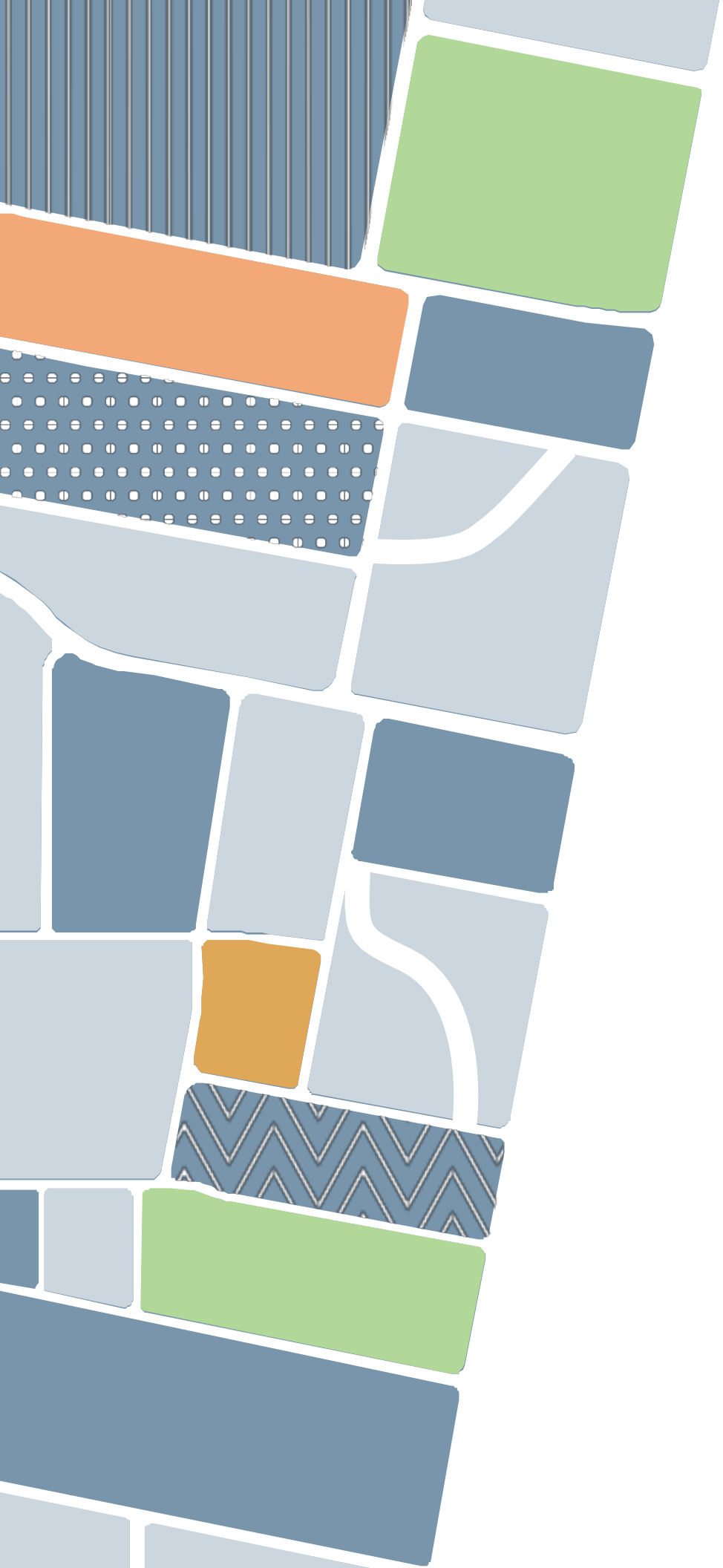


Clair-Maltby

Transform. Connect. Community.

Energy and Other Utilities Study- Background Report and Technical Work Plan (Phase 1)

Prepared by:
Amec Foster Wheeler

June 2017

CITY OF Guelph
Making a Difference

Background Report & Final Technical Work Plan

City of Guelph

Clair-Maltby Master Environmental Servicing Plan & Secondary Plan – Task E Energy & Other Utilities Study (Phase 1)

To:	Arun Hindupur City of Guelph
Date	14/06/2017
From:	Tijo Joseph Amec Foster Wheeler Environment & Infrastructure PBN: 899879050PG0030

Contents

amec foster wheeler

connected excellence in all we do

Amec Foster Wheeler Environment & Infrastructure
A division of Amec Foster Wheeler Americas Limited
900 Maple Grove Road, Unit 10
Cambridge, ON N3H 4R7
Tel 519-650-7100
Fax 519-653-6554

www.amecfw.com

1 Review of Policies, Plans, and Programs

1.1 Study Background

The Clair-Maltby area in the City of Guelph (the City) is located in the City's southeast quadrant. Clair Road, Victoria Road, and Maltby Road border the site to the north, east, and south respectively [1] (see Figure 1). Spread across an acreage of over 520 hectares, this parcel of land is the last unplanned greenfield site in the City [1]. The Clair-Maltby area is adjacent to a mixed use node currently being developed around the Clair Road - Gordon Street intersection (see Figure 2). In 2016, the City commissioned a Master Environmental Servicing Plan (MESP) and Secondary Plan Study for the Clair-Maltby area, technically the Clair-Maltby Secondary Plan Area (SPA) as per the Terms of Reference (TOR). The TOR also defines a Primary Study Area (PSA), currently being defined as the SPA plus lands within 500 m of SPA boundary (see Figure 3). The Secondary Plan will develop a comprehensive land use plan for the site and will inform a number of the new community's attributes including but not limited to:

- Urban design needs;
- Land use mix;
- Built form heights and densities; and
- Location of public places and other community services.

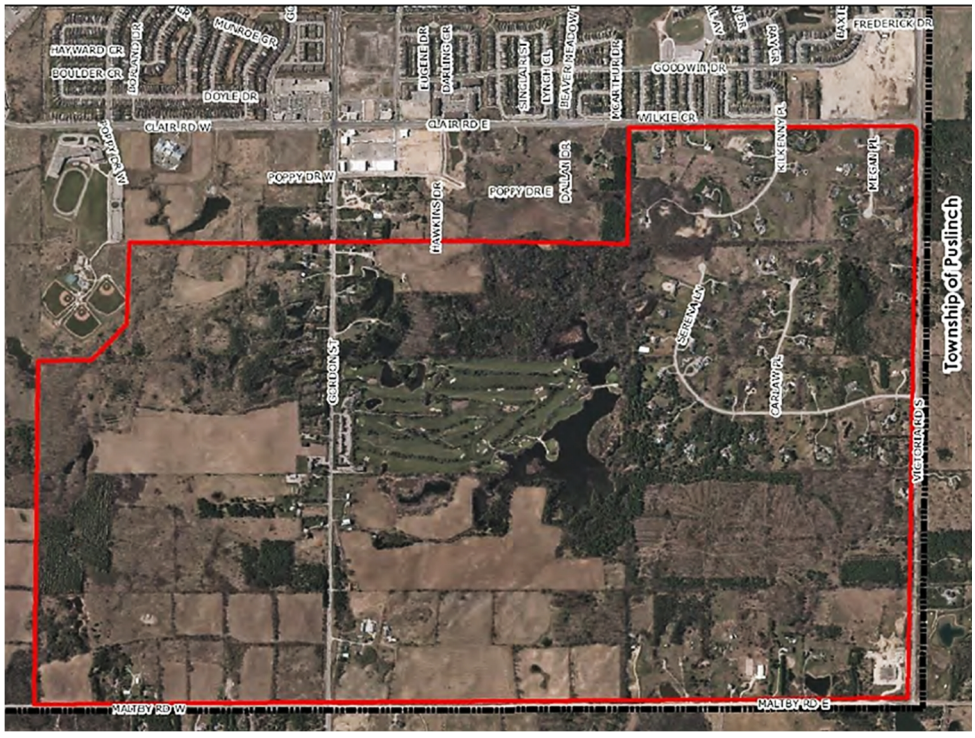


Figure 1: 2012 Orthophoto Clair-Maltby Secondary Planning Area (Source: City of Guelph)

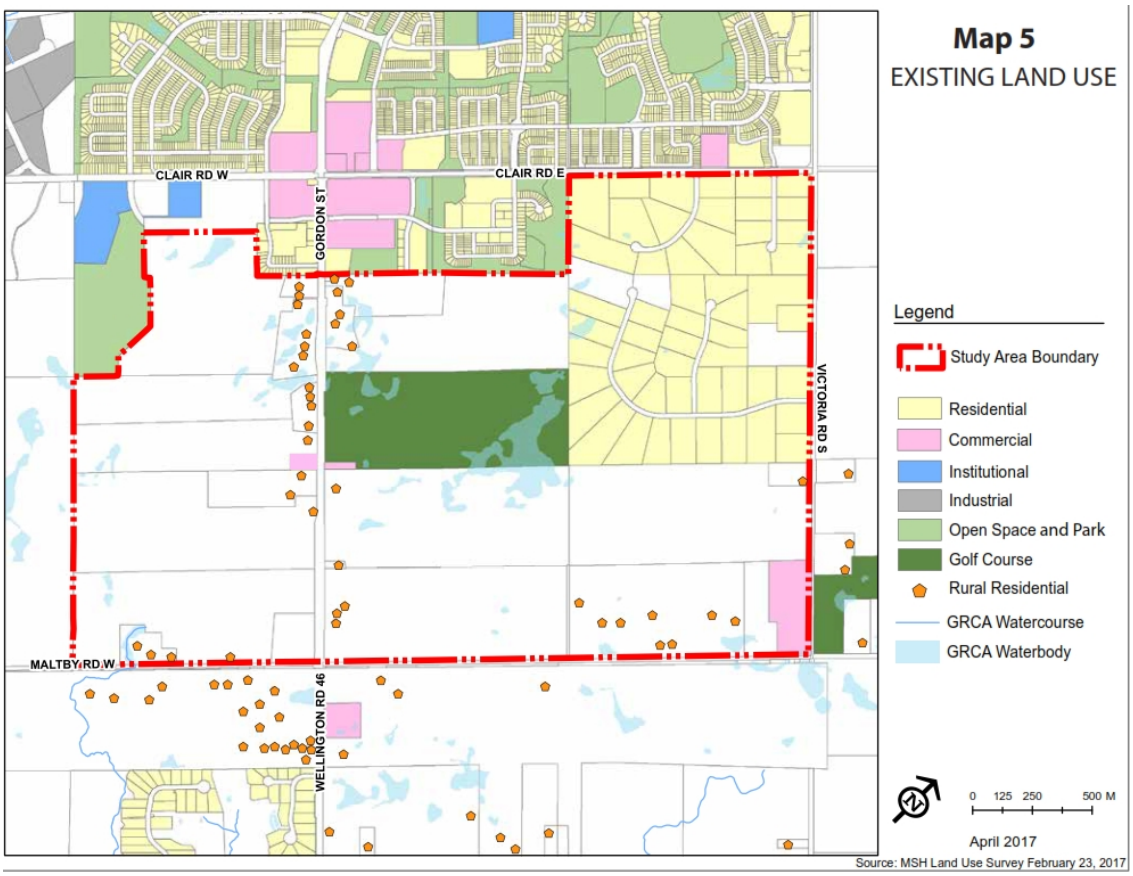


Figure 2: Existing Land Use Plan

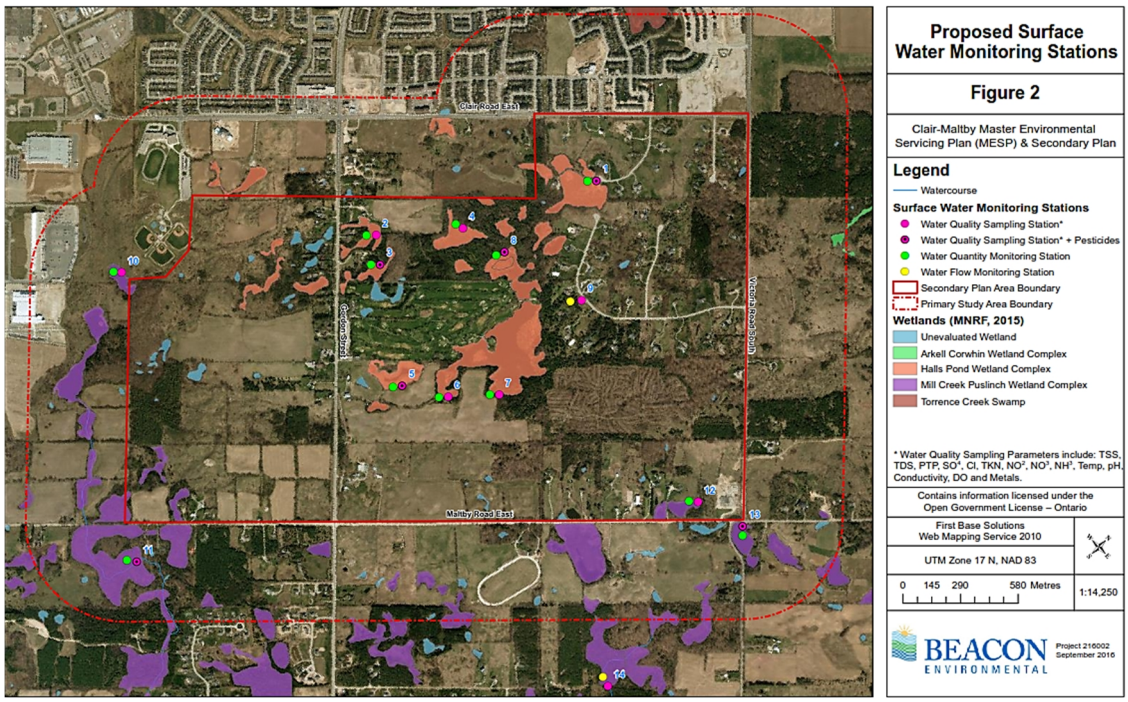


Figure 3: Clair-Maltby Primary and Secondary Study Area Boundaries

The MESP and Secondary Plan study is comprised of different study components (see Figure 4). One study component of the MESP & Secondary Plan is termed *Energy & Other Utilities*. As per the TOR stated for the MESP and Secondary Plan, a reduction in energy use and greenhouse gas (GHG) emissions is a key consideration expected throughout the Secondary Plan study with the aim to establish a community that is carbon-neutral. In developing the Energy & Other Utilities (EOU) study component, guided by stated objectives in the TOR, Amec Foster Wheeler gave consideration to the following aspects for the new Clair-Maltby community:

- Energy efficiency and energy management of the built environment and associated infrastructure;
- Alternative energy sources to provide clean energy;
- Energy aspects that contribute to green transportation; and
- Water conservation and efficiency.

