WESTON 7

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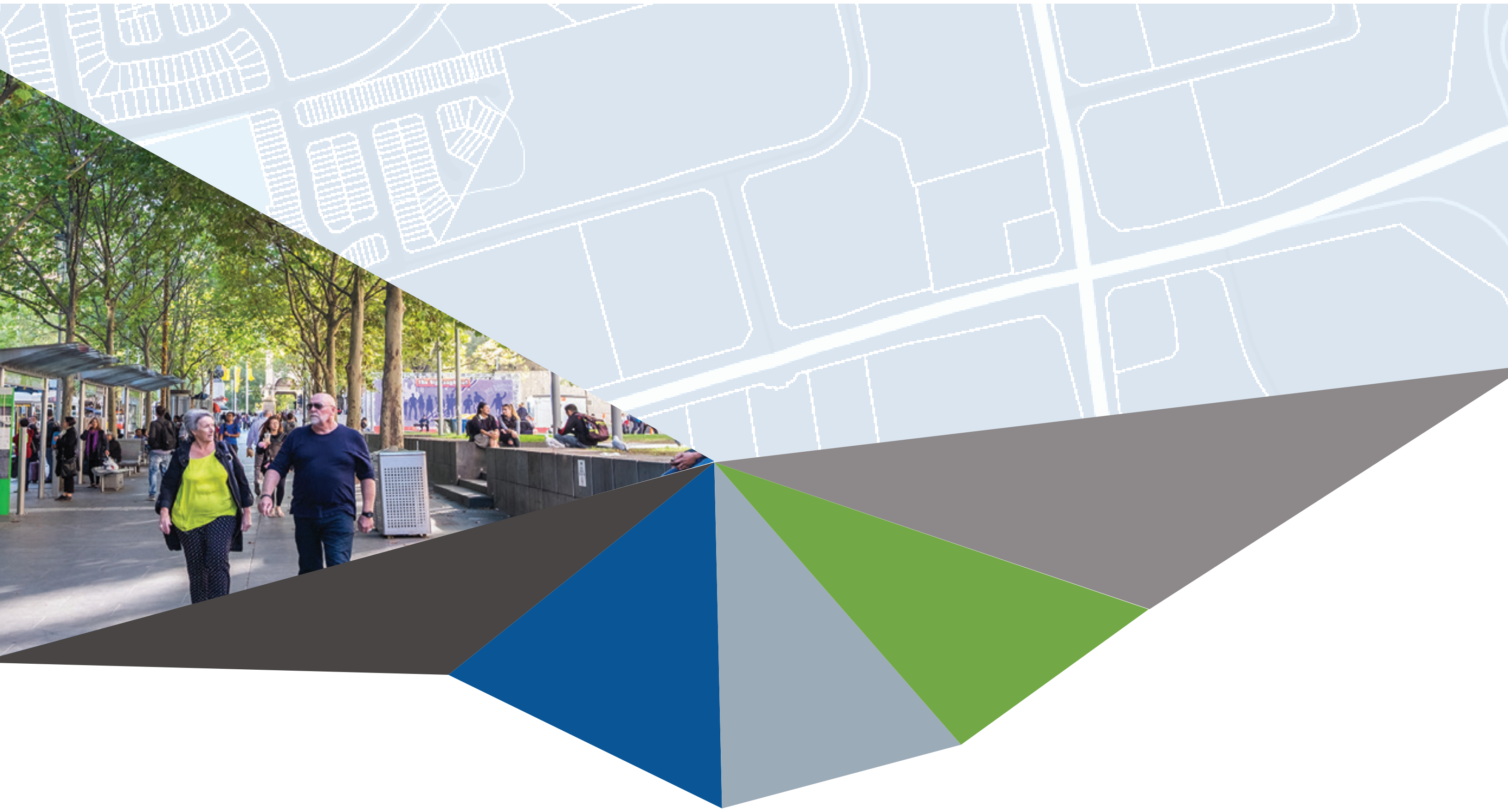
COMMUNITY ENERGY PLAN

APPENDIX 4

October 29, 2018



VAUGHAN

URBAN STRATEGIES INC.

WESTON ROAD AND HIGHWAY 7 COMMUNITY ENERGY PLAN

Prepared in support of the Weston Road and Highway 7 Secondary Plan - Phase 1

October 12, 2018

EQ BUILDING PERFORMANCE

URBAN EQUATION

EXECUTIVE SUMMARY

This Community Energy Plan (CEP) seeks to inform the anticipated energy use of the Weston Road and Highway 7 Secondary Plan area, informing long term energy planning for development. Focused on the importance of climate change to Vaughan, as advanced in the York Region Official Plan, Vaughan Official Plan, Green Directions Vaughan and the Municipal Energy Plan, the Community Energy Plan seeks to provide the high-level background knowledge required to eventually plan for an energy efficient, low-carbon community in Vaughan.

Energy Demand and Efficiency

The anticipated energy demand of the buildings planned in the development are established in section 3.0. Importantly, this demand has been calculated according to a density target of 160 people and jobs per hectare. Aligned with Vaughan's long term goal to become a net zero carbon city, a carbon emissions metric is adopted to evaluate performance. In this section, three building energy performance scenarios are presented: baseline compliance with the Ontario Building Code (OBC), incremental improvement beyond the OBC, and towards net zero carbon. These scenarios are predicated on the directions advanced in regional and municipal policies and plans, including Green Directions Vaughan and the Vaughan Sustainability Performance Metrics. In terms of the three energy and carbon performance scenarios analyzed, Scenario 2 and 3 represent a 11% and 59% reduction in energy use, and a 12% and 84% reduction in GHG emissions over the baseline scenario 1, respectively (see table on subsequent page and additional information in Section 3).

Incremental and significant reductions in carbon emissions are determined possible with advancements in building technology, focusing primarily on reducing heating and domestic hot water loads. Designs approaching net zero

Percentage change in energy use profiles for scenarios 2 and 3 relative to scenario 1.

Scenario	1: OBC Compliance	2: Incremental Improvements	3: Towards Net Zero
Overall Energy Intensity (ekWh/m^2)	172	152.7 (-11%)	70.1 (-59%)
Natural Gas Use (ekWh)	68,769,880	59,647,937(-13%)	129,200 (-99%)
Natural Gas Intensity (ekWh/m^2)	101.2	87.8 (-13%)	0.2 (-99%)
Electricity Use (kWh)	48,145,380	44,133,794 (-8%)	47,504,513 (-1%)
Electricity Intensity (ekWh/m^2)	70.8	64.9 (-8%)	69.9 (-1%)
Total GHGs (tonnes CO_2e)	14,840	12,990 (-12%)	2,399 (-84%)
GHG Intensity (tonnes CO_2e/capita*)	1.36	1.19 (-13%)	0.22 (-84%)

* Per capita assumes 160 people and jobs per hectare.

carbon involve fuel switching from natural gas to electricity, relying on the relatively lower carbon impact of the electricity grid.

Carbon emissions resulting from transportation needs and other infrastructure associated with the development are discussed, and it is recommended these be explored further through engaging the broader consulting team.

Resilience

Energy resilience is an important factor in adapting to climate change. Both technological and people driven, organizational solutions are explored in this CEP. Voluntary guidelines for increased backup power capacity, particularly for multi-unit residential buildings, are reviewed. This includes strategies for expanding the use of emergency generators, particularly in high rise residential buildings, to provide power for longer and to additional services.

Energy Technologies

Several technologies, focused on renewable, efficient and low carbon options, are identified which can serve community energy demands. Technologies explored in detail include the feasibility of geothermal systems for heating and cooling and the use of Combined Heat and Power (CHP) technology to provide both electricity and thermal energy. Technologies may also improve resilience by virtue of providing power independent of the electricity grid during power outages, for example by using CHP to provide emergency backup power.

Community Energy Systems

Community scale / district energy systems allow the community to provide local generation and demand response, improving resilience and creating more opportunities for integration of renewable and low carbon strategies. High and low temperature district thermal options, as well as micro-grid electricity storage and delivery, are explored. Community energy systems identified open up possibilities related to fuel flexibility, future-proofing energy supply options and allowing for adaptability over time.

Key Recommendations

High performance building design is a key aspect of any Sustainability strategy, and is a focus of provincial and municipal climate change action plans. A 12% and 84% carbon emissions reduction is determined to be achievable with incremental and more significant improvements in building design over Code, reflecting a 11% and 59% energy improvement.

