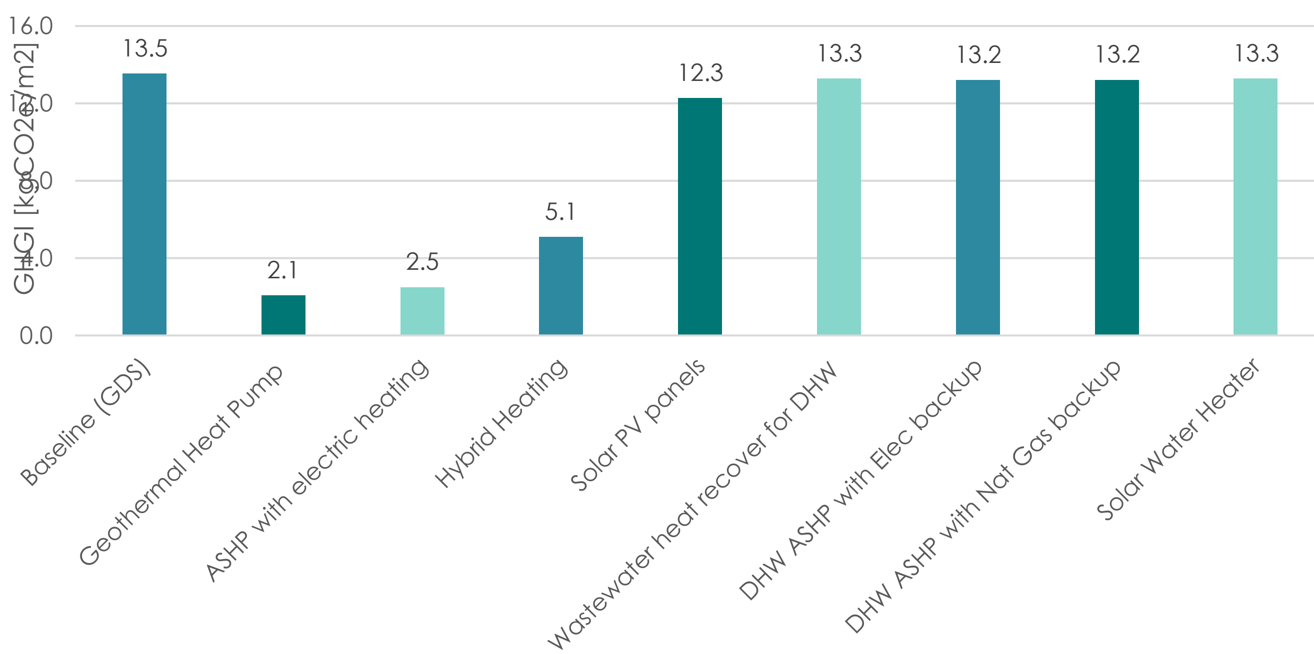


*Figure D-13 – GHGI Results for Commerical Industrial*

**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.

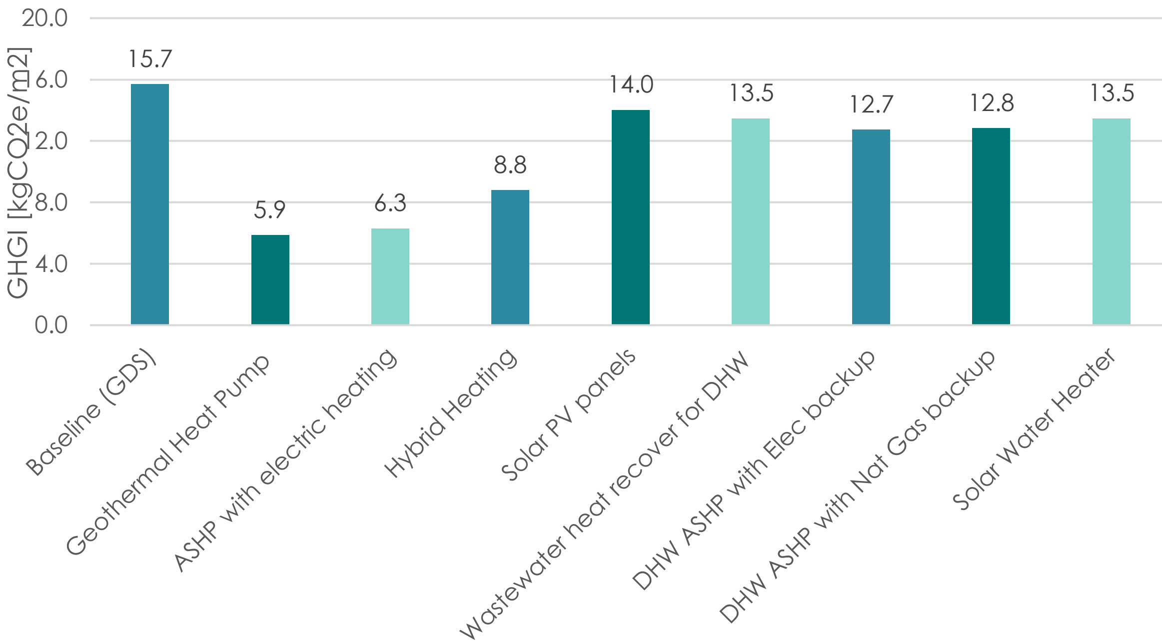



*Figure D-14 – GHGI Results for Schools*

# Appendix D.

**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 $14,000/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 – 7,500 (per stats provided by planning consultant)
- Annual days of operation – 365 days
- Washroom flush rate- 1.6 GPF*
- Urinal flush rate-1 GPF*
- 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.

**pratusgroup.ca**

Pratus