The first task undertaken by Amec Foster Wheeler for the EOU study component was a background review of existing applicable policies, studies, standards, and reports related to energy to set the context in developing the technical work plan for the EOU study component.

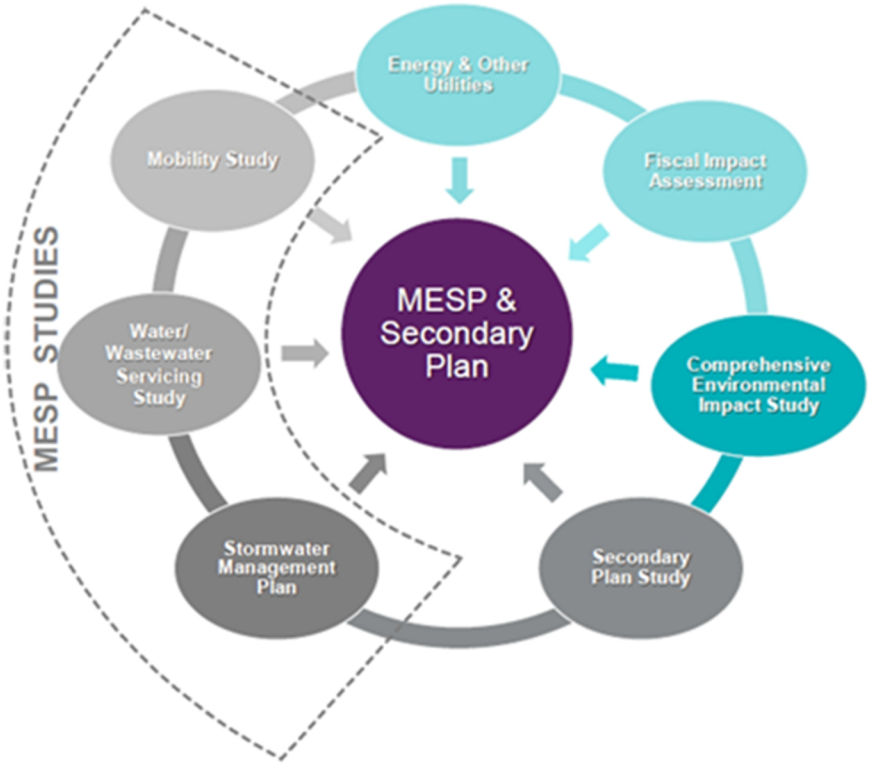


Figure 4: Clair-Maltby MESP Study Structure Components

1.2 Review of the City of Guelph Official Plan

The City of Guelph, a historic city founded in 1827, is one of the fastest growing municipalities in Canada. With an estimated population of 130,000 at the end of 2015, the City's long term average annual predicted population growth rate is 1.6% [11]. Under the Greater Golden Horseshoe Growth Plan, the population is predicted to increase to 175,000 by 2031 and 195,000 by 2041. The City's Official Plan establishes a framework for the desired development of the City to 2031. The following vision is stated in the City's Official Plan - "*The integration of energy, transportation and land use planning will make a difference in the environmental sustainability, cultural vibrancy, economic prosperity and social well-being of Guelph*". Some of the guiding principles stated in the Official Plan relevant to the EOU study component include:

- Building a compact, mixed use (residential, employment, etc.) and transit-supportive community;
- Ensuring an appropriate range and mix of housing types including affordable housing (30% of all new residential units constructed must be affordable [20]), special needs housing, and the presence of unique neighborhoods;
- Managing growth based on environmental, cultural, economic, and social considerations;
- Developing a sustainable transportation system providing for well-connected multiple modes of transport for walkers, cyclists, public transit users, and motorists;
- Specific to greenfield areas, planning to provide for a diverse mix of land uses at transit-supportive densities (a minimum of 50 residents and jobs per hectare in greenfield areas);
- Specific to greenfield areas, planning for lands designated as Industrial to achieve a density target of 36 jobs per hectare, lands designated as Corporate Business Park to achieve a density target of 70 jobs per hectare, and an overall average density target for employment lands of 46 jobs per hectare;
- Implementing policies and actions that will contribute to achieving targets set in the City's Community Energy Plan (CEP);
- Designing places and buildings to support a lower carbon footprint including through minimizing energy consumption;
- Establishing land use patterns that support energy-efficient buildings and opportunities for district energy;
- Promoting the use and generation of renewable and alternative energy systems;
- Specific to greenfield areas, ensuring that the new development is designed to promote energy conservation, alternative and/or renewable energy systems, and water conservation;
- Decoupling energy use and population growth;
- Reducing overall energy demand through an integrated planning approach; and

- Establishing and undertaking policies to target reducing annual GHG emissions by 60% from 2007 levels to 7 tons of carbon dioxide equivalent (eCO_2) per capita by 2031.

1.3 Review of the City of Guelph Community Energy Plan

Stated here is the City's energy vision and goals in support of this vision as reported in the CEP:

Energy Vision for Guelph[18]
Guelph will create a healthy, reliable and sustainable energy future by continually increasing the effectiveness of how we use and manage our energy and water resources.

Goals in Support of Guelph's Energy Vision[18]
1. Guelph will be the place to live and invest supported by its commitment to a sustainable energy future
2. Guelph will have a variety of reliable, competitive energy, water, and transport services available to all
3. Guelph energy use per capita and resulting greenhouse gas emissions will be less than the current global average
4. Guelph will use less energy and water per capita than comparable Canadian cities
5. All publicly funded investments will visibly contribute to meeting the four CEP goals

The City adopted a Community Energy Plan in 2007 (in 2010, the CEP was renamed the Community Energy Initiative (CEI) to reflect a living document). The CEP presents a framework for climate change mitigation in the City through reducing energy use and GHG emissions. Based on information presented under Section 4.7 of the Community Energy Plan in the City's Official Plan (Amendment OPA 48) and the CEP document, the following are the stated key objectives, policies, and targets relevant to the EOU study component:

- Establishing policies and programs to target reducing the City's overall energy use by 50% from 2007 levels to 34 megawatt hours (equivalent basis) per capita by 2031;
- Making suggestions for changes to the Ontario Building Code (OBC) and regulations that support energy efficiency standards in all built forms;
- Developing an integrated energy mapping tool that considers the type, mix, density, and distribution of land use for energy planning and identifying opportunities for district energy implementation;
- Encouraging the development of renewable energy systems and alternative energy systems and targeting at least 25% of the City's total energy needs from local renewable sources by 2021 and at least 30% of the City's electricity requirements with Combined Heat and Power (CHP) by 2031;
- Deriving at least 10% of the City's base load heat from biomass sources particularly base load heating for large commercial or institutional structures larger than 10,000 m^2.
- Reducing summer peak demand by at least 40% by 2031;
- Creating an integrated energy metering and management network across the City;
- Planning for high density and mixed land uses to allow for improved viability of district energy;

- For ongoing new constructions (residential, commercial, institutional) from 2012 to 2031, striving to achieve a 1.5% improvement over the 2012 OBC energy efficiency requirements;
- Supporting energy efficient development for the built form through promoting building orientation patterns that maximize solar gain, building designs that reduce building cooling demand (through measures such as improved insulation, green or reflective roofs, efficient glazing), designs built to energy standards such as Energy Star or LEED, building energy performance labelling schemes, and through energy efficiency monitoring programs;
- Incorporating urban design elements that reduce the number of car trips taken by at least 1% per year for the foreseeable future while developing Scale Projects (it is anticipated that a major facilitator for this will be through creating districts where many of the daily tasks can be accomplished through alternate modes of transport);
- Implementing light rail or low-impact buses (defined as clean diesel, diesel hybrid, or natural gas powered) on high volume routes to reduce individual vehicle trips by 0.5% per year; and
- Establishing programs in the City that will encourage the purchase of more fuel efficient vehicles with the objective of improving the average fuel efficiency by 2% per annum for the foreseeable future.

According to the CEP, in seeing through the CEI, some of the collective sustainability benefits assured for the City's community include:

- Consistently lower domestic energy and water charges relative to other neighboring cities;
- Better air quality owing to reduced GHG emissions;
- Reduced vulnerability to market volatility related to energy;
- Enhanced collateral value of energy and water efficient residential and commercial property;
- Better management of future risk associated with cost or regulatory impacts linked to GHG emissions reduction.

Guelph City Council recently (April 2016) approved initiating an update to the CEI to address any identified gaps, new policies and regulations, latest technical and best practices, and to factor in the analysis of local, regional, and global markets [17].

1.4 Review of Ontario's Cap & Trade Program

Ontario's Cap & Trade regulation came into effect on 1st July, 2016. Under the program, the province has set a limit to the number of tonnes of GHG emissions emitted into the atmosphere (142 megatons in year 1 of the program to be reduced over time down to 125 megatons by 2020) from businesses, institutions, and homes combined. The program is expected to

generate around $1.8 billion per year. The province expects the generated funds to support investment in GHG emission reduction programs.

1.5 Review of Ontario's Climate Change Action Plan

Ontario's Climate Change Action Plan (CCAP), a five-year plan to address climate change over the long term in Ontario was released in June 2016. The plan aims to fight climate change through reducing GHG emissions and outlines the main steps the province will take to achieve this objective. From the CCAP, action areas relevant to the EOU study component include:

- Facilitating increased availability and uptake of zero-emission vehicles (ZEVs) with a mandate to achieve electric and hydrogen vehicles sales at 5% of the total provincial sales by 2020 (a revised target will be set five years later);
- The above action item will be supported through various rebates (up to $14,000 per eligible vehicle purchase or lease under the program until 2020, rebate for low and moderate-income households for vehicle replacements with new or used electric or plug-in hybrid vehicles, and rebate for purchase and install of charging stations), HST relief (to be introduced in 2018 for new Battery Electric Vehicles purchases), and free overnight battery charging (starting 2017 for four years covering residential and multi-unit residential building customers);
- Encouraging households to switch one of their vehicles to an electric vehicle, and encouraging all new drivers to purchase ZEVs;
- Increasing the availability and use of low carbon buses;
- Implementing regulation that will achieve a 5% GHG reduction from gasoline use by 2020 including through making low carbon fuels such as propane more available and more used;
- Assisting fuel distributors financially with setting up infrastructure to supply biofuels;
- Creating a requirement for all new houses & townhouses with a garage to be constructed with an appropriate charging receptacle for vehicle charging in the garage and a requirement (*anticipate this by 2018*) for newly built commercial places and workplaces to provide charging stations;
- Speeding up the implementation of the province's Cycling Strategy and Action Plan which will continue to establish commuter cycling networks;
- Financing availability (through a newly created Green Bank) to residential and business owners to fund energy efficient technology in their buildings;
- Incentivising homeowner purchase and installation of technologies such as geothermal and air-source heat pumps, solar thermal, and solar photovoltaic systems;
- Providing rebates for purchase of near net zero carbon emission homes;
- Updating the Building Code with intent for efficiency targets for net zero carbon emission small buildings by 2030 latest;
- Establishing a renewable content (methane from landfill, organic waste etc.) requirement for natural gas; and
- Expanding the Green Button Program (*Guelph Hydro is a participating utility*) across the province.

1.6 Review of the City of Guelph District Energy Strategic Plan

The Guelph District Energy Strategic Plan (DESP) covers the period from 2013 to 2041 and aims, through creating a district energy network, to supply at least 50% of the heating requirements of residential buildings and commercial, industrial, and institutional (ICI) facilities in the City. In a district energy system, a central plant produces steam, hot water, and/or chilled water (where applicable) which is then supplied to energy users downstream through underground piping (typically in Municipal rights of way) to meet their space conditioning or hot water requirements. In Ontario, there are district energy systems in Cornwall, Hamilton, London, Markham, Ottawa, Sudbury, and Toronto [42].

The benefits for a district energy system (DES) include the following [28]:

- A district energy thermal plant can be serviced by a combined heat and power unit which is more efficient than a conventional electric power generating plant;
- A district energy plant can be designed to be capable of switching to renewable fuels such as biomass; and
- For end users (such as residential or commercial buildings), a DES enables doing away with boiler, furnace, or air-conditioning unit installs on site.

The DESP shortlisted ten sites in Guelph as potential candidates for the initial implementation of district energy projects. The focus was on developing a district heating system (as opposed to a district heating and cooling system) at the shortlisted sites. Two of these sites, one located downtown (Galt District Energy System) and the other at the Hanlon Creek Business Park, now have operational district energy systems. The Galt District Energy System consists of a thermal plant in the Sleeman Centre Arena serviced by a natural gas boiler and a central chiller unit providing space heating and space cooling needs respectively. The Hanlon Creek Business Park District Energy System currently caters to two customers covering an area of about 50,000 ft^2.

One of the outcomes of the DESP was modelling the heating needs of the City (for approximately 30,000 land parcels) based on the prevailing energy scenario in 2013 and some energy performance assumptions as described below:

- 25% of all energy consumed in the City in 2012 was to meet heating demand;
- A building energy efficiency scenario implemented as provided in **Table 1** (e.g., by 2041, new construction to be 30% more heat efficient than 2013);
- A major retro-fit rate of 1% of the existing building stock per annum; and
- Heating and cooling demands based on Climate Zone 6a.