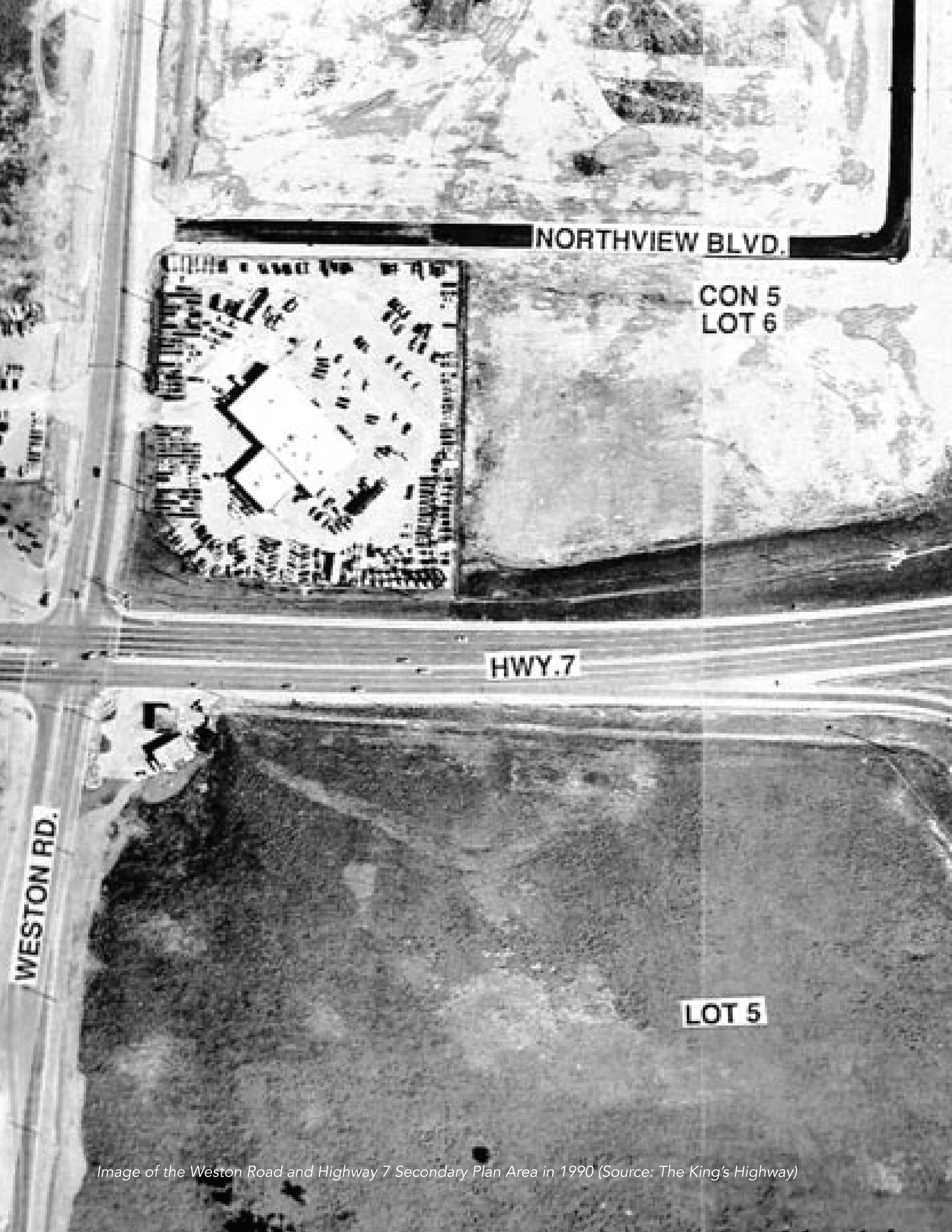


Image of the Weston Road and Highway 7 Secondary Plan Area in 1990 (Source: The King's Highway)

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Plaza parking lot in Plan Area.

1.0 INTRODUCTION

A Community Energy Plan (CEP) is a wide reaching approach to planning for the energy needs of a development site. Typically this is applied at a subdivision or district level, and accounts for the expected energy use of all planned buildings. A CEP is therefore specific to the development site for which it is created.

1.1 Why Plan for Energy at the Community Scale?

Beyond energy planning, a CEP is an opportunity to consider energy efficient, renewable, and low carbon strategies at an early stage. By conducting this analysis beyond the scope of individual buildings, innovative and unique solutions for the community often present themselves. A CEP can be used to help define energy goals and targets for the community, and can assist municipalities or other local jurisdictions in meeting their energy and carbon targets. In addition to reducing energy use and carbon emissions, a CEP can provide cost savings by way of renewable energy sources and providing security against volatile utility prices; increase system resiliency against increasing extreme weather events; and contribute towards sustainability certification, including Leadership in Energy and Environmental Design (LEED), One Planet Living, and the Living Building Challenge.


Aerial view of Plan Area

1.2 About this CEP

The scope of this CEP aligns with Phase 1: Background/Existing Conditions of the larger Weston Road and Highway 7 Secondary Plan. The intent of the CEP is to address energy conservation and on-site energy generation at both the community and building scale, ensuring conformity with provincial plans and strategies, the Regional Official Plan 2010, the Vaughan Official Plan, the Municipal Energy Plan, and the Vaughan Sustainability Performance Metrics. By offering a high-level community energy analysis, it will provide the groundwork for future energy and carbon feasibility studies once the final master plan option has been chosen.

In this report, a focus on low carbon, energy efficient and resilient development will be addressed in four primary categories:

1. Energy and Carbon Efficiency: How much energy do we expect the community to use? What is the impact of this energy use? What levels of performance are achievable?
2. Resilience: What strategies are available for resilience in the face of climate change? How can the community work together to improve resilience overall?
3. Energy Supply Technologies: What options are available for on-site generation of energy, including renewables? How can these lower environmental impact?
4. Community Energy Distribution Systems: How can energy be delivered locally through district scale systems? How can energy technologies and resiliency strategies be incorporated into these systems? What are the options for funding and administering these systems?

2.0 CONTEXT

Chapter 2.0 provides an overview of the Weston Road and Highway 7 Secondary Plan area (“study area”), and the relevant regional and municipal policies and directions advanced in a suite of plan and strategy documents.

2.1 Site Overview

The study area is located on approximately 126 hectares (311 acres) of land in Ward 3. The Plan Area is bounded to the north by Chrislea Road/Fieldstone Drive/Portage Parkway (includes parcel on northeast corner of Chrislea Road and Portage Parkway) and the western terminus of Wildflower Gate. The Plan Area is generally bound by Ansley Grove Road/ Whitmore Road until Winges Road to the west, as well as Rowntree Dairy Road, and Weston Road. Highway 407 and Highway 400 form its boundaries to the south and east, respectively.

The Plan Area is composed primarily of retail commercial uses, with some office and employment uses at the westerly portion of the Plan Area. There are several big box retail stores, as well as retail strip plazas and stand-alone commercial uses, with extensive surface parking areas along the Highway 7 frontage throughout the Plan Area. There are also two high-rise mixed use condominium apartment towers at the northeast corner of Weston Road and Highway 7. Surrounding land uses that abut the Plan Area include an established low-rise residential community to the northwest, manufacturing and other employment uses to the southwest, Highway 407 to the immediate south and Highway 400 to the east.

While a number of density targets and associated development footprints are being explored, this CEP is predicated on a density figure of 160 people and jobs per hectare, with the following land-use footprints representing new space:

- Retail space: 51,000 m^2
- Commercial/Institutional: 34,000 m^2
- High-density Residential: 400,900 m^2
- Low-density Residential: 193,700 m^2

Figure 1: The Weston Road and Highway 7 Secondary Plan area.

2.2 Policy Drivers

York Region Official Plan (2010)

The York Region Official Plan is predicated on sustainability, noting in section 1.2 that sustainability is the lens through which the Region formulates, enhances, and implements policy. The Plan supports and encourages city building focused on green building, community design that includes sustainable buildings and water and energy management, and zero carbon and waste production. To this end, it highlights the importance of adopting progressively higher standards in energy and water efficiency, renewable energy systems, and waste reduction.

This language is codified in section 3.2, where policies include reducing vehicle emissions, establishing greenhouse gas reduction targets for the Region, developing clean air initiatives, and identifying links between climate change, community planning, and public health. Specific to energy, the Plan also requires that local municipalities develop community energy plans for new community areas to reduce community energy demands, optimize passive solar gains through design, maximize active transportation and transit, and make use of renewable, on-site generation and district energy options including, but not limited to, solar, wind, water, biomass, and geothermal energy (5.6.10).

The Regional Official Plan encourages a number of energy efficiency and conservation targets for new buildings in order to achieve its vision of a sustainable region (5.2.21):

a. Grade-related (3 storeys or less) residential buildings achieve a performance level that is equal to a rating of 83 or more when evaluated in accordance with Natural Resources Canada's EnerGuide for New Houses: Administrative and Technical Procedures.
b. Mid- and high-rise residential (4 storeys and greater) and non-residential buildings be designed to achieve 40 per cent greater efficiency than the Model National Energy Code for Buildings, 1997.
c. Industrial buildings (not including industrial processes) be designed to achieve 25 per cent greater energy efficiency than the Model National Energy Code for Buildings, 1997.

It also advocates for all new buildings to include, where feasible, on-site renewable or alternative energy systems to produce at least 25 percent of the total building energy use (5.2.28). The same policy notes that where on-site renewable energy systems are not feasible, consideration should be given to purchasing grid-source renewable energy.

Vaughan Official Plan (2010)

Vaughan's Official Plan sets forward a vision that will shape the City and guide its transformation into a vibrant, beautiful, and sustainable city. The policies advanced in the Official Plan are rooted in principles of minimized energy use, water consumption, and solid waste generation, alternative transportation choices, and protection of the natural environment.

Resource and energy conservation is a critical piece of Vaughan's sustainable vision. Policy 8.1.1.1 enshrines its importance, requiring the maximization of efficiency and minimization of resource and energy consumption by way of the efficient provision of utilities and services. It also requires the City to support and encourage measures to conserve energy resources. The Official Plan includes policies which encourage community energy plans with identified energy targets, in addition to clarification about Vaughan's energy consumption, identification of opportunities and targets for on-site energy generation and district energy systems, the provision of development standards and design guidelines to maximize energy efficiency, and supporting smart electrical meters and innovating energy storage technologies (8.5.1.2, 8.5.1.5, and 8.5.1.7). More broadly, the Official Plan requires the implementation of the climate change actions housed in Green Directions Vaughan to establish a long-term target of carbon neutrality for municipal facilities, infrastructure, and operations (3.7.2.1).

The importance of sustainable energy and resource use is also advanced in section 9.1.3, Sustainable Development. Policies in this section call on the development of standards to provide a high-level of energy efficiency, maximized solar gains, on-site renewable energy systems, future installation of electric vehicles, water efficient landscaping, maximized permeable services, green roofs, and construction waste reduction and landfill diversion (9.1.3.1). These standards have since been developed as the Sustainability Performance Metrics.

MEMBERSHIPS

Partners for Climate Protection Program

The City of Vaughan is a member of the Federation of Canadian Municipalities' (FCM) Partners for Climate Protection (PCP) Program. The PCP is a 5-milestone program to take action on climate change that involves creating GHG inventories, setting GHG reduction targets, developing action plans, implementing actions to reduce emissions, and monitoring and reporting on results. To date, Vaughan has achieved Milestone 3.

ClimateWise Business Network

The City of Vaughan is a founding member of the ClimateWise Business Network along with York Region, Lake Simcoe Region Conservation Authority, and Alectra. ClimateWise is a network of leading businesses and institutions operating in and around York Region Ontario who are setting and achieving sustainability goals. Members of ClimateWise have the opportunity to use its Reduction Framework to set targets and report on carbon emission reductions.

Green Directions Vaughan (2009)

The Community Sustainability and Environmental Master Plan, also known as Green Directions Vaughan (GDV 2009) functions as the City's sustainability plan and influences virtually all aspects of the City's operational and regulatory activities, including the growth management strategy. The intent of the Community Sustainability and Environmental Master Plan is to establish the principles of sustainability, which will then be used in the development of other plans and master plans to achieve a healthy natural environment, vibrant communities and a strong economy.

