

2022 Community Energy Use and Greenhouse Gas Emissions Inventory



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ClimateAction



Land Acknowledgement

We acknowledge that we are gathered today on the traditional lands of the Anishinaabek (AUh-nish-in-ah-bek), Haudenosaunee (Ho-den-no-show-nee), Lūnaapéewak (Len-ah-pay-wuk) and Attawandaron (Add-a-won-da-run).

We acknowledge all the treaties that are specific to this area: the Two Row Wampum Belt Treaty of the Haudenosaunee Confederacy/Silver Covenant Chain; the Beaver Hunting Grounds of the Haudenosaunee NANFAN Treaty of 1701; the McKee Treaty of 1790, the London Township Treaty of 1796, the Huron Tract Treaty of 1827, with the Anishinaabeg, and the Dish with One Spoon Covenant Wampum of the Anishnaabek and Haudenosaunee.

This land continues to be home to diverse Indigenous peoples (First Nations, Métis and Inuit) whom we recognize as contemporary stewards of the land and vital contributors to society. We hold all that is in the natural world in our highest esteem and give honor to the wonderment of all things within Creation. We bring our minds together as one to share good words, thoughts, feelings and sincerely send them out to each other and to all parts of creation. We are grateful for the natural gifts in our world, and we encourage everyone to be faithful to the natural laws of Creation.

The three Indigenous Nations that are neighbours to London are the Chippewas of the Thames First Nation; Oneida Nation of the Thames; and the Munsee-Delaware Nation who all continue to live as sovereign Nations with individual and unique languages, cultures and customs.

This Land Acknowledgement is a first step towards reconciliation. It is the work of all citizens to steps towards decolonizing practices and bringing our awareness into action. We encourage everyone to be informed about the traditional lands, Treaties, history, and cultures of the Indigenous people local to their region.



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1. Purpose of this Document

The purpose of this document is to provide an overview of:

- energy consumption in London (a high-level inventory of energy use) during the period 1990 to 2022;
- associated greenhouse gas (GHG) emissions; and
- energy expenditures in London.

On April 23, 2019, the following was approved by Municipal Council with respect to climate change:

Therefore, a climate emergency be declared by the City of London for the purposes of naming, framing, and deepening our commitment to protecting our economy, our eco systems, and our community from climate change.

London's Climate Emergency Action Plan (CEAP) was approved by Council in April 2022. Within the CEAP, listed under Area of Focus 10 – *Measuring, Monitoring and Providing Feedback* workplan, actions for the City of London include:

- 1.a. Continue to provide Londoners with the latest information on local greenhouse gas emissions and the expected impacts of climate change.
- 3.c. Provide Municipal Council with a report on community wide and corporate GHG emissions on an annual basis.
- 3.d. Provide the public with an easy-to-find and easy-to-use platform(s) and visuals for presenting information on Climate Emergency Action Plan implementation progress, community-wide GHG emissions, corporate GHG emissions, and progress on adaptation measures being undertaken.

This document is the measurement tool to highlight London's progress towards meeting its community energy reduction and GHG emissions reduction targets along with other targets and directions.

The City of London also reports this information on an annual basis to Carbon Disclosure Project (CDP) Cities and the Global Covenant of Mayors for Climate & Energy.

A complete listing of previous reports is found in Section 3.

2. Background

The City of London does not have direct control over how much energy is used in London, but it does have influence. The control over energy use in London rests primarily with citizens, visitors, employers, and employees. Individual and collective action with respect to sustainable energy use, energy management, and energy conservation is critical for our future.

There are many factors that influence how much energy a city uses to function and thrive:

Land use and urban development – planning city growth sets the framework for how much energy is needed for a city to function. Mixed density balances the energy-efficiency of higher-density and social demand for living space. Mixed land use reduces the distance people and goods need to travel.

Urban design – urban design can either negate or enhance the energy efficiency benefits of good functional planning (mixed land use and mixed density). This includes design factors such as connectivity between city blocks, streetscape design, and street orientation.