Table 1: Energy Efficiency Evolution 2013 to 2041 assumed for Guelph District Energy Strategic Plan [29]

Building Type	Period	Energy Performance
New Construction Residential	2013-15 2016-18 2019-28 2029-33 2034-41	• OBC with an average 10% non-compliance • OBC with full compliance encouraged by Energy Performance Labeling • 1.5% / year efficiency gain • 1.0% / year efficiency gain • 0.5% per / year efficiency gain
New Construction Commercial	2013-14 2015-17 2018-27 2028-32 2033-41	• OBC with an average 10% non-compliance • OBC will full compliance encouraged by Energy Performance Labeling • 1.5% / year efficiency gain • 1.0% / year efficiency gain • 0.5% per / year efficiency gain
Existing Residential & Commercial (Major retro-fits)	2013 2014-15 2016-26 2017-36 2036-41	• No improvement over 2012 Baseline (BL) • 20% more efficient than Baseline • 3.0% / year efficiency gain • 1.5% / year efficiency gain • 1.0% per / year efficiency gain

On the above described basis, areal heating intensity maps were developed for the City forecasting into 2041. Figure 5 depicts the forecast areal heating intensity map for the City in 2041 as provided in the DESP.

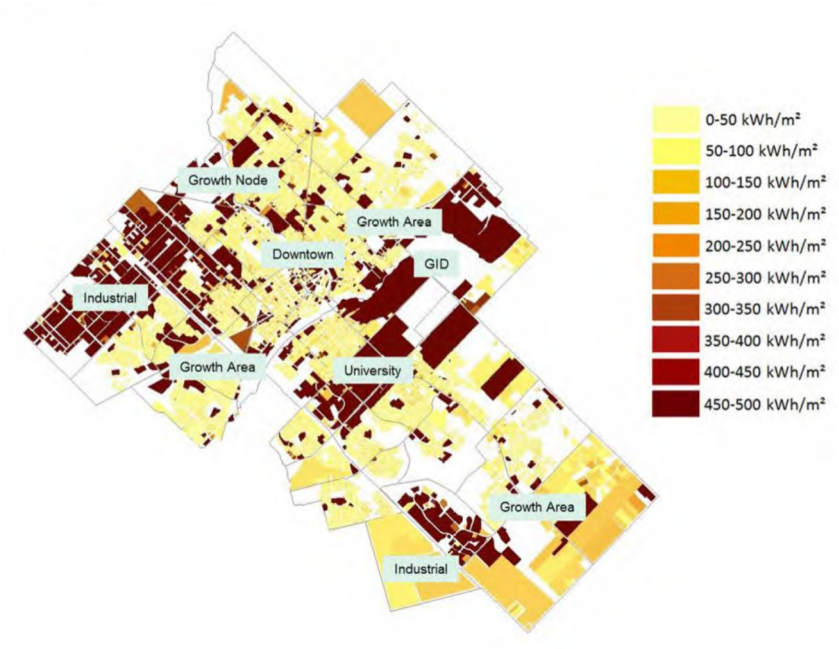


Figure 5: City of Guelph Areal Heating Intensity Map Forecast for 2041 [29]

The following target customers were proposed in the DESP for provision of heating services from a DES:

- Residential
  - Apartment buildings with at least 3 storeys;
  - Any developments with at least 100 homes per hectare.
- Commercial
  - Single large commercial buildings of at least 1,000 m^2;
  - Any multi-building developments on a single site with a total finished area of at least 10,000 m^2.
- Institutional
  - Federal, Provincial and City-owned buildings;
  - University of Guelph;
  - Guelph General Hospital;
  - Schools and Colleges.
- Industrial
  - Both existing and new industrial customers as potential targets for both District Heating and Cooling services.

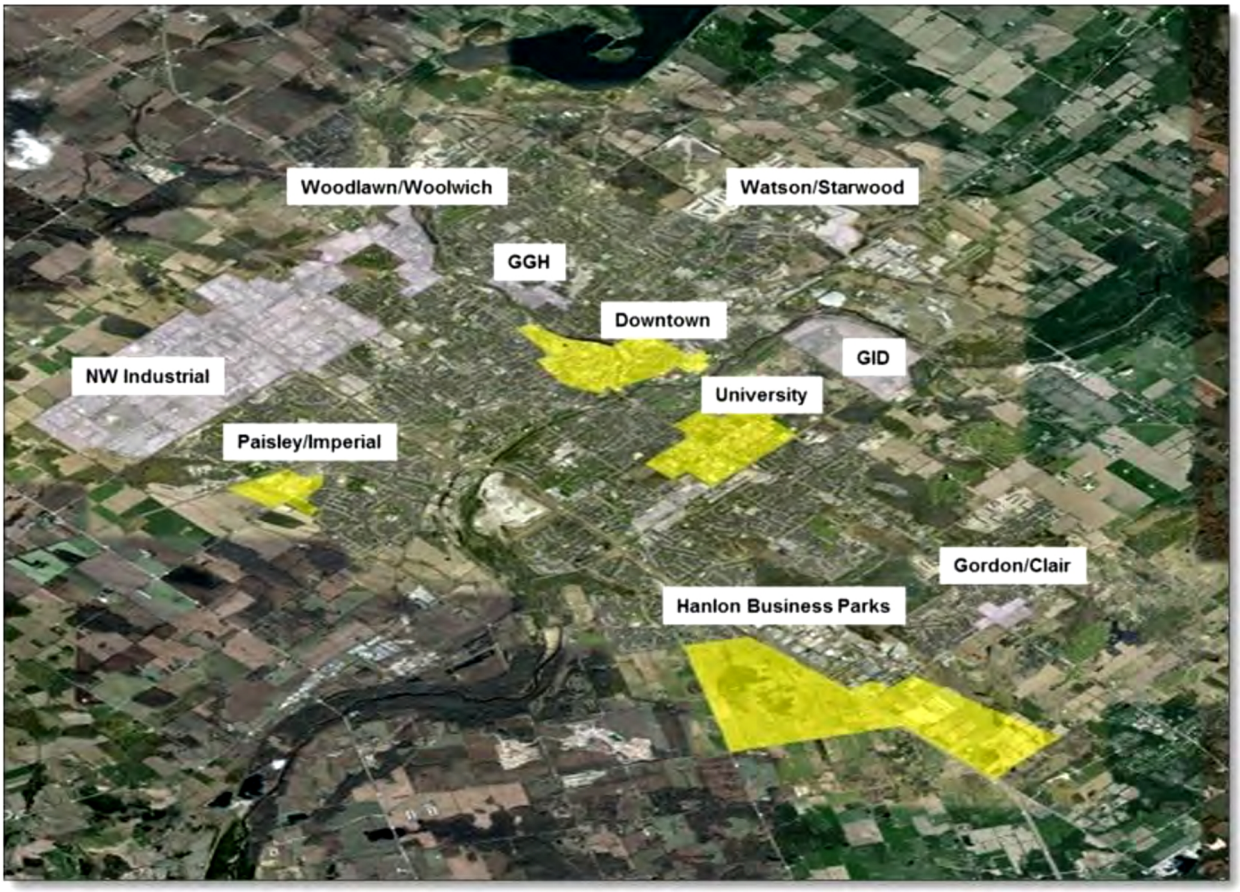


Figure 6: Priority Areas for District Energy [29]

The DESP anticipated that in the long term it would become commercially feasible to add low density energy users onto the district network as long as the users are within a 200 m radius of the network. A density factor guideline of 5:1 was also provided in the DESP.

Finally, based on conducted energy simulations, the DESP identified priority areas which had the potential for district energy implementation in the City. These areas are depicted in Figure 6 above.

Owing to concerns with the existing two district energy systems not expanding their customer base as anticipated, and against the backdrop of the recent district energy asset write-offs and write-downs by Envida (Envida runs the district energy systems in the City), it was recently reported that the City is currently working on a long-term modelling study (final report to Council was anticipated by June, 2016[1]) to ascertain the future prospects for district energy in the City [54].

1.7 Policy Aspects Related to Transportation in the City

According to the Growth Plan for the Greater Golden Horseshoe (2006), policy guidance related to public transit include:

- Development of transit-supportive densities;
- Multi-modal transport networks with priority for public transit; and
- Promotion of alternative transport choices such as walking and cycling.

The City's Official Plan, as mentioned earlier, also recognizes the relevance of public transit, proposes transit-supportive densities, and identifies the Greenfield Area as one of the key areas in the City to support public transit in the long term [13]. The City's goal, as indicated in the Official Plan, is to achieve a target of 15% transit modal split over the next 20 years (from 2015) [13].

The CEI has a goal of reducing the transportation sector associated energy use by 25% before 2031 [4]. Specifically, CEI strategy recommendations to reduce energy use related to transportation include developing projects with urban design features that reduce the number of individual vehicle journeys by at least 1% per year and creating a city-wide program to support the adoption of fuel efficient automobiles for personal use that will increase average fuel efficiency by 2% per year.

The Guelph-Wellington Transportation Study, completed in 2005, proposed transport demand management measures deemed practical for Guelph. **Table 2** is adapted from measures tabulated in the Guelph-Wellington Transportation study. Some of these measures are already identified in the City's Official Plan and CEP. As is evident, facilitating alternate transportation such as public transportation, biking, and walking for the City's residents is actively encouraged.

[1] Per latest feedback from the City, district energy projects are on hold for now.

Table 2: Transport Demand Management Measures for the City of Guelph

Strategy	Scope
Urban Form (system of modes and corridors)	To encourage alternate modes of transport
Increased Density	
Mixed Uses	
Neighborhood Design	
Car Pool Programs	
Guaranteed Ride Home Program	
Parking Supply Management	
Cycling Routes & Facilities	
Pedestrian Trails & Walkways	
Increased Transit Service & Routes	
Transit Fare Strategies	
Preferential Transit Facilities	
Improved Inter-City Transit	
Telecommuting	To discourage auto use
Alternative Work Schedules	
Parking Pricing & Supply Management	

Guelph Transit is the City's public transit provider. One of Guelph Transit's plans for the future is the creation of a new north/south route to run from Clair Road to Woodlawn Road along Gordon/Norfolk/Woolwich corridor (10 minute bus frequency on weekdays). If implemented, this is anticipated to assist in promoting the use of public transit by the Clair-Maltby community.

In 2012, the City released the Guelph Cycling Master Plan (GCMP). According to the GCMP, factors that encourage more biking include the presence of:

- Bike lanes;
- Wide curb lanes;
- Off-road alternatives; and
- End-of-trip facilities.

The GCMP proposed increasing the length of on-road bike lines by an additional 110 kms and the length of multi-use boulevards by 5.6 kms [34]. Figure 7 presents part of the proposed cycling network relevant to the Clair-Maltby area, as obtained from the GCMP.

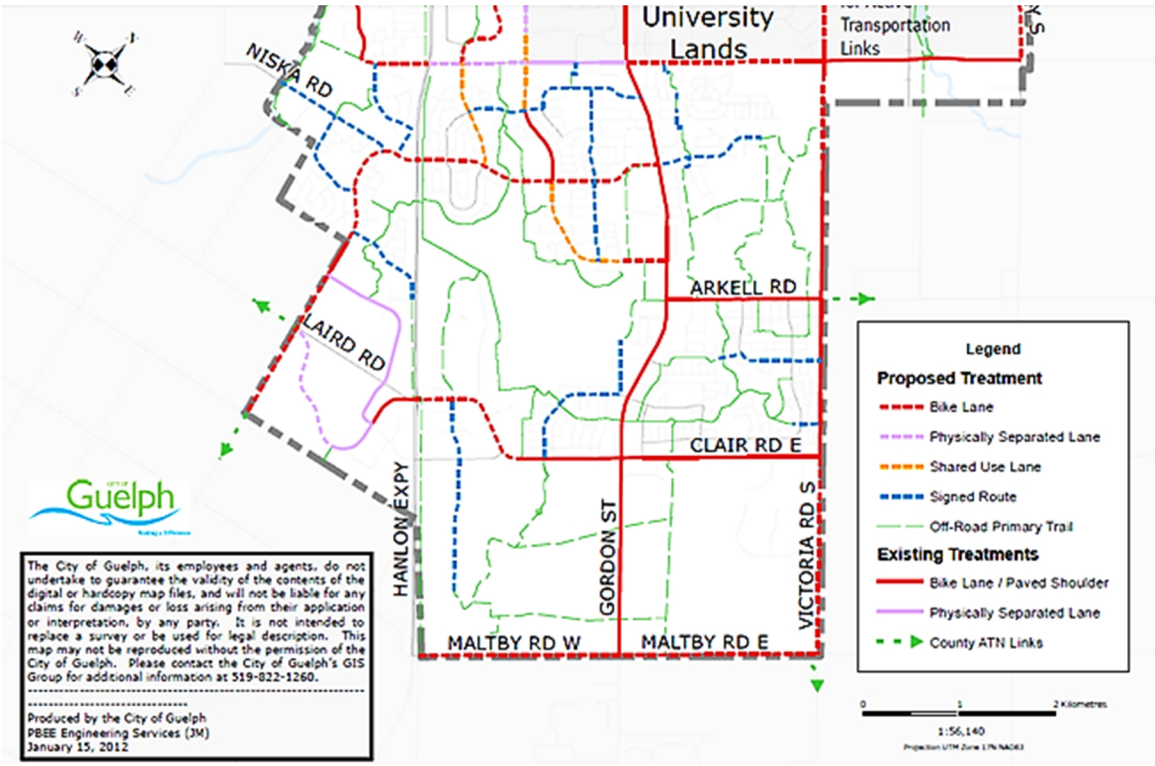


Figure 7: Proposed Cycling Network (relevant to the Clair-Maltby site) [34]

The City has defined minimum bicycle parking requirements for new developments. These requirements along with improved proposals, as presented in the GCMP, is provided in Figure 8 below.