GDV 2009 includes a number of objectives pertinent to this CEP, including:

- Objective 1.1: To reduce greenhouse gas emissions and move towards carbon neutrality for the City of Vaughan's facilities and infrastructure; and
- Objective 1.2: To promote reduction of greenhouse gas emissions in the City of Vaughan

Municipal Energy Plan

The Vaughan Municipal Energy Plan (MEP) employs a holistic approach to energy planning at the community level, taking into account energy generation and transmission infrastructure, land use planning, economic development and overall education on energy issues by the community at large. The MEP retains the overarching vision and environmental ethic from Green Directions Vaughan (GDV).

The MEP establishes a greenhouse gas (GHG) reduction target that aligns with the unique features of the Vaughan community, and is based on a business-as-usual scenario of 2,097CO_2e in 2031. The GHG emissions target advanced by the MEP is a 22% per capita reduction from the 2013 BAU projection to 2031 (equivalent to an absolute growth in GHG emissions of 3.8% above the 2013 baseline). Achieving a 22% reduction in GHG emissions will result in a total GHG reduction of 459,900 tonnes/year, translating to total GHG emissions of approximately 1,637 ktCO_2e for the community as a whole by 2031.

In order to successfully meet these targets, the MEP outlines a number of actions and opportunities, including encouraging new residential and commercial buildings to be designed, built, and operated using energy more efficiently; achieving an EnerGuide rating of 80 and be more efficient than buildings built before 2012; advancing a smart community energy system; and implementing active transportation and Transportation Demand Management initiatives.

Ontario Building Code

The Ontario Building Code (OBC) defines the level of performance buildings are required to meet through the Supplementary Standard SB-10, with the goal of increasing efficiency over time. For context, in 2012 the SB-10 became 15% more efficient than the 2006 version, and in 2017 became 13% more efficient than 2012. By comparison, in Toronto, the Toronto Green Standard (TGS) mandatory Tier 1 compliance typically requires 15% better than the current SB-10, while voluntary Tier 2 requires 25% better. These levels of efficiency are intended to increase every four years.

The changes to the current Code, which will come into effect January 1st, 2019, have been devised to make new houses and large buildings ready to be net-zero in the future. In practical terms, three of the most significant changes include adding a loading requirement to roof designs for all new large buildings to future-proof for solar technologies; a requirement for a conduit on all new houses and large buildings to allow for the installation of solar photovoltaics or a solar hot water system; and a requirement for all apartment buildings and condominiums to incorporate a heat or energy recovering unit as part of their ventilation systems.

Vaughan Sustainability Performance Metrics

The Sustainability Performance Metrics program (the Metrics), implemented as part of the review of development applications, meets a specific objective of Green Directions Vaughan, the Community Sustainability and Environmental Master Plan, to create a City with a sustainable built form. The City of Vaughan, in collaboration with the City of Brampton and the Town of Richmond Hill, created the Sustainability Performance Metrics as a tool to achieve healthy, complete, sustainable communities. The Metrics contain a number of mandatory requirements related to a number of topics, including infrastructure and buildings. Notably, the Metrics recognize that the OBC is the mandatory standard, such that an additional sustainability score is not provided to meet the OBC energy efficiency requirements. Additional points are available if single-family homes are built to meet an EnerGuide of 83 and buildings are designed with energy savings relative to a Model National Energy Code of Canada for Buildings (per York Region Official Plan policy 5.2.21); and where deemed viable, a district energy feasibility study has been conducted.

2.3 Carbon Emission Trends

Carbon Intensity of Energy Sources in Ontario

Focusing on carbon in addition to energy efficiency will shape what 'high performance' means for the Weston Road and Highway 7 Secondary Plan area. In recent years the government of Ontario has significantly reduced the greenhouse gas emissions associated with electricity production by shuttering coal plants and investing in conservation and demand response, in line with the Province's Long-Term Energy Plan (2010) and the Climate Change Action Plan (2016-2020). Conversely, the carbon impact of natural gas, typically used for heating and domestic hot water in new buildings, remains relatively flat.

This highlights the fact that very significant reductions in GHG emissions will at some point involve a degree of fuel switching from natural gas to electric based space and water heating. This is, however, not typical practice in Ontario. While a unit of electricity emits on average 30% of the GHG emissions when compared to an equivalent unit of natural gas, it currently costs approximately 5.8 times as much to generate that electricity (assuming a market rate of $0.14/kWh and 0.25/m3 of natural gas) before equipment efficiencies are accounted for.

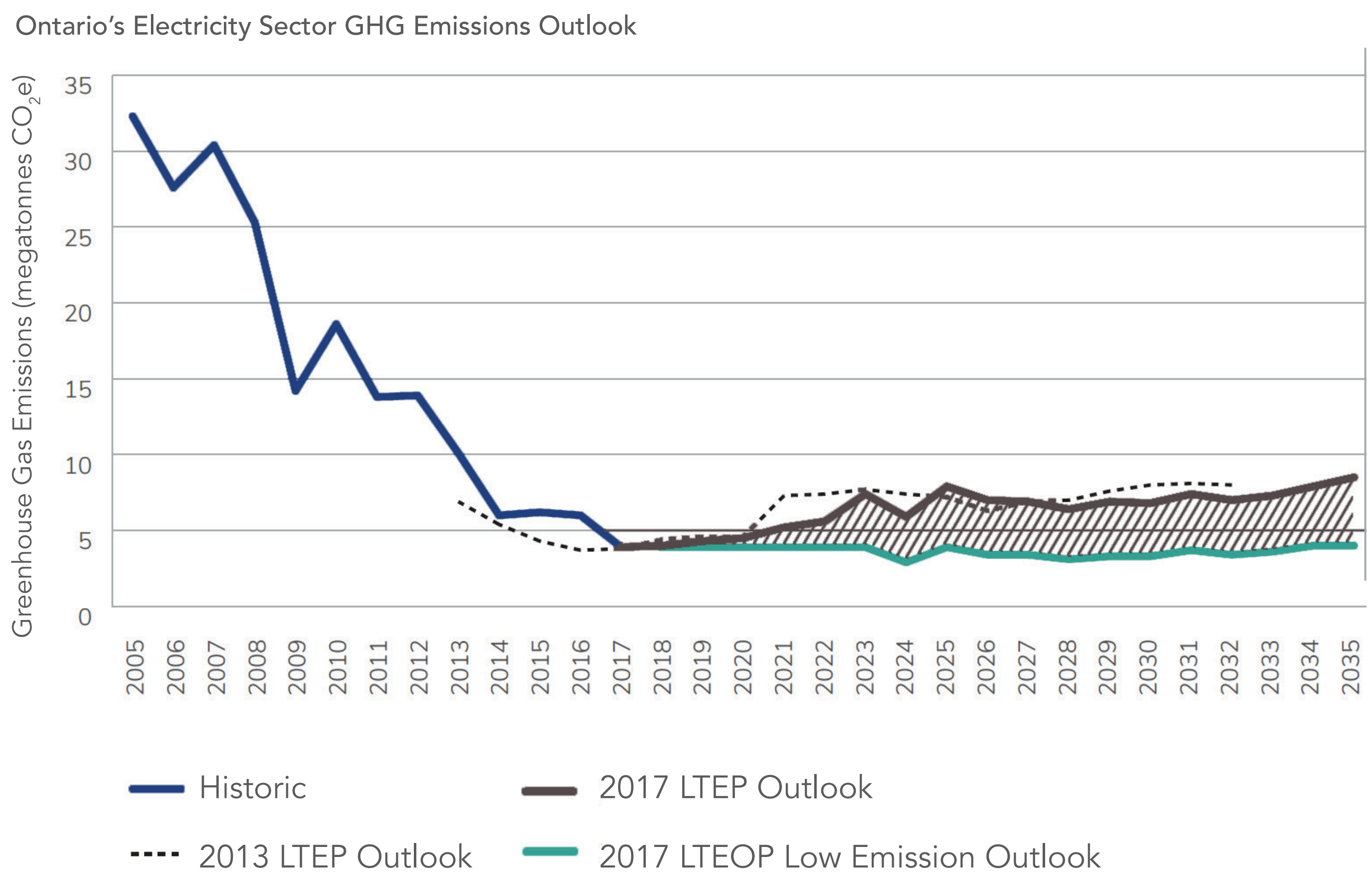


Figure 2: Historical and projected emissions from Ontario's electricity sector (Adapted from LTEP, 2017).

The City of Vaughan has ambitions to minimize its carbon emissions and energy use, with a long-term goal of maximizing energy efficiency and reducing greenhouse gas emissions. Given the carbon intensity associated with natural gas, it will be important for the City to consider fuel switching to cleaner sources within the study area to achieve deeper reductions in carbon emissions, particularly if carbon neutrality is a desired long-term outcome.

Aerial view of the Plan Area.

3.0 ENERGY DEMAND AND EFFICIENCY

This section first establishes the projected energy demand of the Weston Road and Highway 7 Secondary Plan area, then outlines options to meet these demands. Aligned with the goals of York Region the City of Vaughan and the Province of Ontario, an underlying focus on reducing carbon emissions and improving resiliency have informed the entirety of this report.

3.1 Establishing a Metric

In alignment with the goals of the policy drivers noted above, a focus on both carbon emissions in addition to energy use reduction is reflected in this report.

Referencing the Ontario Building Code (OBC) Supplementary Standard SB-10, Division 3 Table 1.1.2.2[1], the following weighting factors have been applied:

Table 1: Weighting factors for grid electricity and natural gas.

	Grid Electricity	Natural Gas
kg CO_2e/ekWh	0.050	0.1808

[1] Emissions factors are as per Division 3, Chapter 1, Table 1.1.2.2 of the Supplementary Standard SB-10 to the Ontario Building Code. These are 0.050 kgCO2e/kWh of electricity and 1.899 kgCO2e/m3 of natural gas (converted to 0.1808 kgCO2e/ekWh using a conversion factor of 0.0952 m3/kWh). The 2016 National GHG Inventory Report notes an emissions factor for Ontario grid electricity of 43 g CO2eq/kWh.