Transportation – transportation planning accounts for the movement of people and goods. In an ideal world, you would minimize the interactions between the two. However, the reality is that a city's transportation network often must serve both needs at the same time. An energy-efficient transportation system is one that provides several competitive choices for the movement of people and goods.

Buildings – The design, construction, and maintenance of all building types (homes, office buildings, commercial, institutional, and industrial buildings) have a significant impact on the energy consumed by buildings. New buildings can be designed that approach net-zero energy use, but most of London's buildings are old, inefficient designs that often have unseen problems with their insulation and draft-proofing. Building type can also affect energy use and associated emissions. Building energy modelling done for the London Energy Efficiency Partnership (LEEP) Project indicates the following:

- Single-family residential buildings (detached, semi-detached and row housing) require more energy for winter space (interior) heating than for summer space (interior) cooling;
- Conversely, commercial office buildings require more energy for summer space cooling than for winter space heating; and
- Multi-unit residential buildings generally have a balance between annual space heating and space cooling energy demand.

Personal choices and actions – Design and technology has its limits. For example, a programmable thermostat has no energy conservation benefit if its user does not program it. Social norms are a powerful influence on people's behaviour.

Local economy – the nature of the economic base will influence how much energy it will use. For some businesses, energy use is a minor cost. For others, energy bills can make the difference between profit and loss. For many local employers, there are opportunities for energy conservation, energy-efficiency, and renewable energy generation waiting to be developed.

Leadership – Spoken words, commitments, and actions drive change and influence both residents and other leaders. Actions taken by leaders in the business, institutional, government and our communities with respect to energy conservation, reducing the use of fossil fuels, reducing GHG emissions, and adapting to climate change will inspire others to act.

Seasonal weather variations can affect energy use and associated emissions. London's climate is one that is dominated by heating demand during cold weather months. On average, the heating season starts in late September and ends in May. With climate change, energy demand for heating is expected to fall.

The energy demand for space cooling (i.e., air conditioning) in London is relatively small compared to space heating. However, on a hot summer day, a typical household's electricity demand will be three times greater than a cool summer day. This short term "peak demand" places strain on Ontario's electricity generation and supply system. With climate change, the energy demand for air conditioning is expected to increase.

3. Previous Inventory Reports

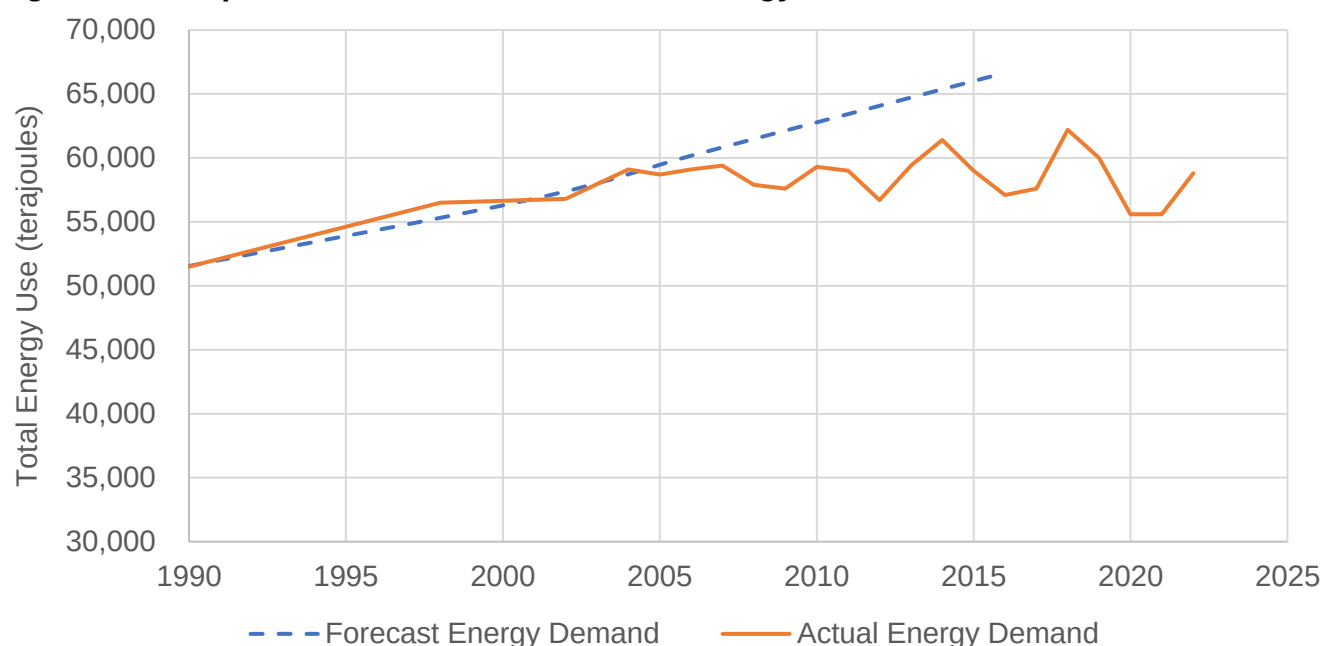
The following is a list of the previous energy inventory reports that have been prepared for London:

- *2020 Community Energy & Greenhouse Gas Inventory*, published on the City of London's Get Involved London website in August 2021.
- *2019 Community Energy & Greenhouse Gas Inventory*, published on the City of London's Get Involved London website in December 2020.
- *2018 Community Energy & Greenhouse Gas Inventory*, prepared by the City of London for the Civic Works Committee in October 2019.
- *2017 Community Energy & Greenhouse Gas Inventory*, prepared by the City of London for the Civic Works Committee in August 2018.
- *2016 Community Energy & Greenhouse Gas Inventory*, prepared by the City of London for the Civic Works Committee in August 2017.
- *2015 Community Energy & Greenhouse Gas Inventory*, prepared by the City of London for the Civic Works Committee in June 2016.
- *2014 Community Energy & Greenhouse Gas Inventory*, prepared by the City of London for the Civic Works Committee in May 2015.
- *2013 Community Energy & Greenhouse Gas Inventory*, prepared by the City of London for the Civic Works Committee in July 2014.
- *2012 Community Energy & Greenhouse Gas Inventory: Challenges & Opportunities*, prepared by the City of London for the Civic Works Committee in October 2013.
- 2011 data was highlighted in the *Environmental Programs Update*, prepared for the Civic Works Committee meeting in May 2012.
- *2008 Energy Use Inventory Report*, prepared by the City of London for the Environment and Transportation Committee in July 2010.
- *2007 Energy Use Inventory Report*, prepared by the City of London for the Environment and Transportation Committee in May 2008.
- *2006 Energy Use Inventory Report*, prepared by the City of London for the Mayor's Sustainable Energy Council in November 2007.
- *1998 Air Emissions and Energy Use in the City of London*, prepared for the London Energy/Air Emissions Reduction Strategy Task Force in March 2000.
- *1990 City of London Air Emissions Study*, prepared by SENES Consultants in association with Proctor and Redfern Limited and Torrie Smith Associates for Vision '96 in September 1995.

4. Community Energy Use

Total energy use in London in 2022 was 58,800 terajoules¹, 14 per cent above 1990 levels, and the same as 2005 levels. As seen from Figure 1, since the mid 2000s, London's total energy use has dropped below the forecasted "business as usual" track forecasted in the 1990s. This illustrates the impact that energy conservation activities over the last 15 years have had decoupling energy use from growth.

Figure 1 - Comparison of Forecast vs. Actual Energy Demand for London



The COVID-19 pandemic continued to have an impact on energy used in London, with overall total energy use in 2021 being two per cent lower than pre-pandemic levels in 2019, as shown in Figure 1 above and Table 1 below.