Residential, Cultural and Institutional Bicycle Parking Requirements

Type of Activity	Long-term Bicycle Parking Requirement (where applicable)	Short-term Bicycle Parking Requirement
Residential, multiple dwellings (containing 3 or more units)	Minimum 6 spaces for developments >20 units.	1 per dwelling unit plus 2 visitor spaces per 20 units**.
Cultural services (eg. libraries, community centers, government buildings)	1 space per 10 employees. Minimum requirement is 2 spaces.	1 space for each 200 m^2 of floor area. Minimum requirement is 2 spaces.
Assembly-based cultural services (eg. theaters, churches, stadiums)	N/A	10% of required automobile parking.
Health-related (medical clinics, hospitals)	1 space per 20 employees; minimum 2 spaces.	Consider on a case by case basis; minimum 2 spaces per public entrance.
Primary or Secondary Schools	1 space per 20 m^2 of classroom plus 1 space per 800 m^2 of office space.	1 space for each 500 m^2 of floor area or minimum of 6 spaces.
Junior high and high schools	1 space per 40 m^2 of classroom plus 1 space per 1000 m^2 of office space.	1 space for each 500 m^2 of floor area or minimum of 6 spaces.
Parks	N/A	20% of parking spaces

Commercial and Industrial Bicycle Parking Requirements

Commercial Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Grocery stores and food retail	1 space per 500 m^2 of floor area; minimum 2 spaces.	1 space for each 300 m^2 of floor area; minimum 2 spaces.
Convenience Store	N/A	No less than 6 spaces.
General retail	1 space per 500 m^2 of floor area or 5% of required automobile parking.	1 space per 300 m^2 of floor area; minimum 2 spaces.
Hotel / Motel	1 space per 20 rooms.	5% of required automobile parking**
Restaurants	5% of required automobile parking.	1 space per 300 m^2 of floor area or 5% required automobile parking.
Restaurants (take-out)	N/A	1 space for every 100 m^2 gross floor area or minimum of 6 spaces.
Office	1 space per 500 m^2 of floor area or 4% of require automobile parking.	1 space for each 500 m^2 of floor area or minimum of 6 spaces.
Manufacturing and production	4% of required automobile parking.	4% of required automobile parking**

Figure 8: Bicycle Parking Requirements [34]

The GCMP also recommended developing a comprehensive, well-connected cycling network throughout the City with adequate signage and well supported by end-of-trip facilities and network maps that are updated regularly. The target proposed in the plan is to achieve 3% of all trips by bikes by 2022.

One of the key action items under CCAP is to facilitate increased availability and uptake of ZEVs. To support this endeavor, Ontario has announced plans to build a network of 500 electric vehicle stations across the province [35]. The network, expected to be fully in service by March 2017, is anticipated to ease commuter concerns with vehicle range and drive the province's plan to achieve 5% of new vehicle sales as electric vehicles by 2020 [35]. Six of these electric vehicle stations will come up in the following locations in Guelph and Wellington County [36]:

- Guelph – Social Services Building – 138 Wyndham St. S;
- Aberfoyle – Puslinch Library – 29 Brock Rd. S.;
- Arthur – Arthur Library and Medical Centre – 110 Charles St. E.;
- Arthur – Arthur Sports Complex – 158 Domville St.;
- Harriston – Tim Horton's – 182 Elora St;
- Mount Forest – Mount Forest Sports Complex – 850 Princess St.

One of these locations, the Aberfoyle – Puslinch Library location, is in close proximity to the Clair-Maltby site. The City presently has two public electric vehicle charging stations. It is also noted that some property builders are now installing charging stations in parking lots of their new developments in the City[2]. In summary, growing vehicle range, more affordable electric vehicles in the market, government rebates, and the establishment of an extensive charging network across the province, is anticipated to increase the purchase of electric vehicles from current levels in the long term.

1.8 Building Codes, Standards, and Rating Systems

The 2012 Ontario Building Code (OBC), a set of rules defining the minimum standards for building construction in the province, was enacted by Ontario Regulation 332/12 and came into force on January 1, 2014. The OBC sets out mandatory technical construction requirements as well as mandatory energy efficiency requirements for Part 3 (applicable major occupancy

[2] The City currently encourages multi-unit residential and commercial developers to provide 5% of parking spaces as EV-ready.

categories and exceeding 600 m^2 in building area or exceeding three stories in building height) and Part 9 (applicable major occupancy categories, of three or fewer stories in building height, and having a building area not exceeding 600 m^2) residential and non-residential buildings. New efficiency requirements in the OBC (2012) which come into effect starting January 1, 2017, will increase the energy efficiency requirements in Part 9 buildings by 15% from current levels, and in Part 3 buildings by 13% from current levels [51].

Besides the OBC which is a mandatory standard, there are other voluntary standards or energy efficiency rating schemes in today's housing market for energy efficient homes. This includes EnerGuide rated homes, ENERGY STAR® homes, R-2000 certified homes, and net zero ready (NZE) or NZE homes [47].

ENERGY STAR® for New Homes is a green building program in Canada that has witnessed much success in recent times. It is reported that in 2014, 32% of all homes built in Ontario were ENERGY STAR® qualified [49]. The latest version, ENERGY STAR® for New Homes Standard - Version 12.6, came into effect since April 2015 [50]. Typical features of ENERGY STAR® homes include [50]:

- More efficient space conditioning systems;
- ENERGY STAR® qualified fenestration products;
- Additional insulation in walls and ceilings;
- Minimal air leakage;
- Additional electrical savings (a minimum of 400 kilowatt-hours of saving measures).

R-2000 certified homes are built to the R-2000 standard developed by Natural Resources Canada (NRCan) [48]. The last update to the standard came into effect in July 2012. Typical features of an R-2000 home include [48]:

- High insulation levels in walls, ceilings and basements;
- High-efficiency fenestration;
- High-efficiency heating;
- Whole-house mechanical ventilation;
- Testing to ensure minimal air leakage;
- Water-conserving fixtures.

NRCan also administers the EnerGuide Rating System which uses a scale of 0 to 100 to rate a home's energy efficiency [55]. **Table 3** presents the typical EnerGuide rating for housing at various energy efficiency levels [55].

Table 3: EnerGuide's Typical Rating for Various Housing Characteristics [42], [55]

House Characteristics	Typical Rating
Older house not upgraded	0 to 50

Upgraded older house	51 to 65
Energy-efficient upgraded older house	66 to 74
Minimum Ontario Building Code for new homes as of January 1, 2012	80
An energy efficient new home	86+
House requiring little purchased energy	91 to 99
Zero Net Energy home	100

Through the ecoENERGY Innovation Initiative, NRCan has a project involving five builders (including Reid Heritage in Guelph) to build 25 net-zero-energy (NZE) pilot homes across Canada [45]. The goal is to further the cause of NZE communities in future developments at an affordable price point. The current premium between build to code and NZE-Ready and NZE-Accomplished homes is around $40,000 and $85,000 ($65,000 on the lower end) respectively [45]. Builders quote added benefits of NZE to include more comfort, resilient, and healthier homes [45]. Canadian Home Builders Association (CHBA) has also kick-started a Net Zero Energy Labelling Program. Reported measures to get to NZE-readiness include significantly improved insulation and air-tightness, installing highly performing triple-pane windows, use of an air source heat pump, a hybrid heat pump water heater, a heat recovery ventilator, LED lighting, and very efficient appliances [45], [46].

For energy efficient housing, across all the rating schemes, the key considerations remain the building's thermal envelope, energy efficient equipment, or energy conservation practices. In Guelph, various builders including Gemini Homebuilders Inc., Terra View Homes Inc., Sloot Construction Ltd., and Reid's Heritage Homes Ltd. now offer energy efficient housing (that is exceeding OBC 2012 mandated energy efficiency levels) such as ENERGY STAR® rated homes as part of their portfolio. Reid Heritage Homes Ltd. has also announced that by the end of 2016, all its future community developments will be NZE-Ready homes [45]. In summary, the various building energy performance levels, as reported by the CHBA, can be positioned as follows [45]:

- Homes built to OBC – assumed as baseline case
- ENERGY STAR® rated homes – 20% more efficient than baseline
- R-2000 certified homes – 50% more efficient than baseline
- NZE-ready homes – 80% more efficient than baseline
- NZE homes – 100% more efficient than baseline

Another aspect to consider is equipment standards. Under Ontario's Green Energy Act of 2009, there are regulations stipulating minimum energy performance levels for some appliances and products relevant to use in buildings. In addition, NRCan, on behalf of the federal government

and under the Energy Efficiency Federal Act, has also set minimum product efficiency standards covering some energy using equipment.

1.9 Ontario's Green Button Initiative

In 2014, the Green Button Initiative was launched in Ontario. Through this program, residential and commercial electricity users in Ontario can access and monitor their electricity usage data through a choice of information technology applications thus empowering users to gain insights on their usage patterns and thereby better managing their usage. More than 50% of Ontarians can now access their consumption data in the Green Button standard. A schematic of how the Green Button Initiative works, as sourced from http://greenbuttondata.ca/, is provided in Figure 9 below.

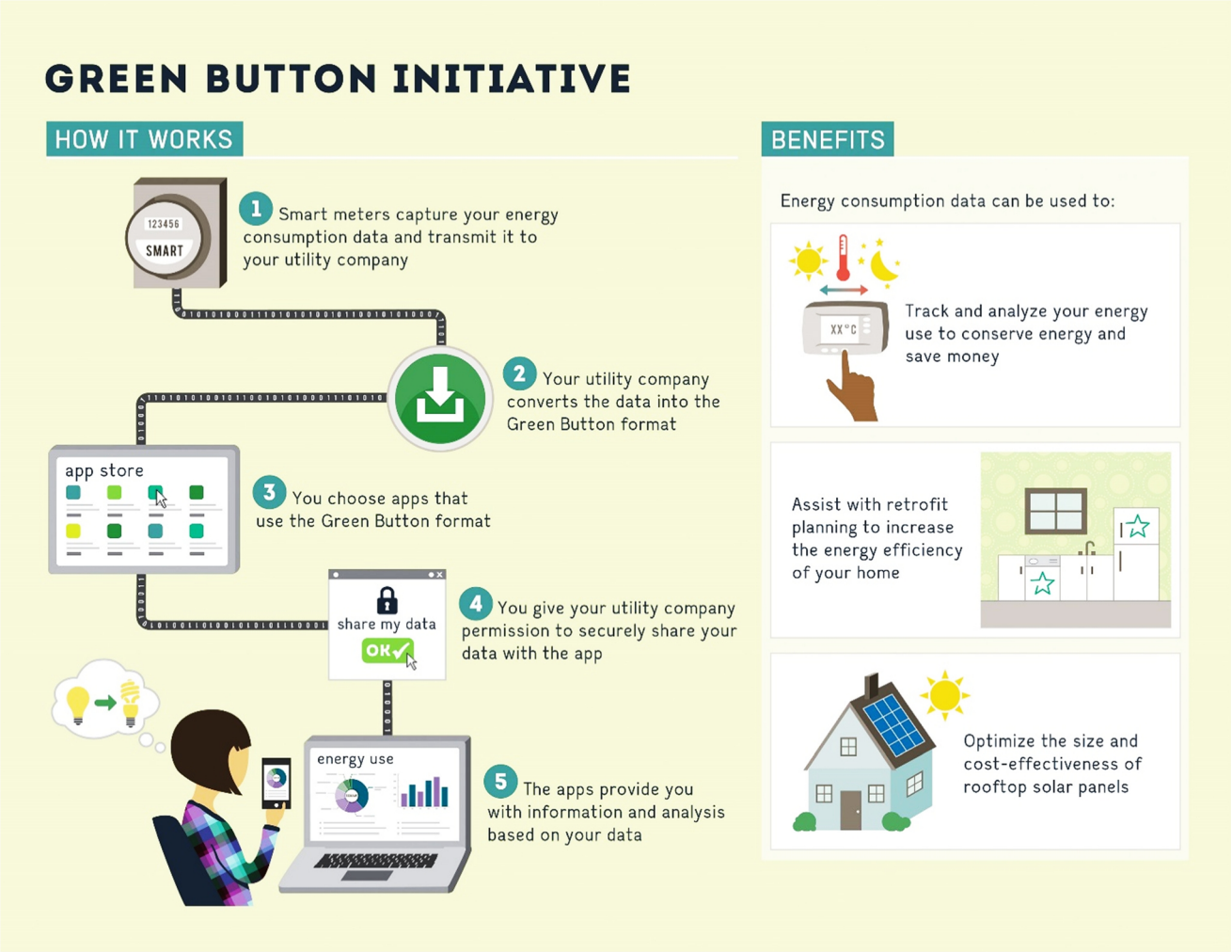


Figure 9: Ontario's Green Button Initiative [40]

1.10 Policy Aspects Related to Water Use

The City's entire water demand is presently met through groundwater sources. In 2006, a Water Supply Master Plan (WSMP) was released by the City [25]. The WSMP reported water conservation and efficiency as a top priority for the City (most cost effective and readily available new water source) [25]. Three reduction targets, relative to the City's 2006 daily water production volumes, were set in the WSMP for average daily water usage as follows [25]:

- Reduction of 10 percent (5,300 m^3/day) in average day water use by 2010;
- Reduction of 15 percent (7,950 m^3/day) in average day water use by 2017;
- Reduction of 20 percent (10,600 m^3/day) in average day water use by 2025.

In 2014, the WSMP Update was released. Water conservation and efficiency efforts remain a top priority in the WSMP Update. The WSMP Update, under an Enhanced Water Conservation Scenario, recommended a revised water demand reduction target of an additional 9,147 m^3 per average day by 2038.

Table 4: Blue Built Home and Ontario Building Code Standards [26]

Fixture/Appliance	OBC Standard	Blue Built Home		
		Bronze	*Silver*	*Gold*
Toilet	4.8litre	<= 4litres	<= 4litres	<= 4litres
Washing machine	NA	High-efficiency ENERGY STAR® washing machine	High-efficiency ENERGY STAR® washing machine	High-efficiency ENERGY STAR® washing machine
Laundry floor drain (or trap)	NA	Waterless floor tap	Waterless floor tap	Waterless floor tap
Hot water system	NA	NA	Hot water delivery system	Hot water delivery system
Greywater system	NA	NA	NA	Greywater reuse system
Rainwater system	NA	NA	NA	Rainwater harvesting system

In 2009, the City released the Water Conservation and Efficiency Strategy (WCES) Update (an update to the City's 1999 Water Conservation and Efficiency Study). A suite of water conservation and efficiency measures were recommended in the WCES Update [32]. For new residential builds, recommendations included rebates to builders for installation of:

- High efficiency or dual flush toilets;
- Low flow showerheads and low flow kitchen faucets;
- Water efficient clothes washers, central humidifiers, and floor drain covers;

- Grey water reuse system;
- Rainwater harvesting system;
- Watering timers;
- Water efficient landscapes.