3.2 Establishing Energy Demands

An important step in determining both the energy savings potential and impact of energy generation and storage is to establish an energy demand profile for the community. In the context of this report, this primarily refers to the projected building operational energy.

Energy demands reflect the occupancy types of a buildings in the development, how they are constructed and the types of activities that will take place in them. Energy consumption and annual emissions subsequently reflect the established energy demand as well as how that demand is met in terms of both fuel source and equipment efficiency.

This report first establishes the annual energy demands of the development built to a baseline scenario designed to meet the Ontario Building Code. The report then subsequently explores several options for meeting these demands reflecting two additional levels of performance. In general, demands can be met by a combination of conventional systems, relying on grid supplied electricity and standalone thermal systems, efficient, renewable and low carbon technologies or district based systems which encourage low carbon sources of energy as well as energy sharing within the community.

Through our extensive project experience combined with publicly accessible data found in the City of Toronto Zero Emissions Building Framework[2], expected energy demands have been established for each building type. Based on the GFA outlined in section 2.1, and following a site density of 160 people and jobs/hectare, the following energy demands, as demonstrated in table 2, were determined for the development.

Table 2: Annual energy demands for the Weston Road and Highway 7 Secondary Plan area.

Annual Energy Demands	ekWh	ekWh/m^2
Cooling Demand	16,311,146	24.0
Heating Demand	44,962,753	66.2
Base Thermal (DHW) Demand	19,540,959	28.8
Base Electrical Demand	41,402,921	60.9

[2] See *Appendix C – Parametric Modelling Results of the Zero Emissions Building Framework*, which provides projected energy use intensity by end use for each archetype and each Tier of the TGS.

3.3 Building Level Energy Efficiency

Typically the energy demands of a building are met through conventional energy delivery, consisting of an electrical grid connection and standalone thermal systems (e.g. in building gas fired boiler and electric chiller).

The OBC defines the level of performance buildings are required to meet through the Supplementary Standard SB-10, with the goal of increasing efficiency over time. For context, in 2012 the SB-10 became 15% more efficient than the 2006 version, and in 2017 became 13% more efficient than 2012. By comparison, the Toronto Green Standard (TGS), a local example of a high performance building energy efficiency policy, mandatory Tier 1 compliance typically requires 15% better than the current SB-10, while voluntary Tier 2 requires 25% better. These levels of efficiency are intended to increase every four years.

For the purpose of goal setting, three separate building energy profiles are proposed. Projected annual energy use, energy use intensity and carbon emissions can be established for the development for each scenario, starting with the energy demands established in Section 3.2.The following three energy profile scenarios have been developed:

- Scenario 1: Baseline Compliance with Ontario Building Code (OBC);
- Scenario 2: Incremental improvement beyond OBC; and
- Scenario 3: Towards Net Zero Carbon.

Scenario 1 is the baseline scenario, reflecting the minimum energy performance as outlined in the current OBC SB-10 and the mandatory requirements of the Vaughan Sustainability Performance Metrics.

Scenario 2 represents an incremental increase in energy efficiency which can be achieved with improvements in currently available technology. An improvement in the range of 10-15% over OBC requirements is determined to be feasible, depending on the building type. For comparison this is roughly equivalent to the TGS version 3 Tier 1, which is the minimum performance currently required for new development within the City of Toronto.

Scenario 3 represents an energy profile with the goal of approaching net zero carbon. This scenario reflects a best case, aspirational performance option, and aligns with the long-term direction from the York Region Official Plan, Vaughan Official Plan, and Green Directions Vaughan. The key drivers towards meeting this scenario include dramatically reducing building loads, and providing space and domestic hot water heating requirements exclusively using low-carbon electricity rather than fossil fuel, to achieve a lower overall carbon impact.

TORONTO GREEN STANDARD

TGS is a tiered approach similar to the BC Step Code. Tier 1 is the current mandatory performance level. Tiers 2 through 4 are voluntary, incentivized with a development charge refund. Mandatory performance will increase every 4 years (In 2022, Tier 2 performance levels will become mandatory) with the goal of approaching net zero energy and carbon use by 2030 with Tier 4 mandatory performance.

3.4 Building Energy Use Projections

Energy use profiles, identifying projected gas and electricity use, as well as resulting carbon emissions, are outlined in table 3. The calculations shown in figure 4 were completed by multiplying gas or electricity use in kWh by the appropriate carbon intensity (kgCO2e/kWh or ekWh) in Table 1.

The energy use profiles in table 3 were calculated using a six-step process:

1. Define development type data source, development area, and occupants. Energy data sources include low-rise modeling experience (low-rise residential), and the City of Toronto Zero Emissions Building Framework (high-rise residential, office, and retail).
2. Determine energy use by end use for each development type and for each scenario.
3. Determine the energy use by end use for the subject development type based on the proportion of each development type.
4. Determine the GHG impact based on GHG intensity factors for electricity and natural gas (see table 1).
5. Use heating and cooling efficiency factors to determine the heating and cooling load requirements based on energy use.
6. Divide by relevant efficiency to determine the loads (see table 2).

Table 3: Energy use profiles for each of the three building level energy efficiency scenarios.

Scenario	1: OBC Compliance	2: Incremental Improvements	3: Towards Net Zero
Overall Energy Intensity (ekWh/m^2)	172	152.7 (-11%)	70.1 (-59%)
Natural Gas Use (ekWh)	68,769,880	59,647,937(-13%)	129,200 (-99%)
Natural Gas Intensity (ekWh/m^2)	101.2	87.8 (-13%)	0.2 (-99%)
Electricity Use (kWh)	48,145,380	44,133,794 (-8%)	47,504,513 (-1%)
Electricity Intensity (ekWh/m^2)	70.8	64.9 (-8%)	69.9 (-1%)
Total GHGs (tonnes CO_2e)	14,840	12,990 (-12%)	2,399 (-84%)
GHG Intensity (tonnes CO_2e/capita*)	1.36	1.19 (-13%)	0.22 (-84%)

* Per capita assumes 160 people and jobs per hectare.

Figure 3: Total gas and electricity use (eMWh/year) per scenario.

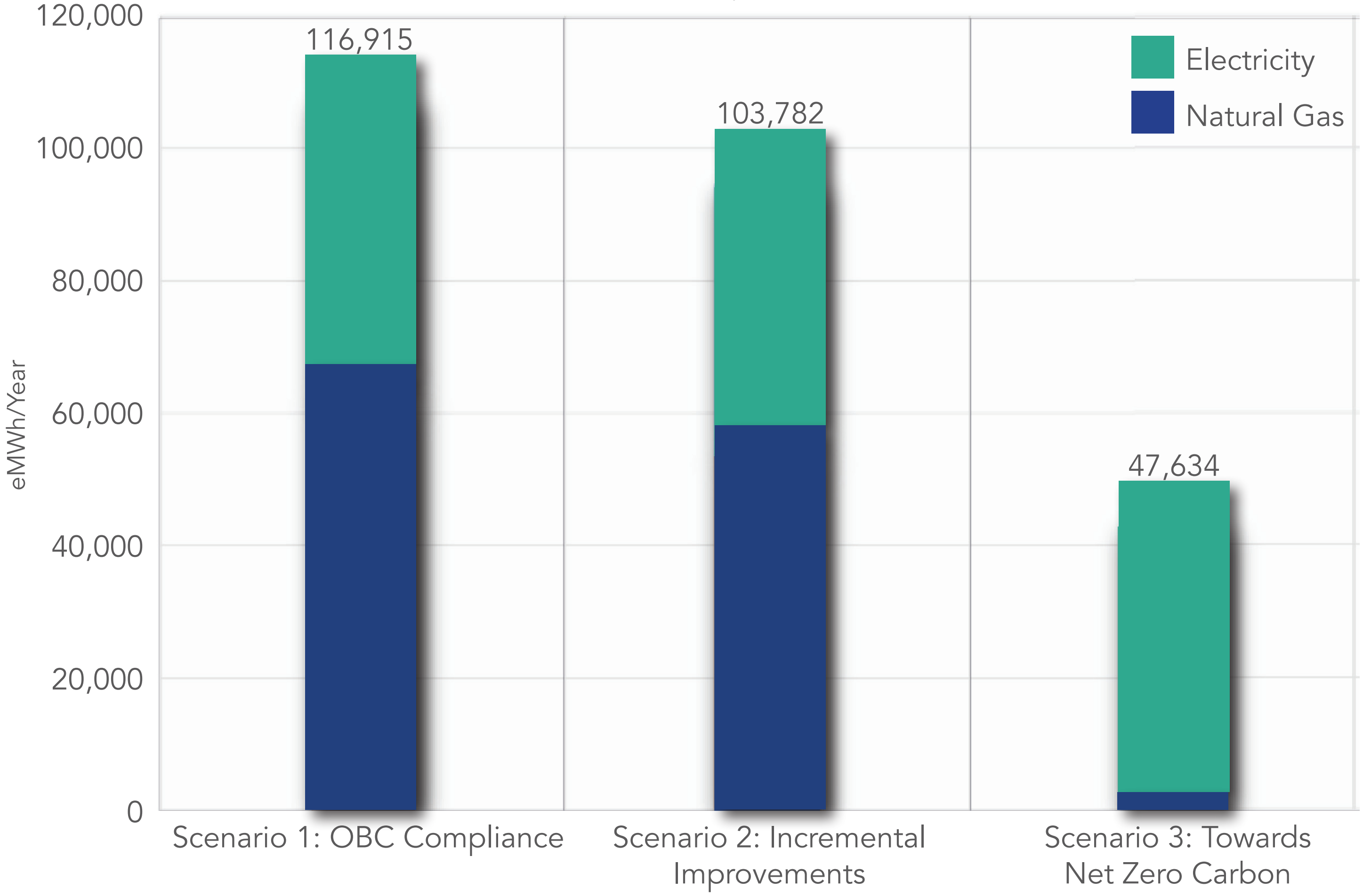
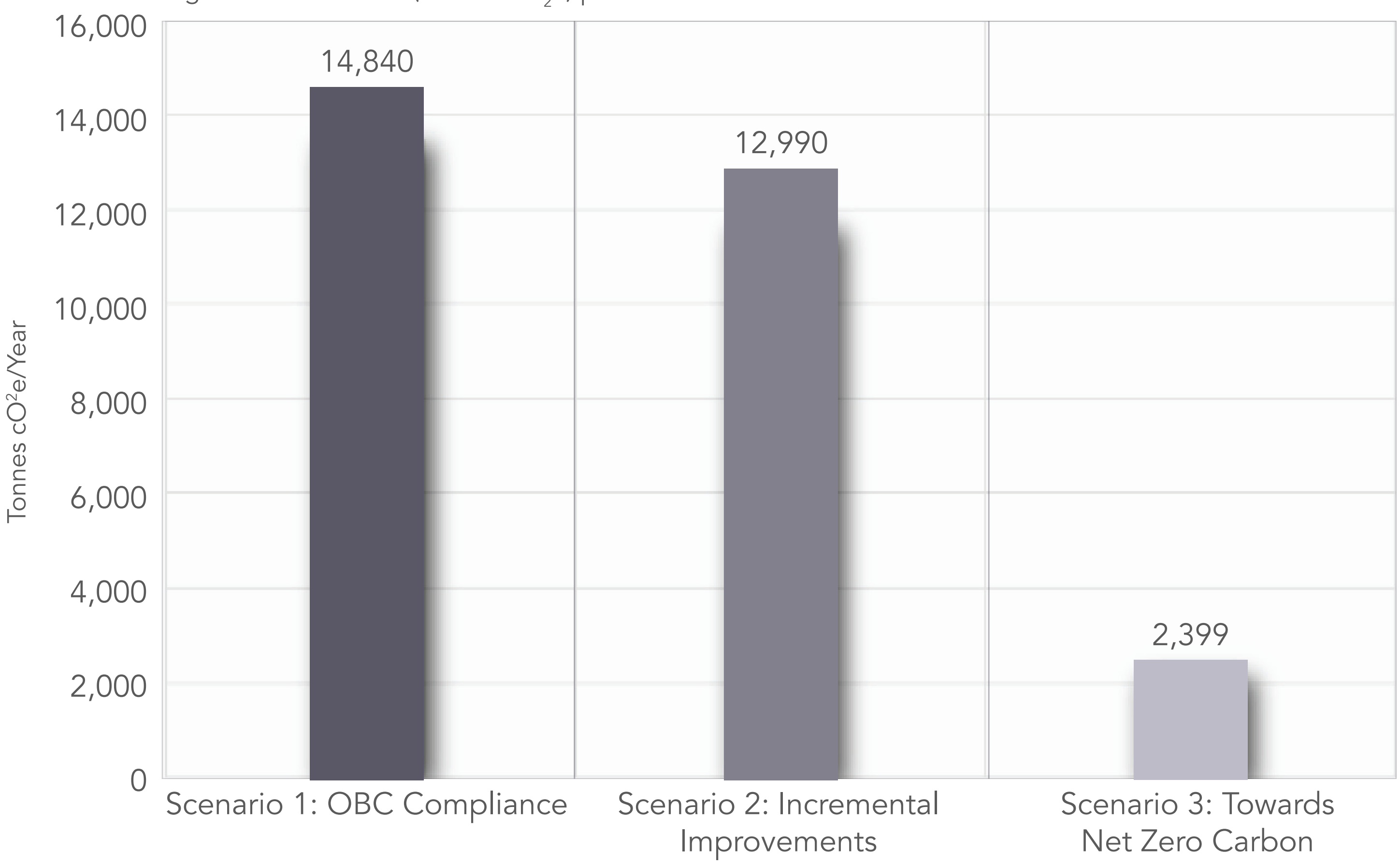