The City currently administers the Blue Built Home Program, a certification program for new homes that involves the use of high quality fixtures and appliances which can result in up to 62% savings in water usage [26]. A comparison between the Blue Built Home certification levels and the corresponding OBC requirements is provided in **Table 4** above.

In 2015, C3 Water Inc. (C3W), on behalf of the City of Guelph, conducted a literature review of water efficiency strategies[3]. Guided by the literature findings, C3W reported the following general best practices:

- Adoption of smart metering;
- Water loss control (involves leak detection and repair);
- Pressure management (higher pressure results in a higher leakage rate); and
- Active leak detection.

1.11 Policy Aspects Related to GHG Emissions

In 1990, Ontario's GHG emissions totaled 181.8 megatons of eCO_2 [2]. As of this report date, Ontario has set the following GHG emissions reduction targets with reference to the baseline year of 1990 [3] (see Figure 10):

- 2020 Short term target – 15% (to approximately 155 megatons of eCO_2)
- 2030 Midterm target – 37% (to approximately 115 megatons of eCO_2)
- 2050 Long term target – 80% (to approximately 36 megatons of eCO_2)

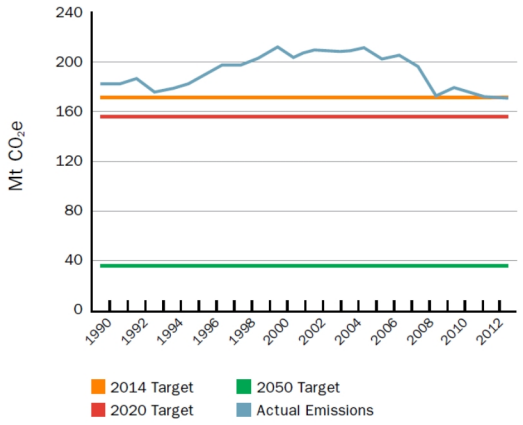


Figure 10: Ontario GHG Emission Trends and Targets (1990 to 2013) [10]

[3] A 2016 Water Efficiency Strategy Update report is now available. This report will be referred to by Amec Foster Wheeler in considering water efficiency measures to be applied to the built form as part of Phase 2 work. We have also noted from the 2016 Water Efficiency Strategy Update that the existing Blue Built Home Program's three-level certification will be transitioned to a single-level program.

The CCAP provides a sector-wise forecast of emission trends in Ontario until 2020. This is presented in Figure 11. Current provincial GHG emissions are at around 6% below 1990 levels [5]. Ontario has met its 2014 target of a 6% reduction [27]. The CEI states an overall reduction target of 50% by 2031 (with reference to the 2005 baseline year) for the City's energy consumption. This is in line with the City's goal under the CEI of achieving a lower per capita energy use relative to other comparable Canadian cities. The City, through its CEI, has also established a GHG emissions reduction target of 50% on a per-capita basis by the year 2031 (baseline year as 2005) [4] and a goal of a reduced GHG emissions per capita relative to the prevailing global average.

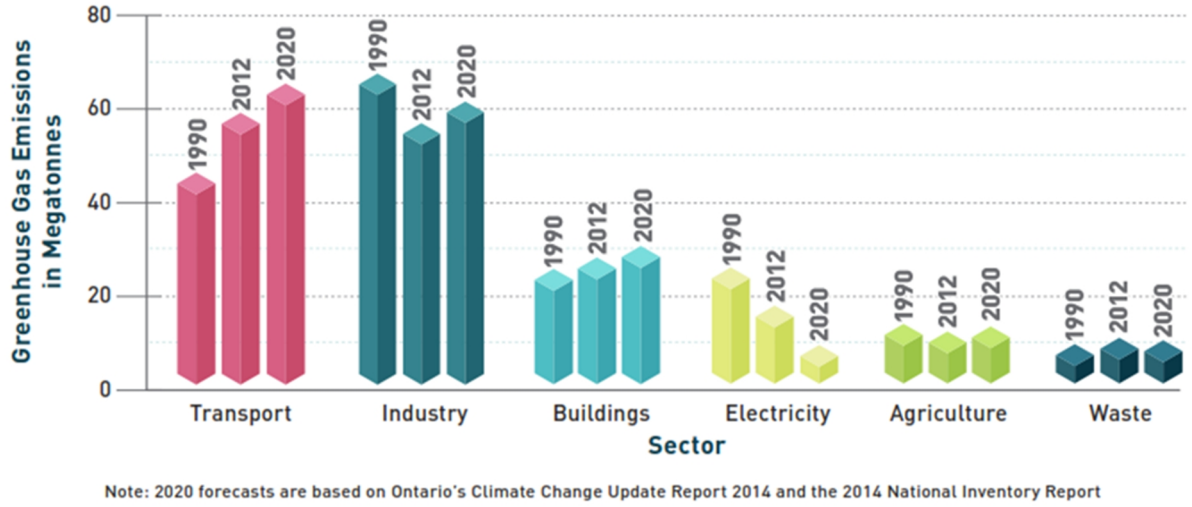


Figure 11: Ontario's Emissions Trends 1990 – 2020 (Forecast) [27]

2 City of Guelph Energy & Water Use Trends

2.1 City of Guelph Energy Consumption, Energy Users, & Other Relevant Energy Data

In 2014, the City's energy use per capita stood at 213.4GJ/capita [15]. **Table 5** presents sector-based natural gas and electricity consumption data for 2014 [15]. Based on this data, for natural gas, the sector-wise distribution was Residential - 32.5%, Commercial – 33.9%, and Industrial – 33.6%. Electricity consumption, based on 2014 data, was distributed among the sectors as follows; Residential – 20.4%, Commercial – 31.2%, and Industrial – 48.4%. Guelph Hydro Electric Systems Inc. (Guelph Hydro) is the electricity distribution company that services homes and businesses in the City. Guelph Hydro is a provincial leader (ranked 4th in efficiency out of 72 local electricity distribution companies in 2015 [8]) in energy conservation efforts. The company achieved peak electricity demand reduction of 20 megawatts and electricity consumption reduction of 130.9 gigawatt hours in the period from 2011 to 2014 through energy conservation and saveONenergy programs [8].

Table 6 is a summary from Guelph Municipal Holdings Inc.'s 2015 Annual Report presenting information on Guelph Hydro's electricity customers, electricity consumption data, and distribution system performance. The average monthly consumption for Guelph Hydro's residential customers was 673 kilowatt hours (kWh) in 2015, a lower figure compared to the typical household monthly electricity consumption (800kWh) in Ontario [8]. A typical breakdown of residential energy usage in Canada by end-use is provided in Figure 12.

Around 50% of the City's energy use can be attributed to energy required for heating and cooling in buildings [9]. With over 4,325 heating degree days (compared to 180 cooling degree days), the energy demand for space heating is high in the City [18]. While Ontario is typically a summer peaking province, some communities witness peak electricity demand in summer, while other communities do in winter [19]. Peak electricity demand in Guelph occurs in summer (for e.g., peak electricity demand peaked to 301MW in the summer of 2015) influenced by the simultaneous use of air-conditioning equipment by various end-users.

Table 5: Natural Gas and Electricity Consumption by Sector [15]

Sector	Natural Gas (m^3)	Electricity (kWh)
Residential	93,509,108	668,953,095
Commercial	97,669,999	1,020,440,107
Industrial	96,700,923	1,582,349,981
Total	287,880,030	3,271,743,183

Table 6: Summary of Guelph Hydro Customers, Electricity Consumption, and Distribution System Performance [8]

Electricity Customer	**Total Electricity Consumption in 2015 (gigawatt hours)**
Residential (49,132 customer accounts)	396
Commercial (4,694 customer accounts)	1,114
Large Industrial (5 customer accounts)	297
Season	**System Peak Demand (megawatts)**
Summer	301 (without generation)
Winter	269
Renewable Energy Installation	**Energy Generated (megawatt hours)**
Feed-in-Tariff (FIT) (33 installations)	9,208 (average system size ~235kW)
MicroFIT (319 installations)	2,576 (average system size ~6kW)
Cogeneration Installation	**Nameplate Capacity (megawatts)**
4 Installations	11.2

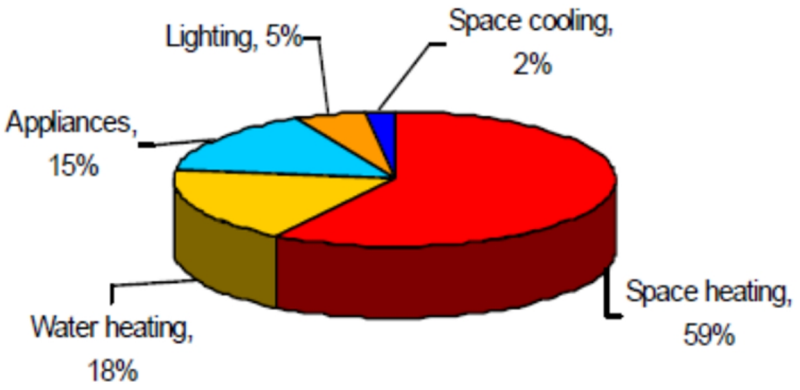


Figure 12: Typical Residential Energy Usage by End-Use (2006 data) [53]

One of the important aspects to consider when reviewing building energy usage is the building vintage (in other words, the building's construction year), the building structure classification (e.g. detached housing or apartment under the residential category etc.), and the building type (e.g. office building or retail building under the commercial category etc.). These aspects influence the building's energy usage or energy use intensity. Related information in this regard, as gathered from multiple sources, is presented below.

The housing stock in the City is mostly comprised of low density housing with approximately 53,000 housing units in the City [20]. Figure 13 below presents past and projected population and household growth in the City between 2001 and 2031. Figure 14 that follows depicts how the distribution of housing stock structure type evolved from 1996 to 2011 in the City. Figure 15 is a depiction of the distribution of housing stock in the City by density based on data from 2007 (that is, low, medium, or high). As evident from Figure 15, low density housing stock dominates in the City. However recent build permits issued by the City suggest housing stock additions to the market are now more of medium and high density type.

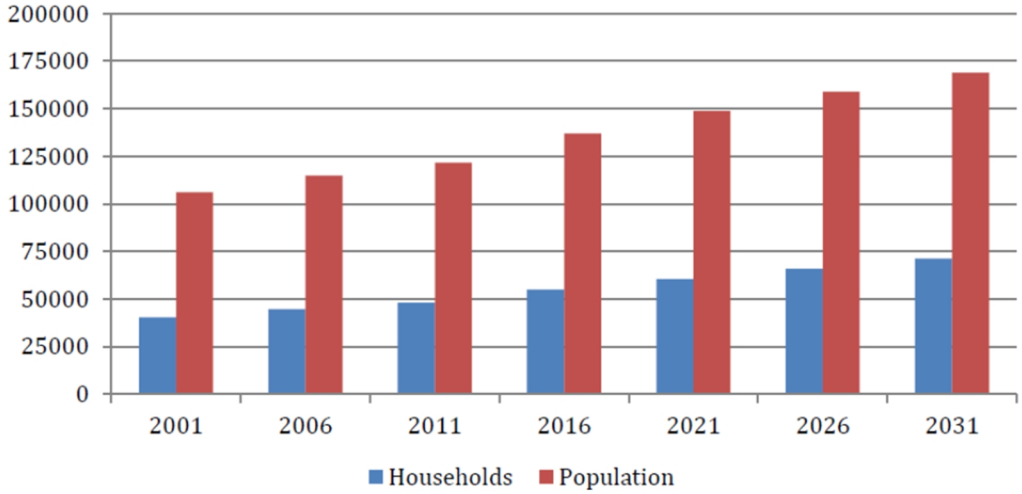


Figure 13: Historical and Projected Population and Household Growth in Guelph, 2001-2031 [20]

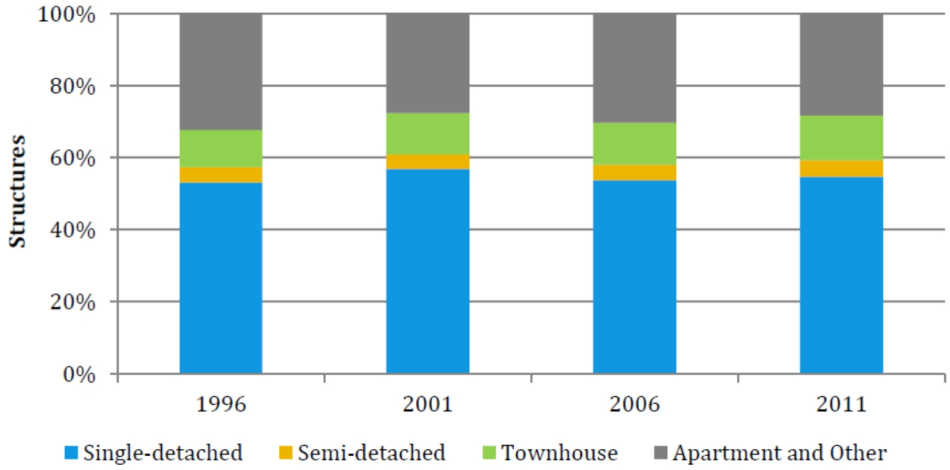


Figure 14: Housing Stock by Structure Type in Guelph, 1996-2011, Source: Statistics Canada, 2011 Census

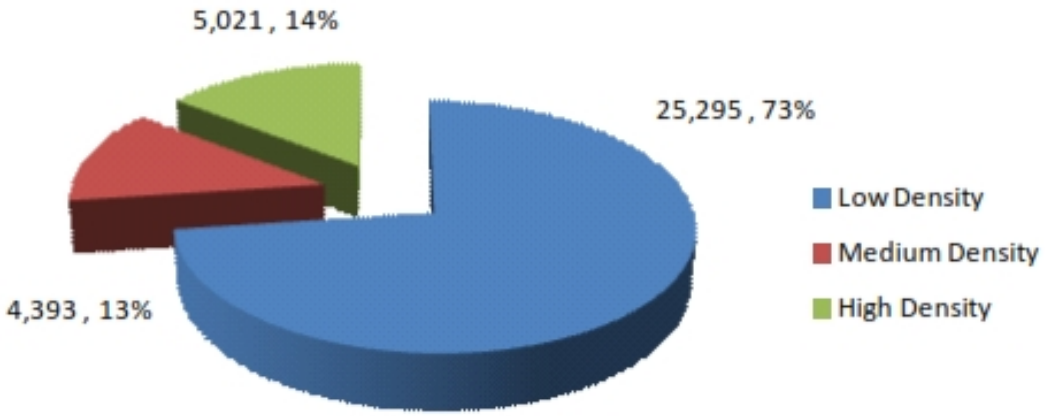


Figure 15: Housing Sector Breakdown by Density (No. of units and %, 2007) [32]

A household survey that provides some useful context on energy use in households in Ontario is the Households and the Environment Survey (HES) that was administered by Statistics Canada in 2011. The HES – Energy Use supplement to HES was informed by feedback from around 3,000 respondents in the province. Relevant data from this supplement is tabulated in **Table 7** and presents information on the distribution of heating equipment type, distribution of fuel type, and average energy use by dwelling type, vintage, and area among the households in the province. **Table 8**, also sourced from the HES, reports on the penetration level of ENERGY STAR® appliances in Ontario households.