Figure 4: Total GHGs (tonnes CO_2e) per scenario.

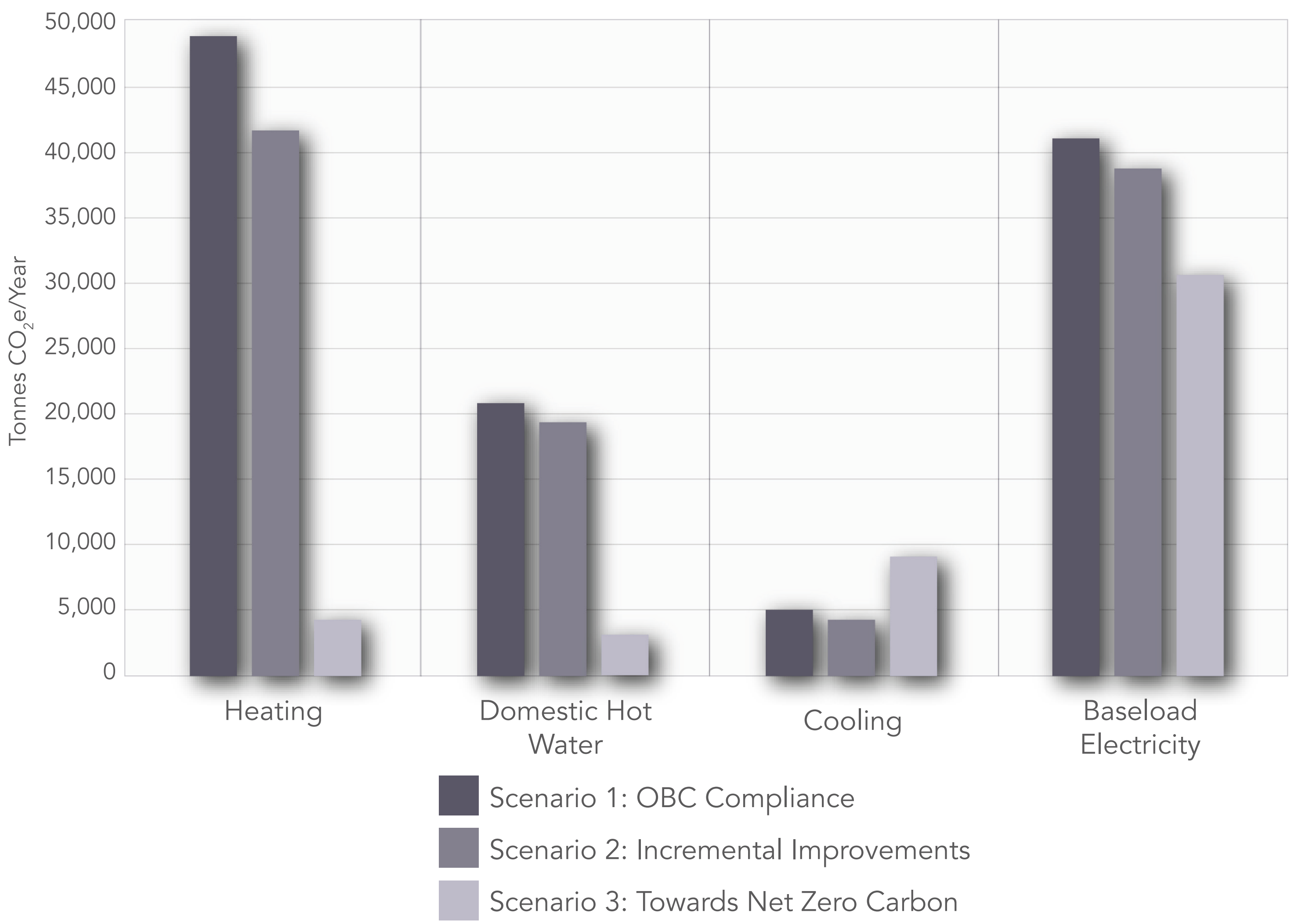


Scenario 2 and 3 represent a 11% and 59% reduction in energy use, and a 12% and 84% reduction in GHG emissions over the baseline scenario 1, respectively. Significant GHG reductions in Scenario 3 are a result of fuel switching away from natural gas, as well as a general a focus on load reductions for space and water heating savings throughout all scenarios.

Figure 5 displays how each scenario impacts the major energy end uses (heating, domestic hot water, cooling and base load electricity including HVAC, lighting and plug loads). A focus on carbon efficiency is evident by the sharp decline in space heating and thermal base loads (domestic hot water), which traditionally rely on natural gas fired equipment. This decline is achieved through a focus on load reduction strategies such as improved building air tightness, enhanced thermal envelope, and improved heat recovery efficiencies.

Space cooling and electrical baseloads remain comparatively flat throughout the scenarios, again a function of the carbon metric and a primary focus on natural gas reduction.

Figure 5: Impact of scenarios on heating, domestic hot water, cooling, and baseload electricity.



3.5 Other Energy Uses

As a complete community, energy implications beyond the context of buildings within the development should also be considered. Detailed quantification of these impacts should engage a broader consulting team, including stormwater/waste water and traffic planning.

Street-lighting will add to the electricity use of the community overall, and should be considered when evaluating community energy systems and distribution strategies. Lighting loads depend heavily on the spacing, lighting requirements and lighting efficacy, with LEDs providing a significant load reduction over traditional lighting technologies.

Transportation implications occur as a result of the design and location of the community. The number of Single Occupant Vehicle (SOV) trips which are likely to be taken, versus use of public transit, carpooling, and other modes of transportation will have a direct impact on GHG emissions. Design decisions can influence this impact, and could be considered in a transportation specific carbon strategy for the development.

Wastewater treatment requires energy to process wastewater, typically dominated by electrical energy. Requirements vary depending on the plant type and size, however a range of 0.1 to 0.5 kWh/m3 of wastewater treated may serve as a realistic starting point.

The energy demand and efficiency analysis provided in this section should be considered high-level at this juncture in the study area's planning process. However, it provides the necessary information to begin setting relative goals for building level performance, as described in the three scenarios: OBC compliant, incremental improvements over OBC, and towards net zero. It also demonstrates the significant impact fuel switching from natural gas to low-carbon energy sources could have within the study area.

In order to better define targets for the study area, a subsequent energy and carbon feasibility study is recommended. The purpose of the feasibility study is to determine energy and carbon performance targets considering both building level performance and community energy systems (as described in the Sections 5 and 6).

Example of LED streetlight.


Community reception centre.

4.0 RESILIENCY

Energy resilience is an important factor in adapting to climate change, as codified in the York Region Official Plan (policy 3.1.7). As a member of the Partners for Climate Protection and ClimateWise, Vaughan is committed to enhancing its resilience by working directly on climate change impacts, adaptation, and resilience by way of sharing information, resources, and best practices with other members.

Recent best practice documents from cities in the GTA provide guidance on planning for increasingly extreme weather. The City of Toronto, in particular, offers two documents that inform the subsequent strategies outlined in this section. First, the Zero Emissions Building Framework provides suggested practices for modeling building resilience in terms of an ability to maintain comfortable indoor temperature during power outages, as well as guidelines for designing for flood protection and heat waves. Second, the Minimum Backup Power Guidelines outlines best practices for backup power, particularly for multi-unit residential buildings (MURBs). It should be noted that many of the energy technologies and delivery options identified in Section 5 and 6 can offer improved resilience as well. These systems can be operated independent of the electricity grid and thus maintain power during power outages for the community. Energy resilience can play a large factor is assessing their feasibility.

4.1 Generators in MURBS

Emergency power is typically provided to meet minimum life safety requirements, just long enough to allow occupants time to evacuate a building. Back up power, however, is designed to provide power to non-life safety requirements over a period of at least 72 hours.

Approximately 86% of customer's power was restored following the 2013 Ice Storm during this 72 hour timeframe[3], which aligns with general emergency preparedness guidelines advocated by the Government of Canada. As extreme weather events are projected to increase in the GTA, there is good reason to provide for residents of high rise buildings throughout this 72 hour period. In addition to emergency power requirements, this could involve providing power to the following:

- Elevators: In addition to a firefighter designated elevator, provide power to at least one elevator for resident use;
- Domestic cold water booster pumps: Provides water for drinking, washing and toilet use during power outage;
- Sump pumps: Power should be provided to ensure protection from flooding of below grade areas; and
- Heating: In some cases may only involve providing power to central boiler and circulation pumps, however in a new construction project more likely involved powering in suite fancoils or heat pumps, which may add significant cost.

Diesel vs. Natural Gas Generators

A large majority of existing generators are diesel powered, however there is growing support of natural gas generators for a variety of reasons. A natural gas generator is supplied with a consistent supply of fuel, removing any refueling concerns and allowing for uninterrupted operation beyond a 72 hour timeframe. While typically 15-20% more expensive than diesel generators[4], it has been reported these costs may even out in taller buildings due to an increase in diesel fuel handling system requirements. To meet the code required response time of 15 seconds of maximum power interruption, natural gas generators typically require a load management system, While this adds cost, it also allows for load selection and possible reduction in the overall generator size, considering all loads are unlikely to peak at the same time.

Natural gas generators present the opportunity to provide Combined Heat and Power (CHP) solutions, outlined further in Section 5.1. This has potential to significantly shift the economics of this decision. It should be noted however that a CHP system is generally a continuously operated machine, and thus stricter emissions requirements will apply compared to an emergency generator which typically run for no more than a few hours a month.

[3] Per Toronto Hydro, 2014 .

[4] Minimum Backup Power Guideline for MURBs, City of Toronto, 2016

Demand Response

Natural gas backup generators open up the possibility of an on site demand response strategy, either for individual buildings or linked on a community level. In this scenario generators would operate not only during power outages but during peak times as well to alleviate stress on the electricity grid. This strategy also has the potential to reduce the size of electrical infrastructure required.

Demand response remains a facet of the Government of Ontario's latest Long Term Energy Plan (LTEP) in meeting the electrical needs of the future while avoiding building or refurbishing expensive power plants for peak capacity.

In Ontario, peak power is often provided by engaging natural gas power plants in response to demand, which contributes the majority of GHG emissions from the otherwise clean electricity grid. On site natural gas generators are typically more efficient than natural gas power plants, and also avoid transmission and distribution losses. As a result an added benefit of demand response is a net decrease in GHG emissions from electricity generation for the community.

4.2 Community Resilience Strategies

With increasing global temperatures, extreme weather events require designs to carefully evaluate back-up power solutions. Typical design intent is to include back-up power via a generator that will supply all emergency (life safety) requirements. Passive design measures such as a relatively low window-wall ratio, high thermal mass elements within the building, and high R-values for the building insulation would assist in maintaining building temperature in the event of heating/cooling system failure.

Areas of Refuge in MURBS

Another resilience strategy advocated particularly for MURBs is to provide an area of refuge within the building. Typically a common indoor amenity space serves this function. This strategy would involve designating a space as a refuge area and providing for minimum levels of heating, cooling, lighting and power during power outages. This allows residents of the building to keep warm or cool, as well as store medicine, charge communication devices and share updates. Designating an area of refuge provides significant economies of scale when compared with providing nominal space heating to each individual unit.

Community Reception Centres

At the community level, a Community Reception Centre may provide added support to residents displaced from their homes in power outages or extreme weather events. A Community Reception Centre is typically operated by a community organization. Permanently designating a building as a Community Reception Centre may involve upgrading the power supply and backup generation capacity to allow for longer operation in power outage or emergency situations.

Given the upcoming changes to Green Directions Vaughan - in particular a greater emphasis on climate change adaptation and resilience - the City should consider the resilience strategies outlined in this section when developing policy language in the Secondary Plan for the study area.

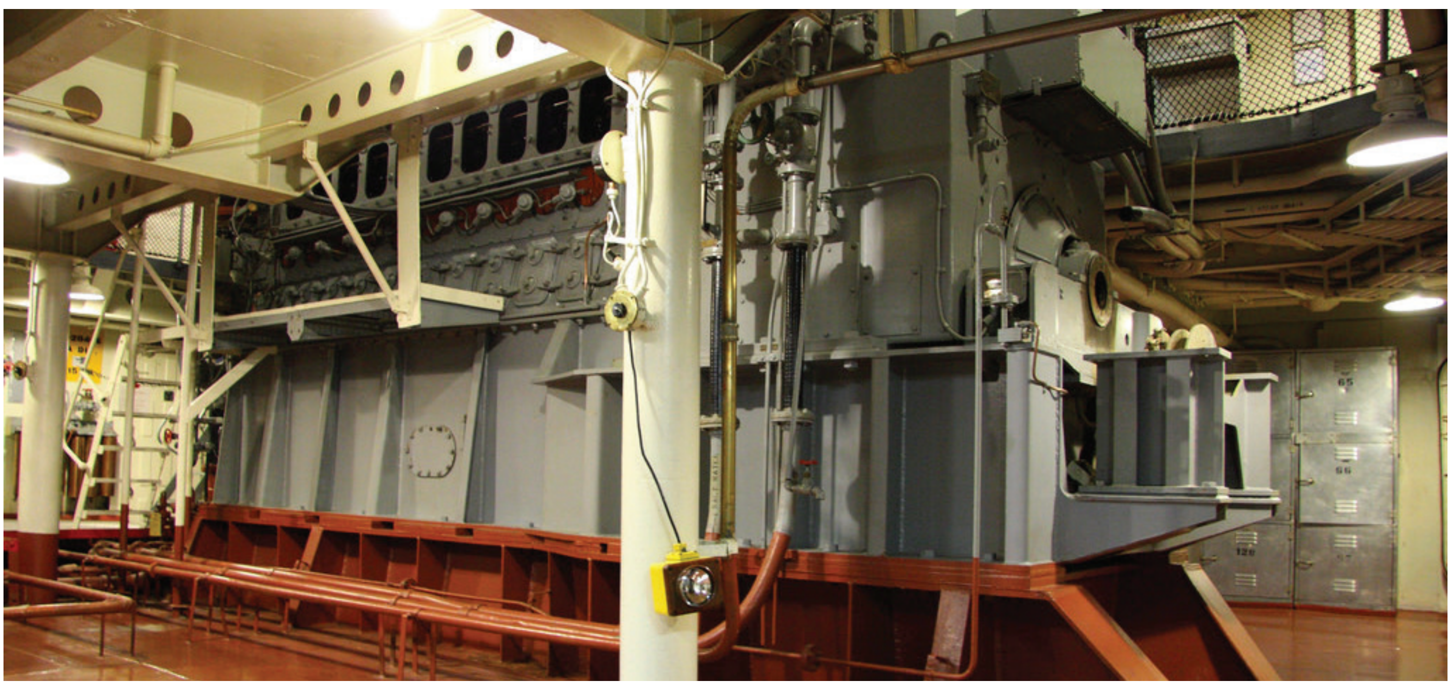


Figure 6: Emergency backup generator.

5.0 COMMUNITY ENERGY TECHNOLOGIES

Community energy technologies refer to the local production of energy, either electrical or thermal, as alternative methods to meet the building energy demands outlined in Section 3. Numerous technologies exist to achieve this end.

This section will elaborate on a few more well-known and viable options, while listing others of reference and further assessment as warranted. Aligned with the sustainability goals of the community, strategies focus on renewable or highly efficiency energy technologies as well as resiliency.

Ownership of these technologies could involve condominium boards or building management, or could involve engaging a micro-utility interested in owning and operating them as part of a community wide system, discussed further in Section 6.

5.1 Combined Heat and Power

Combined Heat and Power (CHP), or cogeneration, combines the on-site generation of electricity by a natural gas powered engine with the recovery of waste heat for space heating, domestic hot water or other thermal energy uses.

Like a simple natural gas fired generator, increases in efficiency compared to a centralized natural gas fired power plant are realized through elimination of distribution loses and size efficiency. Coupled with waste heat recovery, overall efficiency of CHP systems typically reach 80-85%[5], compared to a 55-60%[6] when considering a gas power plant and gas boiler for thermal energy. An absorption chiller may be added to the system, using waste heat in the summer to produce cooling, referred to as tri-generation. CHP systems typically provide economies of scale with quicker payback periods for larger systems. As system size increases financial benefit may also improve as capital costs such as engineering and connection work remain relatively fixed.

Compact sites are favored to limit costly distribution piping a well as distribution losses. As a result CHP systems are more common in larger developments with higher density of floor space. While attractive cost savings can be achieved using CHP, this technology works by replacing grid electricity with natural gas fired local electricity production. This results in a net increase in GHG emissions based on the emission factors presented in Table 1. To counteract this, CHP operation may be limited to peak times when the electricity grid relies more heavily on natural gas power plants, more closely representing the efficiency improvements in Figure 7. Analysis may be required to determine the economic impact of this decision.

CHP systems would increase resilience of a building by providing some level of heat and power independent of grid connections. Indeed a CHP system may double as or replace the need for an emergency generator in some cases.