Table 7: Energy Use Data from Households and the Environment Survey – Energy Use Supplement

Type of heating equipment (%)						
Furnace	Electric baseboards	Boiler	Heating stove	Electric radiant	Gas fireplace	Other
81	7*	5*	2*	**	**	1*
Type of heating fuel (%)						
Electricity	Natural Gas	Oil	Wood/Wood pellets	Propane	Other	
14	76	5	3*	2*	**	
Average energy use (gigajoules per household**)**						
Electricity	Natural Gas	Oil	Wood/Wood pellets	Propane	All fuel types	
30	93	70	77	26	107	
Average energy use by number of household members (gigajoules per household**)**						
One	Two	Three	Four	Five or more	All households	
72	104	103	137	155	107	
Average energy use by number of household members (gigajoules per m^2 of heated area**)**						
One	Two	Three	Four	Five or more	All households	
0.68	0.76	0.70	0.75	0.77	0.74	
Average energy use by area (gigajoules per household**)**						
600 ft^2 or less	601 to 1000 ft^2	1,001 to 1,500 ft^2	1,501 to 2000 ft^2	2,001 to 2,500 ft^2	2,501 or more	All households
39	59	103	117	156	171	107
Average energy use by area (gigajoules per m^2 of heated area**)**						
600 ft^2 or less	601 to 1000 ft^2	1,001 to 1,500 ft^2	1,501 to 2000 ft^2	2,001 to 2,500 ft^2	2,501 or more	All households
0.78	0.74	0.88	0.72	0.72	0.59	0.74
Average energy use by dwelling type (gigajoules per household**)**						
Apartment	Multi-unit (includes doubles, duplexes, row, terrace)	Single-detached dwelling	All other	All households		

33	94	136	**	107		
Average energy use by dwelling type (gigajoules per m^2 of heated area**)**						
Apartment	Multi-unit (includes doubles, duplexes, row, terrace)	Single-detached dwelling	All other	All households		
0.39	0.68	0.80	**	0.74		
Average energy use by building vintage (gigajoules per household**)**						
Before 1946	Between 1946 and 1960	Between 1961 and 1977	Between 1978 and 1995	1996 or later	No information	All households
128	100	108	105	119	47	107
Average energy use by building vintage (gigajoules per m^2 of heated area**)**						
Before 1946	Between 1946 and 1960	Between 1961 and 1977	Between 1978 and 1995	1996 or later	No information	All households
0.89	0.83	0.82	0.68	0.67	0.47	0.74

**Unreliable data, **Note to use data with caution*

Table 8: Energy Star appliance penetration in Ontario households sourced from the Households and the Environment Survey

Main refrigerator	Second refrigerator	Freezer (stand-alone)	Dishwasher	Washing machine
50%	14%	22%	37%	48%

Transportation is another major energy user in the City. It is estimated that personal and light transportation within the City contributes to 30% of the City's energy use [12], [13]. According to the CEP, the use of private cars accounts for a significant component of the City's energy use. Trips using auto mode constituted the majority of commuter trips in the City, achieving trip purposes such as (for the major part) driving to work or discretionary purposes, such as shopping. The 2009 Canadian Vehicle Survey, conducted by Statistics Canada on behalf of Natural Resources Canada and Transport Canada, provides some useful information on road vehicle activity in Canada. The following is summarized based on the findings of the report (focus is on information for light vehicles from the report):

- Number of vehicles per household – 1.45 (reported for Ontario);
- Average distanced travelled for light vehicles (4.5 tonnes or less) - ~16,000kms (reported for Ontario);

- Vehicle fleet composition – Cars (55.4%), Station wagon (3.5%), SUVs (12.8%), Van (12.8%), Pick-up Truck 15.2%, Others (0.3%);
- Vehicle fuel types – Gasoline (96.9%), Diesel (2.9%), Alternative fuels such as electricity, propane, natural gas and 85% ethanol gasoline blend (less than 1%);
- Age of vehicle fleets by vehicle type – Less than 3 years old (18.7%), between 3 and 9 years (50.2%), and more than 9 years old (31.2%);
- Fuel consumption for light vehicles – 10.7 liters per 100 kilometers (L/100 km) for gasoline powered vehicles (7.1 L/100 km specifically for cars and station wagons and 9.5 L/100 km for light trucks) and 10.6 L/100 km for diesel vehicles.

The market share of electric vehicles (there are two categories, Plug-In Hybrid Vehicles (PHEVs) and Battery Electric Vehicles BEVs) in Ontario is slowly increasing. Of the 21,000 electric vehicles on the road in Ontario today, around 7,000 are BEVs [35]. Among plug-in electric vehicles, the car models Chevy Volt, Nissan Leaf, and Tesla S command 70% of the electric vehicle market [35]. No information could be gathered on the number of PHEVs and BEVs in Guelph as of the date of this report.

One of the more significant energy spends for the City is from its 13,000 street lights. Presently, high pressure sodium (HPS) lamps power these street lights resulting in an annual spend of ~ $1.56 million incurred by the City [22]. The City and Guelph Hydro are conducting trials evaluating LED street lights (four different LED makes) at multiple locations across the City [22]. The anticipated benefits from moving to LED lighting include [22]:

- Reduced electricity consumption;
- Reduced amount of urban glow;
- Reduced maintenance (Existing HPS bulbs call for replacement every three years);
- Increased visibility;
- Smart grid programmable.

Trials ran from December 2015 to March 2016 and a report in this regard was anticipated to be released in May 2016 on the basis of which a city-wide rollout was expected to start Fall 2016[4] [22].

2.2 City of Guelph GHG Emissions

In 2014, the City's GHG emissions per capita was 8.9tonnes of eCO_2 [15]. Figure 16 presents the City's emissions breakdown by sector based on 2014 data (total GHG emissions data by sector in 2014 is provided in **Table 9** below). As is evident in Figure 16, the residential, commercial, industrial, and transportation sectors are all equally significant GHG emission contributors for the City.

[4] Per update from the City provided in May, 2017, it is now likely that the rollout of LED street lights will occur only in late 2017 or as late as 2018.

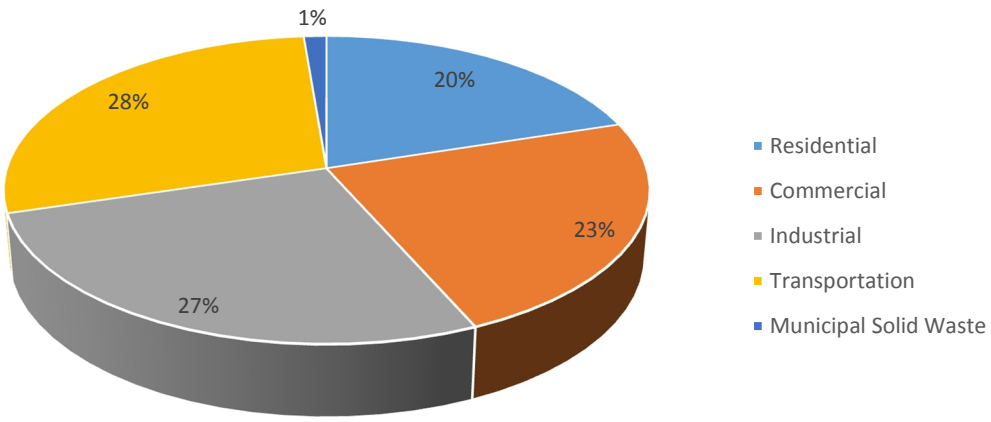


Figure 16: City of Guelph eCO_2 Emissions Sector Breakdown [15]

Table 9: Total GHG emissions (eCO_2 tonnes) by sector in 2014 [15]

Sector	**Total eCO_2 (t)**
Residential	230,248
Commercial	266,232
Industrial	309,353
Transportation	324,426
MSW	14,857
Total	1,145,115

The energy sources linked to the GHG emissions in the City include electricity, natural gas, diesel, gasoline, and municipal solid waste (MSW). Figure 17 presents a breakdown of GHG emissions by source based on the 2014 data. The significant energy sources that contribute to the City's GHG emissions, based on the 2014 data, include natural gas, gasoline, and electricity (note this is based on the grid supply mix in 2014).

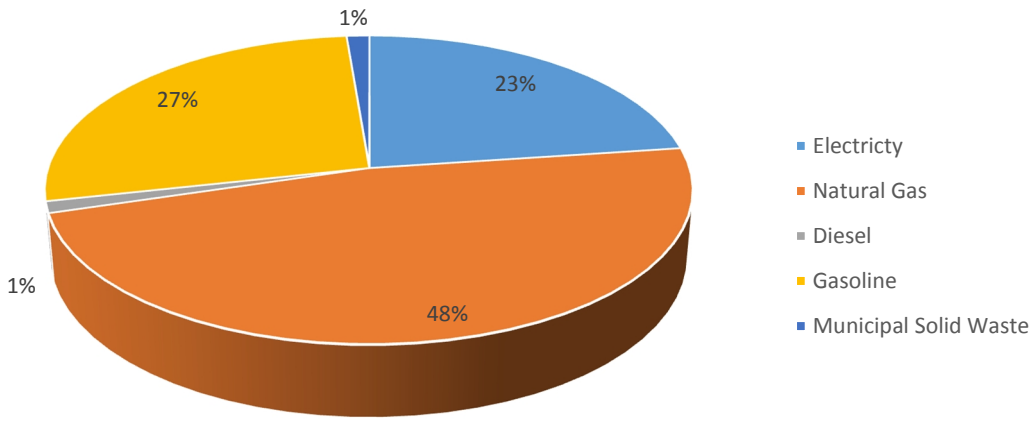


Figure 17: City of Guelph GHG Emissions by Source (2014 data) [15]

2.3 City of Guelph Energy Sources

Energy sources powering the City include gasoline, diesel, electricity, natural gas, solar photovoltaic, and biogas (landfill or digester biogas). The significant energy sources remain electricity, natural gas, and gasoline.

With Ontario completing its phasing out of coal plants in 2014, the supply mix powering the electricity grid in the province has changed significantly and is now more sustainable. Ontario's installed generation capacity stands at 35,951 MW [16]. The current supply mix include nuclear, gas, hydro, and renewables such as wind and solar as well as biofuels (see Figure 18). Based on the list of generation projects of 20MW or more that have been commissioned over the last three years and scheduled to come into service in the next 18 months (that is until Q4, 2017), almost all of which are either hydro, wind, or solar projects, it is anticipated that, going forward, the electricity grid mix supplying Ontario (and also Guelph) will continue to become more sustainable.

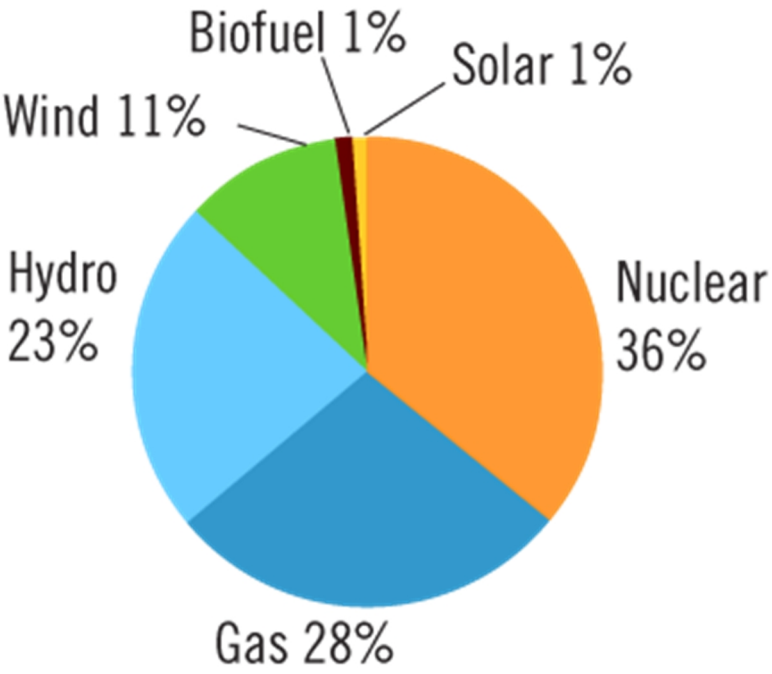


Figure 18: Ontario's Current Electricity Grid Supply Mix [16]

At present, biogas generated electricity (produced at the Eastview Landfill Gas Plant) and solar photovoltaic sourced electricity are the major renewable energy sources in Guelph [4]. In 2012, Guelph met 0.96% of its electricity consumption from renewable sources through producing around 16 million kWh of electricity. In 2015, the Eastview biogas plant generated 8,326 megawatt hours of low carbon energy from the produced landfill gas, while rooftop solar installations operated by Guelph Hydro Electric Systems Inc. and Envida Community Energy Inc. (part of Guelph Municipal Holdings Inc. portfolio) generated more than 200 megawatts of electricity for the Ontario grid [8]. In total, 350 solar installations across Guelph and Rockwood generated 1,784 megawatt hours of electricity in 2015 [8]. This includes 33 installations under the FIT program and 319 installations under the MicroFIT program. Average system size for the latter is around 6kW. The capacity factor (ratio of actual power generation typically over a year by the installed capacity) of solar photovoltaic installations in the City is approximately 16% [4].