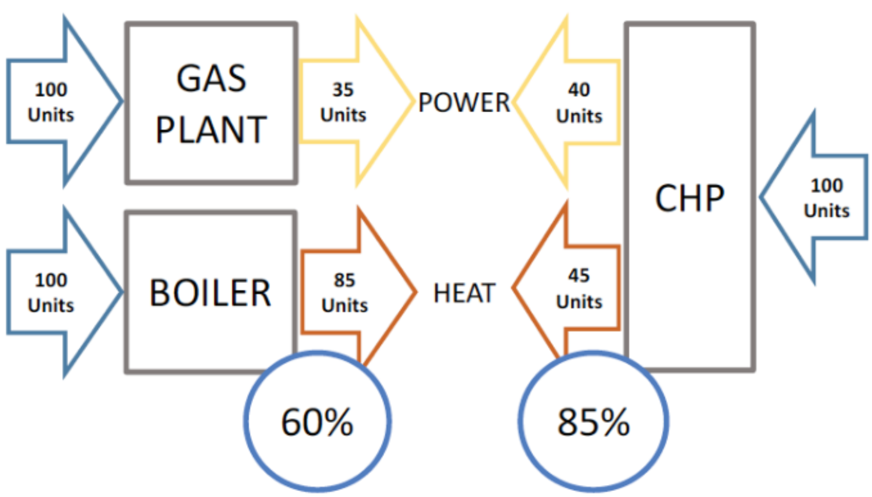


Figure 7: Efficiency of CHP compared to a gas power plant and boiler.

[5] European Environment Agency, accessed 2018
[6] Environmental Protection Agency, accessed 2018

5.2 Ground Source Heat Pumps

A ground source heat pump (GSHP) works by utilizing the stable temperatures of the ground to reject heat in the summer and extract heat from in the winter. In essence the ground acts as a supplier and seasonal storage of thermal energy, which can be considered 'free' compared to natural gas for heating. In contrast, a conventional water loop heat pump (WLHP) system relies on a boiler and heat rejection device to add and remove heat, requiring the consumption of natural gas and electricity. An air source heat pump (ASHP) similarly rejects and accepts heat directly with the outdoor air, however in cold climates such as Toronto peak heating performance can be limited.

By using the ground as a source of both heating and cooling, it is important that a GSHP system balance the heating and cooling loads. Otherwise performance may depreciate over time as localized ground temperature gradually change.

A GSHP thermal loop facilitates the sharing of thermal energy as it allows heating and cooling to be moved around when certain areas in a building, or buildings in a community, require heating while others require cooling. In this way a GSHP loop is amenable to implementation at a community level, with strategies discussed further in Sections 6.1 and 6.2. Loop temperatures in a GSHP system are moderate, requiring electric heat pumps in the conditioned space to increase or decrease the temperature for the heating and cooling loads. Distribution losses are therefore minimized when compared to a high or low temperature thermal distribution system.

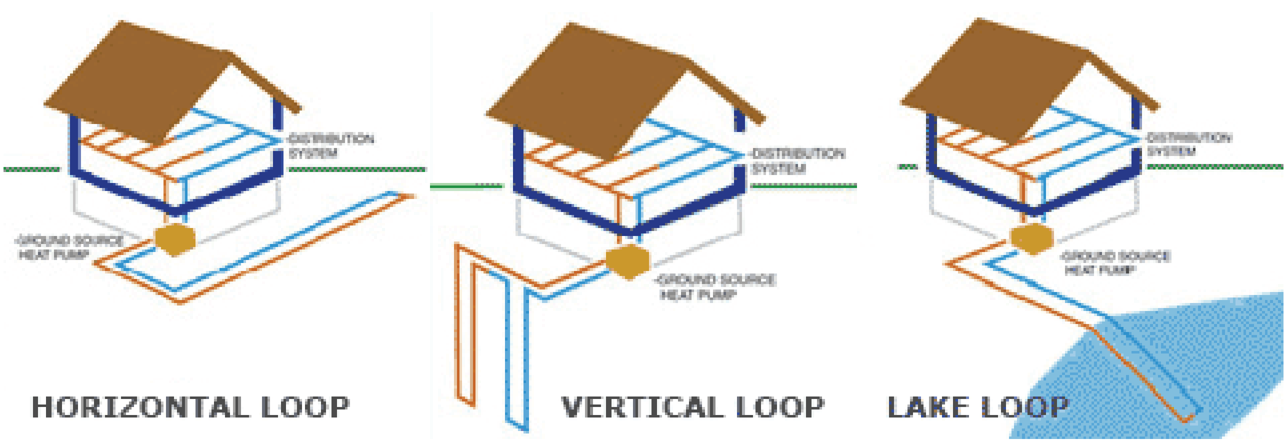


Figure 8: Ground source heat pump schematic (source: Ontario Geothermal Association).

5.3 Other Technologies

Many other innovative, low carbon or renewable technologies exist and may be appropriate for the development. Several examples are listed below for further consideration, representing technologies applied at both the building and community level. Additional energy technologies should be evaluated on their merits as they emerge.

Solar Thermal: Rooftop mounted solar collector for thermal energy. Typically used to offset heating of domestic hot water loads in residential buildings.

Wind: While more common at a utility scale, wind turbines can be situated in an urban setting to generate renewable electricity locally. Size requirements may limit applicability.

Solar Air Heater: Work by drawing incoming air through a transpired solar collector for pre-heating, reducing ventilation heating load.

Earth Tubes: Work by drawing incoming air through tubing in the ground for pre-heating and cooling, reducing ventilation loads.

Wastewater Heat Recovery: A specialized heat exchanger which draws heat from waste water pipes from a building to offset heating loads.

Spectrally Selective Glazing: Glazing which tints in response to solar radiation, sun position, or weather conditions, reducing glare and solar gain within the building. Maximizes quality views while reducing cooling loads.

Ice Thermal Storage: Storage of thermal energy, using electricity to create ice during low demand overnight periods to offset cooling demand during peak periods.

Anaerobic Digestion Biogas: Community wide collection of organic waste for production of biogas, a renewable alternative to natural gas.

Biomass Cogen or Tri-generation: A biomass fueled cogeneration or CHP system to provide backup power and heat, biomass being a renewable source alternative to natural gas. In addition, an absorption chiller can be added to provide cooling (tri-generation).

Off-site Renewable Energy Procurement: Aside from on-site renewable technologies, any development may procure off-site renewable energy generation credits to offset their carbon footprint.

Given the high-level scope of this CEP, it should be noted that decision-making around which community energy technology to pursue for the study area will require additional feasibility studies. Undertaking an energy and carbon feasibility study will help the City better understand the greenhouse gas and energy use intensities associated with each technology, and how these line up with the chosen energy and carbon targets for the community. The feasibility study should also consider the impacts of combining energy technologies, for instance ground source heat pumps and solar PV systems.

Energy storage.

6.0 COMMUNITY ENERGY SYSTEMS

Community energy systems refer to innovative ways to approach the storage and distribution of energy within the community, often referred to as district energy systems. Examples of options to provide both thermal and electrical energy are provided in this section.

It is important to note that the community energy systems highlighted work in conjunction with the technologies noted in Section 5, the resiliency strategies noted in Section 4 and can serve the design profiles noted in Section 3. In fact, incorporating community energy systems may indeed improve the effectiveness of individual technologies and strategies.

While often a significant undertaking, funding and partnership opportunities may present themselves. Private or public Local Distribution Companies (LDCs) may be interested in engaging in partnerships to fund and operate district energy systems as they often serve their interests as well. Additionally, green municipal funds such as those offered by the Federation of Canadian Municipalities (FCM) may be explored to unlock funding and project feasibility.

COMPONENTS OF COMMUNITY ENERGY SYSTEMS

- Chillers/boilers
- Deep lake water cooling
- Biomass
- Geothermal
- Heat pumps
- Waste heat recovery
- CHP
- Bio fuels
- Solar/wind

- Ice on coil
- Chilled water storage
- Heat storage
- Battery
  - Electrode coil
  - Flow type
- Compressed air
- Pumped hydro storage

- Distribution pipe
- Microgrid
- Utility Transmission

6.1 High Temperature District Thermal

District thermal energy provides a means to remove the generation of heating, cooling, domestic hot water (thermal base loads), or a combination thereof, from individual buildings and into the community level. In its place, thermal energy is provided by a centralized plant serving multiple buildings. This can be provided by various technologies, including conventional boilers and chillers, steam, chilled water, or CHP systems. A district system typically involves the construction of an Energy Centre building within the community to house the required equipment.

District thermal energy is not a new concept and examples of this approach can be found in the local context. Enwave serves the cooling needs of numerous downtown Toronto office buildings with its Deep Lake Water Cooling (DLWC) system, and operates district steam plants for heating. Markham District Energy serves the heating, cooling and domestic hot water loads of Markham and Cornell Centre with centralized boilers and chillers, supplemented by CHP.

Several benefits may arise through pursing a high temperature district thermal system, including:

- Reduced space requirements for mechanical rooms, increasing saleable floor area
- Economies of scale compared to standalone systems
- Opportunity to explore high efficiency options
- Opportunity to incorporate low carbon / renewable technologies
- Distribution piping can be installed during servicing for other utilities, minimizing costs and timeline impact.

6.2 Low Temperature District Thermal

A traditional district energy plant provides heating and/or cooling to the temperature required to meet the load, and involves using heat exchangers or fancoils within the building for distribution of heating and cooling. In comparison, a low temperature district thermal system takes its design philosophy from a water-loop heat pump (WLHP) HVAC system in a high rise residential building. The low temperature system relies on heat pumps or variable refrigerant flow (VRF) units located in the home or building. These systems connect to a low temperature (typically 12 to 30°C) distribution loop through which the heat pumps can reject heat to or take heat from. This approach is amenable to incorporating boreholes for ground source heat pump technology or low grade solar thermal.

A low temperature system provides many of the same benefits of a high temperature system, compared in the adjoining text box.

In both high and low temperature systems, a third party company or a condominium type of structure may have to be engaged to own, operate, and maintain the district system. This third party would operate in a utility business structure, potentially charging fixed and variable costs to the end users. The current market situation for third party operators/owners, for example local LDCs, is something that should be explored further.