The Eastview Landfill Gas Energy Plant (see Figure 19), supplied by landfill gas produced at the Eastview Landfill site owned and operated by the City, commenced operation in 2005. Besides the fact that a landfill's capacity to generate biogas declines with time, the decline at the Eastview site was faster than projected. Against this background, the nameplate capacity and Ontario Power Authority contracted capacity for the Eastview facility has been reduced to 1.85MW and 1.7MW respectively since 2012 [6]. The facility is expected to generate power under the current contracted capacity until 2024. The City's wastewater treatment plant accommodates a cogeneration facility that uses methane to produce electricity for the plant.

One of goals under the CEI is a focus on using locally generated alternate energy sources (at least 25% of the City's energy use) and reducing peak energy demand in summer by at least 40% by 2031 [4]. In context of the above (landfill gas as a declining energy resource and solar photovoltaic having one of the lowest capacity factors among renewables), it is key that the number of solar installations in the City is significantly incremented and the feasibility of other renewable sources of energy explored.

Figure 19: Eastview Landfill Gas Energy Plant Photos [7]

2.4 Public Transit & Alternate Transport Choices in the City

Public transit[5], through substituting the use of personal vehicles, is an essential component of any GHG reduction strategy in the City. Guelph Transit is served by a fleet size of 72 vehicles powered by bio-diesel covering 22 routes across the City [33], [56]. In 2014, the fleet logged 4.5 million kilometers, operating seven days a week from 5.45 a.m. to 12.45 a.m. with reduced operational hours (9 a.m. to 6.45 pm) on Sundays and holidays [56]. Public transit ridership in the City now stands at 6.9 million passengers (based on 2001 data, 20% was attributed to work and 20% to discretionary trips [33]) with students making up around 60% of ridership [56]. Weekday ridership is around 22,300 dropping to around 13,000 on Saturdays, and around 8000 on Sundays. Guelph Central Station, the multi-modal transportation terminal in downtown Guelph, is served by other third party transporters including GO Bus, GO Train, VIA Rail, and Greyhound offering intercity services east and west bound.

In 2001, the percentage of trips using alternate modes such as walking, cycling, and transit was around 16.6% (see Figure 20) [33]. As mentioned earlier, trips using auto mode still constitute the majority of trips in the City. Commuter trips in the City include trips to work, discretionary trips such as for shopping, and trips that do not start or end at one's place of residence. Based on data from 2001, majority of the trips (75%) were made within the City and

[5] Reference will be made to the most recent Transportation Tomorrow Survey data for transportation mode shares and statistics during Phase 2 work.

around 55% of commuters had a travel trip less than 5km. Figure 20 also provides a distribution of trip purposes and the corresponding transportation mode, based on the 2001 survey data.

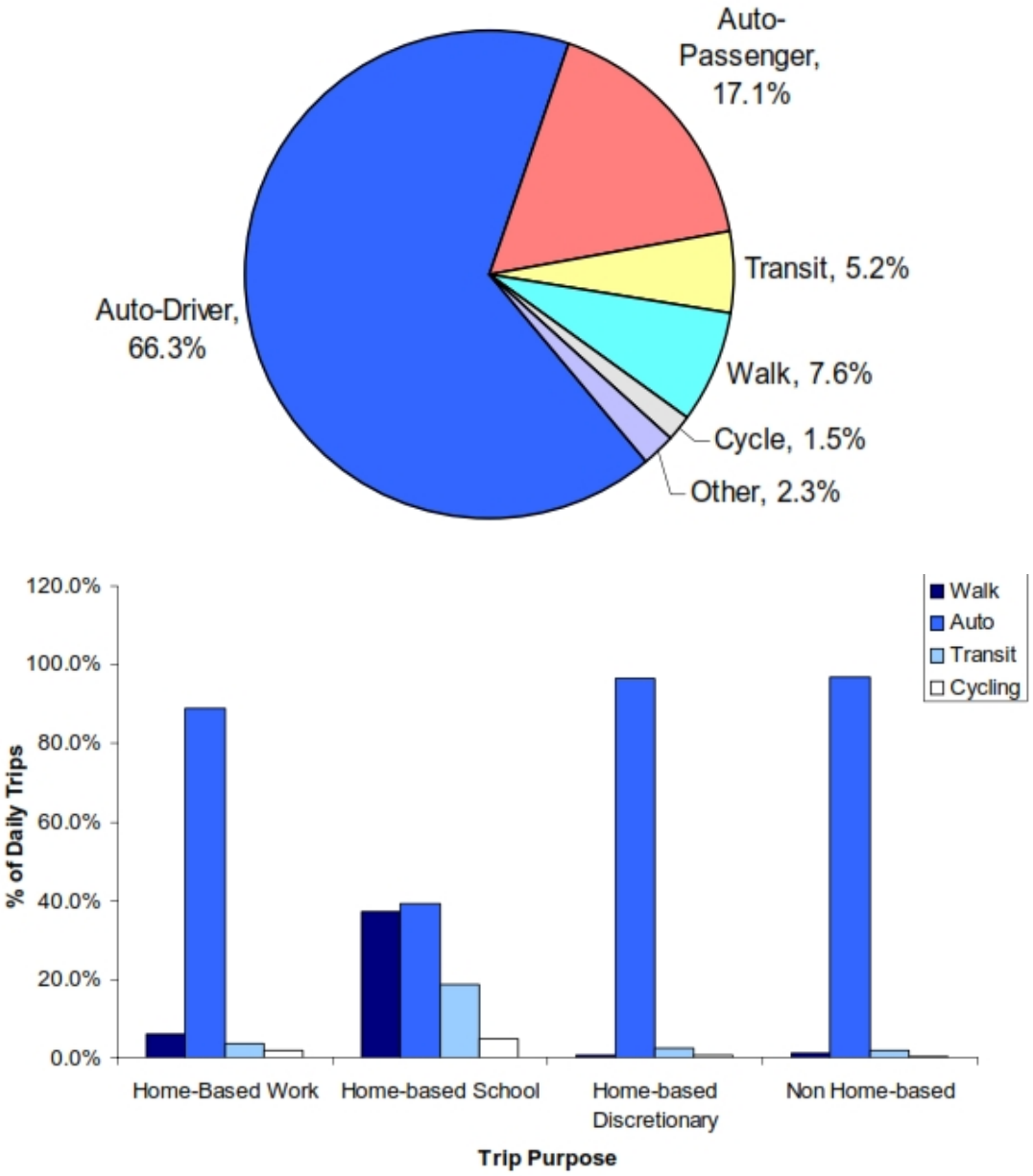


Figure 20: 2001 Modal Share & Trip Purposes [33]

The on-road cycling network now totals 122.73 lane-kilometers of on-road cycling facilities (as of end of 2016).Based on information presented in the Guelph Cycling Master Plan[6], over 90% of trips by bicycle are under 5km (average 2.6km). The distribution between the various

[6] According to the City, an update to the Cycling Master Plan is planned in the next 1-2 years, reflecting improved cycling facility design guidelines and bicycle parking guidelines.

purposes for cycling, based on a 2009 survey in the City, was purely utilitarian (11%), purely recreational (55%) and the rest classified as a mix of both [34].

2.5 City of Guelph Water Usage

The WSMP Update Report published in May 2014 presents information related to water consumption, trends, and forecasts for the City, some of which are listed below [31]:

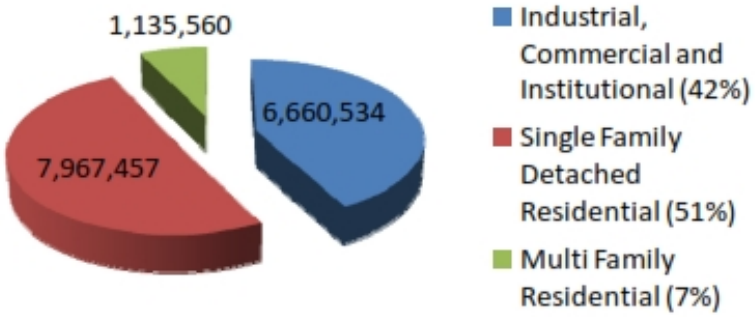
- There is variability in water demand across end users in the different categories; relatively, the variability was observed to be smallest among residential customers and highest among industrial and commercial customers (133 ICI sector customers and 71 largest multi-residential accounts consumed 80% of the overall sector demand [32]);
- Within the residential sector, variability was reported to be still significant with 21% of the low end users consuming less than 25% of the water used by the largest 3% of high end users;
- A downward trend in water demand is observed across all the sectors over recent years, one of the key contributory factors being adoption of water efficient technology;
- While the per capita demand of water declined at a rate of 3% since 2006, it was concluded in the Update report that it was unlikely for this decline rate to be sustained going forward;
- The baseline demand used for future scenario mapping in the update report were 180 liters per capita per day (Lcpd) for the residential sector and 286 Lcpd for the employment sector (consisting of institutional, commercial, and industrial);
- Based on the design per capita demand values and assuming no reduction from further conservation initiatives (that is status quo with conservation initiatives in the City), the projected average day water demand from 2013 to 2038 was estimated and summarized as below:

Year	Population			Demand by Sector			NRW (m^3/d)	Average Water Demand (m^3/d)
	Resid.	Employ.	Total Equiv.	Resid.	Employ.	Total		
2013	130,670	66,730	197,400	23,536	19,059	42,595	5,658	48,253
2018	143,480	73,874	217,354	25,843	21,100	46,943	6,175	53,117
2023	156,290	81,017	237,307	28,150	23,140	51,290	6,691	57,982
2028	168,190	90,340	258,530	30,293	25,803	56,096	7,208	63,305
2033	178,464	96,947	275,411	32,144	27,690	59,834	7,628	67,462
2038	186,299	99,480	285,779	33,555	28,413	61,969	7,903	69,872

Figure 21: Average Day Water Demand [31] (NRW stands for non-revenue water)

- As of December 2013, an annual average day water production decrease of 14% was observed since 2006, with majority of this (>80%) attributed to the City's water conservation programs.

Relevant water usage and trends data from the WCES Update (May, 2009) was also reviewed and is discussed here. In the ICI sector, based on the consumption of the top 133 ICI sector firms in 2007, over 88% was for process water, while the share of domestic water use and water use in the products was estimated as 7.5% and 4.5% respectively (see Figure 22) [32]. Note that a 2016 Water Efficiency Strategy Update report is now complete and will be referred to during Phase 2 work.



Sector	2007 Billed (m^3)	% of Total Billed	Population	Lcpd
Single Family	7,967,457	51%	94,745	230
Multi Family	1,135,560	7%	20,295	153
ICI	6,660,534	42%		

Figure 22: 2007 Guelph Water Demand Profile [32]

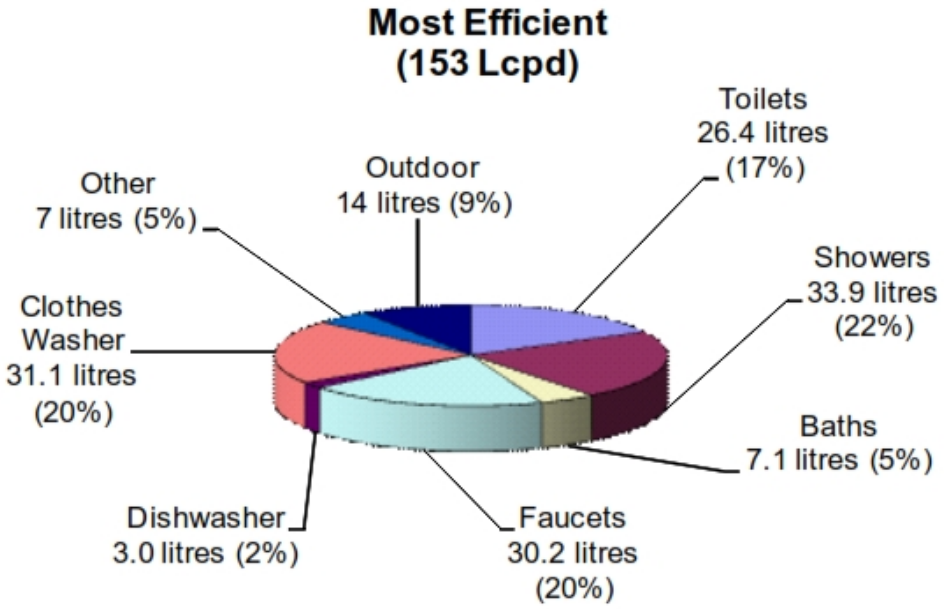


Figure 23: Most Efficient Home Water Demand Profile [32]

To support scenario mapping, a most efficient house model (153 Lcpd achieved) was developed in the WCES Update report (see Figure 23). This house model was envisaged to be outfitted with water consuming fixtures and appliances as follows:

- Toilet with average flush rates of 4.8 liters (high efficiency toilets – HETs);
- Showerheads with flow rates of 9.4 liters per minute;
- Faucets with flow rates of less than 8.35 liters per minute;
- Energy Star front loading washing machines;
- Water efficient water softeners and humidifiers;
- Reduced leakage with new plumbing materials and construction techniques; and
- Water efficient landscaping.

The water demand profile for the 'most efficient house model' is depicted in Figure 23 above. Additionally, water demand profiles for sample homes which went beyond the 'most efficient home' model through rain water harvesting (112 Lcpd achieved) was also modelled in the WCES Update and is presented in Figure 24 .