6.3 Micro-Grids

A micro-grid is a similar concept to a district thermal energy system, however in this case focusing on the local collection, storage and distribution of electrical energy. This approach can involve the use of battery banks, local renewable electricity generation, or both. Distribution of electricity to the end user can then be optimized to reduce carbon footprint, reduce per unit costs (avoiding reliance on the grid during peak rates), or improving resiliency by providing back up power during power outages.

A micro grid typically works in conjunction with the central electricity grid, and can provide benefits to the local distribution company by reducing strain on the grid and deferring upgrades to infrastructure. Benefits include enhanced resilience and independence, reduced electricity costs, and reduced carbon emissions through grid demand response and integration of renewables.

A micro-grid may take several forms, including:

- Behind-the-meter optimization: Storage of grid supplied electricity overnight to deploy during peak periods throughout the day – avoiding electricity cost and carbon impact of the grid peak;
- Storage of excess solar PV production to be used overnight or during periods with less sunlight – increasing local usefulness of renewable energy; and
- Integration of plug-in Electric Vehicle (EV) batteries as a storage device for on peak use of stored electricity.

Battery storage may be centralized in the community, or could simply involve the use of in-house powerpacks and EVs to regulate electricity at the individual home level.

Behind-the-meter optimization may prove to be economically attractive considering on and off peak electricity rates, and warrants further investigation. Furthermore, storage of grid supplied electricity during off peak times for use during peak periods results in a net decrease of carbon emissions as peak electricity generation is often provided by natural gas power plants, the primary source of carbon emissions for the Ontario electricity grid.

Additional considerations of micro grids include the cost and efficiency losses associated with battery storage, as well as regulatory approvals and end user education. In this way utility partnerships may be beneficial.

Community energy systems provide a means to achieve higher energy performance and mechanical cost and carbon emission savings. Moreover, they can lead to capital and operating cost savings for vertical developers and utilities, respectively. In order to understand these potential savings, additional studies are required, including an energy and carbon feasibility study. Understanding the economics of community energy systems, especially when complemented by high performance buildings, energy technologies, and carbon offsets, will be critical to generating buy-in from future developers within the study area, who might otherwise pursue a business as usual approach.


Aerial view of the Plan Area.

7.0 CONCLUSIONS AND NEXT STEPS

This Community Energy Plan provides the groundwork for a future energy and carbon feasibility study. In addition to providing a high-level review of York Region's and the City of Vaughan's energy and carbon goals, it delineates estimated annual operating energy use intensity under three scenarios aligned with the mandatory and aspirational goals of Green Directions Vaughan and the Vaughan Sustainability Performance Metrics.

7.1 Conclusion

The CEP first establishes the projected energy demand of the Weston Road and Highway 7 Secondary Plan area, then outlines options to meet these demands. Aligned with the goals of York Region, the City of Vaughan and the Province of Ontario, an underlying focus on reducing carbon emissions and improving resiliency have informed the entirety of this report.

In terms of the three energy and carbon performance scenarios analyzed, Scenarios 2 and 3 represent a 11% and 59% reduction in energy use, and a 12% and 84% reduction in GHG emissions over the baseline scenario 1, respectively.

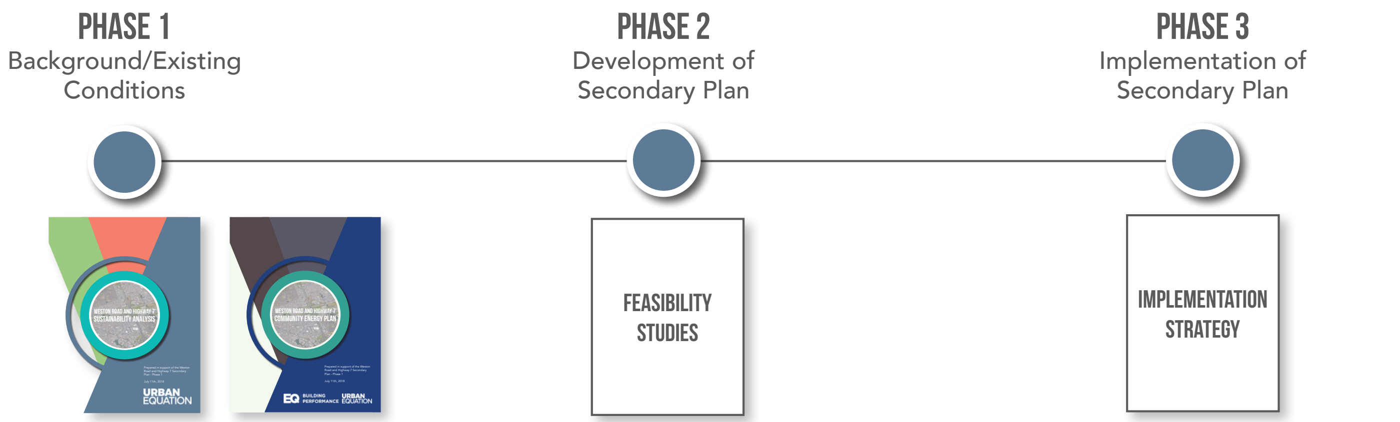
Table 4: Percentage change in energy use profiles for scenarios 2 and 3 relative to scenario 1.

Scenario	1: OBC Compliance	2: Incremental Improvements	3: Towards Net Zero
Overall Energy Intensity (ekWh/m^2)	172	152.7 (-11%)	70.1 (-59%)
Natural Gas Use (ekWh)	68,769,880	59,647,937(-13%)	129,200 (-99%)
Natural Gas Intensity (ekWh/m^2)	101.2	87.8 (-13%)	0.2 (-99%)
Electricity Use (kWh)	48,145,380	44,133,794 (-8%)	47,504,513 (-1%)
Electricity Intensity (ekWh/m^2)	70.8	64.9 (-8%)	69.9 (-1%)
Total GHGs (tonnes CO_2e)	14,840	12,990 (-12%)	2,399 (-84%)
GHG Intensity (tonnes CO_2e/capita*)	1.36	1.19 (-13%)	0.22 (-84%)

* Per capita assumes 160 people and jobs per hectare.

Significant GHG reductions in Scenario 3 are a result of fuel switching away from natural gas, as well as a general a focus on load reductions for space and water heating savings throughout all scenarios. It is clear that scenario 3 represents a paradigm shift in terms of how buildings are built and designed, however also offers the most advantageous design for incorporation of renewable energy technology to create a true net zero community. High performance district energy systems may also work well in this scenario as heating and cooling loads are more balanced.

In addition to providing an overview of district energy systems, the CEP also outlines a number of possible resiliency strategies and infrastructure, and sustainable technologies. When combined with the possible reduction in GHG emissions and energy use at the building and community scales, these strategies and technologies, if implemented, can contribute to achieving the long-term vision for a site which is both carbon neutral and resilient, thus contributing to the energy and carbon emission targets of the Vaughan Official Plan, Municipal Energy Plan, and Green Directions Vaughan.



- Completion of Community Energy Plan and Sustainability Analysis
  - We are here
- Visioning Workshop
- Development of Vision and Guiding Principles
- Development of Land Use Scenarios
- Final Report

- Conduct Energy Feasibility Study
- Determine Performance Targets (i.e. Energy Use and Carbon Emissions)

- Develop Implementation Strategy (i.e. Sustainability Charter, Augmented Sustainability Metrics, LEED ND, etc.)
- Incentive Tools

Figure 9. Implementation diagram

7.2 Next Steps

Figure 9 provides an overview of how sustainability fits into the Secondary Plan project phases. This section expands on the diagram, noting the required steps to ensure a sustainable vision is brought to bear on the Plan Area.

As the planning framework for the Plan Area progresses (**Phase 1**), it is our recommendation that this report inform decision-making regarding the development of the vision and guiding principles as it relates to energy and emissions. Doing so will ensure that sustainability permeates the land use and development scenarios, including elements of transportation, building design and block orientation, and public realm design. Reaching this end will require coordination between consultants to ensure everyone is progressing towards the same sustainability goals and objectives. We also recommend that the land use scenarios be assessed according to the Sustainability Performance Metrics.

In **Phase 2** of the project (Development of the Secondary Plan), we recommend that a deeper energy and emissions feasibility study be conducted to derive evidence-based strategies for carbon emission and energy reduction, both at the scale of the building and the study area. The terms of reference for the feasibility study should include not only a cost-benefit evaluation of the most relevant technologies given the physical context and proposed development (i.e. higher density), but also the exploration of fiscal tools, including section 37 benefits and community improvement plan incentives. Determining which elements to explore in feasibility studies will be largely informed by the goals that emerge from Phase 1. In our experience, these studies often lead to robust strategies that are economically feasible while also advancing specific targets to reach desired outcomes. Given the depth of technical analysis required to complete feasibility studies, the resultant targets are defensible - particularly important when included in Secondary Plan policies.

In Phase 3 of the project (Implementation of the Secondary Plan), we recommend exploring implementation tools to ensure the energy and emissions targets set out in Phase 2 are achieved. While there are a number of implementation tools available, we recommend developing a sustainability project charter, where the strategies defined in Phase 2 will be rolled up into a single document that provides specific goals, key performance indicators, targets, and requirements related to the guiding principles defined in Phase 1. Typically, a sustainability project charter also includes a checklist to be used throughout the project's life cycle, from planning, to design and construction, to maintenance and operations. Importantly, this charter should be considered a living document, flexible and nimble in its approach, understanding that there is a need to balance prescriptive requirements in the short-term and long-term goals, which are apt to change with the evolution of sustainability technologies, policies, and plans.

The sustainability project charter could be supported by a number of tools to incentivize developers to meet the targets set out in Phase 2, including Section 37 benefits, community improvement plan incentives, and street network improvements. Importantly, Vaughan's Official Plan allows the City to request a community energy plan in support of a complete application for Official Plan Amendments, Zoning By-law Amendments, Draft Plans of Condominium, and Site Plan Approval (policy 10.1.3.3.d.xii). However, the City does not have the municipal tools to mandate developers to achieve particular energy targets. In other jurisdictions, Section 37 has been used to incentivize developers to achieve higher energy and carbon performance. In the context of Vaughan, the Sustainability Performance Metrics could also prove useful to reach this end. Determining which incentive tools to use will be a matter of exploration in this final phase of the project. In addition, other implementation mechanisms, including pilot projects, should be explored in this phase depending on the green building technologies and measures that are chosen in Phase 2.