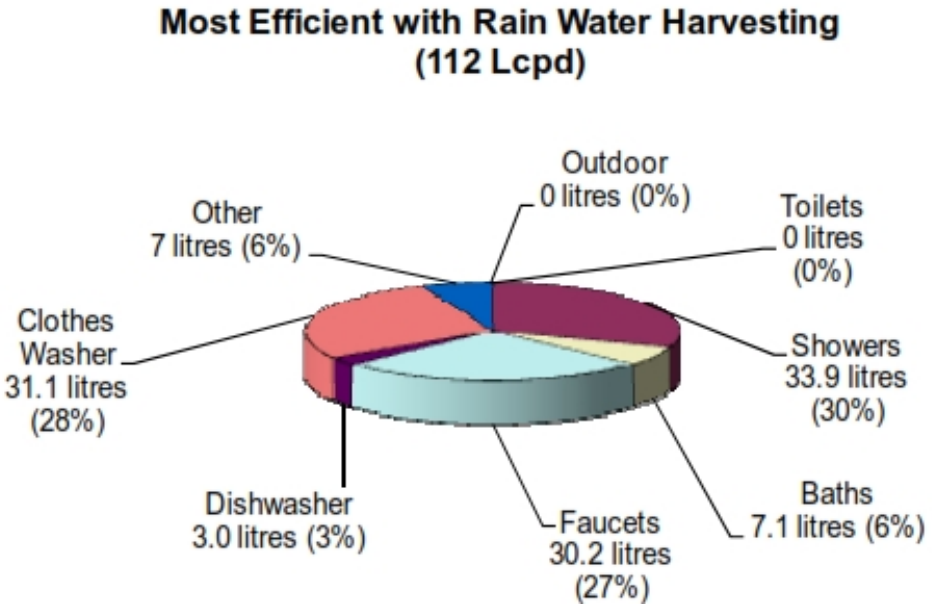


Figure 24: Most Efficient Home with Rain Water Harvesting Water Demand Profile [32]

The water supply and distribution system is one of the significant energy consumers under the City's portfolio. The City currently does not have an automated water metering system [24]. A smart water network, which includes the installation of permanent District Metered Areas (DMAs), is work in progress in the City [23]. The adoption of DMAs, which essentially involves dividing the network into smaller sectors (with at the most 3000 connections), is regarded as a Best Management Practice for water loss reduction [24]. The City also conducts annual leak detection surveys as part of its water loss management strategy. These efforts are expected to translate to energy savings owing to reduced pumping requirements.

3 Draft Technical Work Plan for Phase 2

Based on the review of background documents, including the City's CEI and Official Plan and recent provincial plans such as the CCAP, discussed and summarized under Section 1 of this report, it is established that, at a high level, the key priority energy/water conservation and efficiency, and energy management related action items for the Clair-Maltby new community development are:

- A site that offers a mix of land uses;
  - 30% of all new residential units to be affordable housing
- A site developed at density levels as guided by policy;
  - At a minimum, supporting 50 residents and jobs per hectare
  - At a minimum, developed at public transit supportive density levels
- Land use pattern that supports viability for district energy implementation;
  - Considerations for pre-service for underground infrastructure that needs to be in place to support potential future DES implementation
- Urban site design that encourages alternative mode of transportation;
  - Public transit facility with consideration as well for Inter-City bus services
  - Network of cycling facilities
  - Car share service
  - Pedestrian-friendly road network and design of cross-sections and intersections
  - End-of-trip facilities, bike parking stations
  - Well-connected multi-modal transport
- A site with reduced energy and water consumption and reduced carbon footprint;
  - Reducing potential summer peak demand
  - Built form energy and water efficiency (ENERGY STAR®, LEED, Net Zero Ready)
  - LED street lighting
  - DMA implementation in water distribution network
- A site whose energy demand is met to some degree from alternative/renewable energy sources;
  - Deriving some of the base heat load from biomass sources
  - Sourcing part, if not all of the energy demand from solar photovoltaic roof panels on buildings
- Infrastructure in place to support smart metering of water and energy usage;
- A site that facilitates increased adoption of ZEVs.
  - Adequate charging stations in parking lots
  - Charging receptacle in vehicle garages

Amec Foster Wheeler's proposed framework in developing the draft technical work plan for the Clair-Maltby EOU study component factors in land use considerations (density, land use mix), transportation mode choices, building and site design, and energy using equipment considerations (vehicle type, appliances) for the SPA. The technical work plan and the

associated energy and emission scenario mapping plan is well informed by the various action items and new community attributes listed above under Section 3.

The key steps of the proposed technical work plan are presented in **Table 10** below.

Table 10: Technical Work Plan - Clair-Maltby EOU Study Component

Step no.	Step Description	Task
1	**Defining Clair-Maltby Community Attributes**	During Phase 2 of the Secondary Plan study process, conceptual *community structure alternatives*, informed by a Community Visioning Exercise, will be developed. Further, multiple stakeholders including the consultant team and the City, will provide inputs as the various *community structure alternatives* are considered. Inputs from the study lead for the EOU study component will include energy/water footprint aspects for the various land use categories and any other relevant inputs from a sustainability perspective. It is anticipated that up to three *community structure alternatives* will be shortlisted during the Secondary Plan process. Community attributes are to be defined for each of the proposed *community structure alternatives*. The attributes relevant to the EOU study component will include: ▪ Characteristics for various land use categories; • Residential o Low density o Medium density o High density • Commercial (Floor Space Index, etc.) o Office o Retail o Recreation • Institutional • Municipal Facilities • Vacant • Park ▪ Percentage distribution between built space and that reserved for streets, parking, public spaces, and rights-of-way combined; ▪ Street lighting (linear density of streets, linear density of street lighting).
2	**Receiving ArcMap GIS data**	It is anticipated that up to three *community structure alternatives* will be established during the Secondary Plan study process. The land parcel information (land use categorization / zoning) in GIS format, for the three *community structure alternatives* will form the basis for the energy modelling component of the technical work plan.

Step no.	Step Description	Task
3	**Modelling Baseline Energy Use – Built Form**	For each of the *community structure alternatives,* a business-as-usual (BAU) scenario will be established for energy use and GHG emissions associated with the various land use categories. The system boundary for the analysis will be the SPA boundary. The scenario mapping will have the following features and outcomes: • The energy baseline of the different land use categories will be established based on built forms constructed to the most recent version of OBC 2012 (January 2017 update); ○ Energy use intensity values for electricity (kWh/m^2) and natural gas (BTU/m^2) will be assigned to the respective building types informed by typical values for representative buildings to be established through stakeholder consultation and research; • Energy use per street light fixture will be assigned based on engineering estimates; • Appropriate GHG emission factors will be assigned for electricity and natural gas; • Based on all the above, dispersion of energy usage and GHG emissions among the different sectors as well as among the different energy sources will be established; • A Geographical Information System (GIS) platform will be used to produce energy use spatial trends and patterns and identify energy hot spots for the SPA. The maps will be produced using ArcGIS.
4	**Modelling Baseline Energy Use – Transport**	For each of the *community structure alternatives*, a BAU scenario for transport use by the community, informed by relevant data from the City, and where not available, substituted by statistical data from the 2009 Canadian Vehicle Survey, will be established for energy use and GHG emissions. The system boundary for the analysis will be the SPA boundary. The scenario mapping will have the following features and outcomes: • Only light vehicle usage by the community will be considered; • Number of light vehicles per household will be assigned; • All light vehicles in use by the community will be assigned as new purchases (made in 2017); • The light vehicle fleet composition will be defined between two categories, cars and light trucks; • The light vehicle fuel type distribution will be assigned (that is between gasoline, diesel, and electric); • Fuel mileage values[7] will be assigned for the respective vehicle category using data for selected representative vehicle models (most fuel efficient 2016 model year vehicles) as established from NRCan's 2016 Fuel Consumption Guide; • Tailpipe emissions will be assigned for the selected vehicle models; • Based on the above, energy usage and GHG emissions related to auto mode transport by the community will be established.
5	**Modelling Baseline Water Use**	For each of the *community structure alternatives*, a BAU scenario for water usage will be developed for the built form. Water use intensity values will be assigned to the respective building types based on sector-wise liters per capita per day data provided in the WSMP Update Report and fixture/appliance standards will be guided by requirements in the latest version of OBC 2012 (January 2017 update).
6	**Stakeholder Engagement**	This step is an engagement component and is envisaged to be an interactive process with the various stakeholders (meetings with City departments, utilities, builders in Guelph, sector associations) by Amec Foster Wheeler to collate up to date information about potential opportunities, strategies, and priorities for the built form related to energy and to obtain feedback on considerations made for

[7] NRCan has a list of most fuel-efficient model year 2016 vehicles (across the different classes) sold in Canada[37]. NRCan's 2016 Fuel Consumption Guide will provide fuel consumption levels for the selected representative vehicles[38]. The fuel consumption reported for combined urban and highway driving (55% city driving and 45% highway driving) and associated tailpipe emissions will be used.

Step no.	Step Description	Task
		the EOU study component. As the study progresses, we will seek the City's guidance on the City departments that need to be involved for this task. Further to the stakeholder meetings, Amec Foster Wheeler will prepare a technical memo documenting the relevant stakeholder inputs which is to inform the subsequent higher efficiency scenario modelling exercise.
7	**Modelling Higher Energy & Water Efficiency Case – Built Form**	For each of the *community structure alternatives*, against the respective BAU scenario developed for the built form, a higher level of energy efficiency strategies will be applied. This will include measures such as construction on site conforming to alternative construction standards (ENERGY STAR® and Net Zero Ready) etc. To ascertain the energy impact of applying a higher level of energy efficiency, dispersion of energy usage and GHG emissions will be re-established for the different sectors as well as for the different energy sources and a comparative assessment made with the BAU scenario. Corresponding spatial trend maps will also be produced in digital ArcMap GIS. A list will also be prepared of applied energy efficiency strategies. Amec Foster Wheeler will refer to the City's 2016 Water Efficiency Strategy Update report in establishing the water efficiency measures to be applied to the BAU scenario. Additionally, a comparison will be made between the BAU scenario and an improved water efficiency level (specific to the residential sector) that applies to the built form a City program (Blue Built Home Program administered by the City which will now transition from the existing three-level certification to a single level program) where rebates are offered for a variety of water saving fixtures and appliances to new homes if they achieve indoor demands of no more than 150 litres per capita per average day . Further source water protection and water efficient irrigation and landscaping measures will also be considered.
8	**Modelling Higher Energy Efficiency Case – Transport**	For each of the *community structure alternatives*, against the respective BAU scenario developed for automotive mode transportation, two levels of improvement will be applied (not concurrently), one that assumes an increased uptake of ZEVs by the community resulting in a ZEV fleet composition of 5%, and a second level that assumes percentage of trips using alternate modes of transport. For the second level, alternative transport would involve considering a status-quo (current mode share), medium-high (25%) and a high (30%) target mode split. Energy usage and GHG emissions related to automotive mode transport by the community will be re-established for the two improved levels and a comparative assessment made to the BAU scenario.
9	**Checkpoint - I**	Post the modelling exercise for the various scenarios, the City will be consulted in establishing the best way to visually communicate the modelling results.
10	**Comparative Assessment of Modelling Results for the Community Structure Alternatives**	Results from the various scenario mapping, corresponding to the modelling of the different *community structure alternatives*, will be summarised and a comparative assessment made (based on achieved energy/water savings and GHG reductions) covering the reduction measures applied. This exercise will inform the development of the *Preferred Community Structure Alternative*.
11	**Modelling Refinement of Preferred Community Structure Alternative**	Based on the selected *Preferred Community Structure Alternative*, the modelling will be updated to determine the energy performance and GHG impact of the endorsed Preferred Community Structure Alternative. Feedback from deliberations over the *community structure alternatives* will be incorporated into the refined modelling.
12	**Checkpoint - II**	The City will be engaged at this stage to establish the reporting structure prior to preparation of the draft report.
13	**Draft & Final Reporting**	A draft report will be prepared presenting the energy and emissions forecast maps, results from the various scenario mapping, comparative assessment results, recommended measures to reduce energy impact and GHG emissions, and guidelines on implementing these measures. The draft report will be submitted by Amec Foster Wheeler to the City for review and feedback following which a final report will be released. The final report will ultimately inform the development of the MESP & Secondary Plan.

The basis of the proposed technical work plan involves receiving additional information from the City. **Table 11** identifies the information gap for the proposed work plan.

Table 11: Information Gap

Task	Information required	Source of currently available information	Identified information gap	Source for addressing information gap
Defining Clair-Maltby Community Attributes	% distribution between built space and that reserved for streets, public spaces, and rights-of-way combined	Nil	Yes	The Secondary Plan Process
	% distribution between the various land use categories (residential, commercial, institutional, municipal, vacant, park)	Nil	Yes	The Secondary Plan Process
	Proposed build density (per hectare basis)	At a minimum supporting 50 residents and jobs per hectare (guided by policy)	If more robust data is available, that will help.	The Secondary Plan Process
Defining light vehicle transportation data	Number of light vehicles per household; Light vehicle fleet composition (% distribution between cars and light trucks); Light vehicle fuel distribution (% distribution between gasoline, diesel, PHEVs, ZEVs); Number of vehicle-kilometers and passenger-kilometers.	2009 Canadian Vehicle Survey	Any available latest data from the City would allow for more representative data to be used for the scenario mapping. Data that formed the basis of quantifying the 2014 GHG emissions associated with the transportation sector in the City is requested.	The City
Defining building energy intensity levels	Electricity and natural gas use intensity values for various types of built forms (ideally data from buildings that conform to the latest update (January 2017) of the OBC 2012) Built forms include: *Residential* ○ Single Detached + Semi-Detached + Row Houses ○ Apartments (3 stories or less) ○ Apartments (> 3 stories) *Commercial* ○ Office ○ Retail ○ Recreation ○ etc. *Institutional*	General literature data for Ontario	If data could be arranged from the respective utilities for electricity and natural gas usage for a sample of 25 to 50 buildings for each built form type, but only covering buildings from recent vintage (we assume this will have been built to the latest OBC 2012 update), it would ensure a very robust analysis. Dataset that formed the basis of quantifying the 2014 GHG emissions associated with the residential and commercial sectors in the City is requested.	Guelph Hydro, Union Gas

Task	Information required	Source of currently available information	Identified information gap	Source for addressing information gap
On-going study updates	Any available update that needs to be considered for: Update to the CEI	Nil		The City

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