The main impact was seen in transportation energy use, which was 12 per cent lower than 2019 overall because of many London workplaces shifting to work from home as well as reduced discretionary trips associated with stay-at-home orders and similar restrictions.

Energy used by London's industrial, commercial, and institutional sector increased by seven per cent from the previous year.

Energy used in London's single-family homes was up by six per cent from the previous year. Natural gas use in homes was the main reason, with an increase of ten per cent from the previous year due to colder winter weather increasing the demand for space heating.

¹ A terajoule (or, one trillion joules) is a metric unit for measuring energy, and is approximately equivalent to the energy provided by burning 26,000 litres of gasoline (roughly the amount of gasoline in 500 cars)

Table 1 – 1990-2022 Total Community Energy Use by Sector (Terajoules per Year)

Sector	1990	2005	2019	2022
Transportation	18,200	20,200	21,200	18,800
Residential	13,100	14,800	14,600	14,500
Industrial, Commercial & Institutional (IC&I)	20,200	23,800	24,200	25,600
Total	51,500	58,700	60,000	58,800

NOTE: due to rounding of numbers, individual numbers may not add up to the total

London's industrial, commercial, and institutional buildings and facilities accounted for 43 per cent of all energy used in London (Table 2). London Hydro and Enbridge include multi-unit residential buildings (apartment buildings and condominiums) under the category of commercial buildings. Transportation accounted for 32 per cent of all energy used in London, most of which was associated with personal vehicle use. Single family residential homes accounted for 24 per cent of all the energy used in London.

Table 2 – 1990-2022 Share of Community Energy Use by Sector

Sector	1990	2005	2019	2022
Transportation	35%	34%	35%	32%
Residential	25%	25%	24%	25%
Industrial, Commercial & Institutional (IC&I)	40%	40%	40%	43%

The community energy model developed by the Canadian Urban Institute for the Integrated Energy Mapping for Ontario Communities project, combined with latest provincial Broader Public Sector (BPS) energy data (2020 data), was used to estimate a more-detailed breakdown of energy use by building type, as shown in Table 3.

Table 3 – 2022 Estimated Breakdown of Energy Use by Subsector (Terajoules per Year)

Sector	Sub-sector	Energy Use
Transportation	Fuel sold at gas stations	12,500
Transportation	Road freight transport	3,600
Transportation	Corporate fleets	1,100
Transportation	London Transit	300
Transportation	Railway freight transport	600
Transportation	Domestic aviation	600
Residential	Low-density homes	12,000
Residential	Medium-density townhomes	2,400
Industrial, Commercial & Institutional	High-density residential buildings	1,500
Industrial, Commercial & Institutional	Commercial – office buildings	3,200
Industrial, Commercial & Institutional	Commercial – retail (e.g., malls)	5,500
Industrial, Commercial & Institutional	Industrial	11,300
Industrial, Commercial & Institutional	Institutional - schools	500
Industrial, Commercial & Institutional	Institutional - hospitals	1,200
Industrial, Commercial & Institutional	Institutional - colleges & universities	1,500
Industrial, Commercial & Institutional	Institutional - municipal	400
Industrial, Commercial & Institutional	Other	500

Over the 1990-2022 period, London's population has increased by 42 per cent. In 2022 alone, London's population was estimated to have increased by three percent. Energy use per person in London was 135 gigajoules (GJ) per year in 2022, down 19 per cent from the 2005 baseline and 1990 levels as well (Table 4).

Table 4 – 1990-2022 per Person Energy Use by Sector (Gigajoules per person)

Sector	1990 (Pop. 307,000)	2005 (Pop. 349,000)	2022 (Pop. 435,000)	Change from 1990
Transportation	59	58	43	-27%
Residential	43	42	33	-22%
Industrial, Commercial & Institutional (IC&I)	66	68	59	-11%
Total	168	168	135	-19%

NOTE: due to rounding of numbers, individual numbers may not add up to the total

Figure 2 – Change in Energy Use in London, Per Person by Sector Since 1990

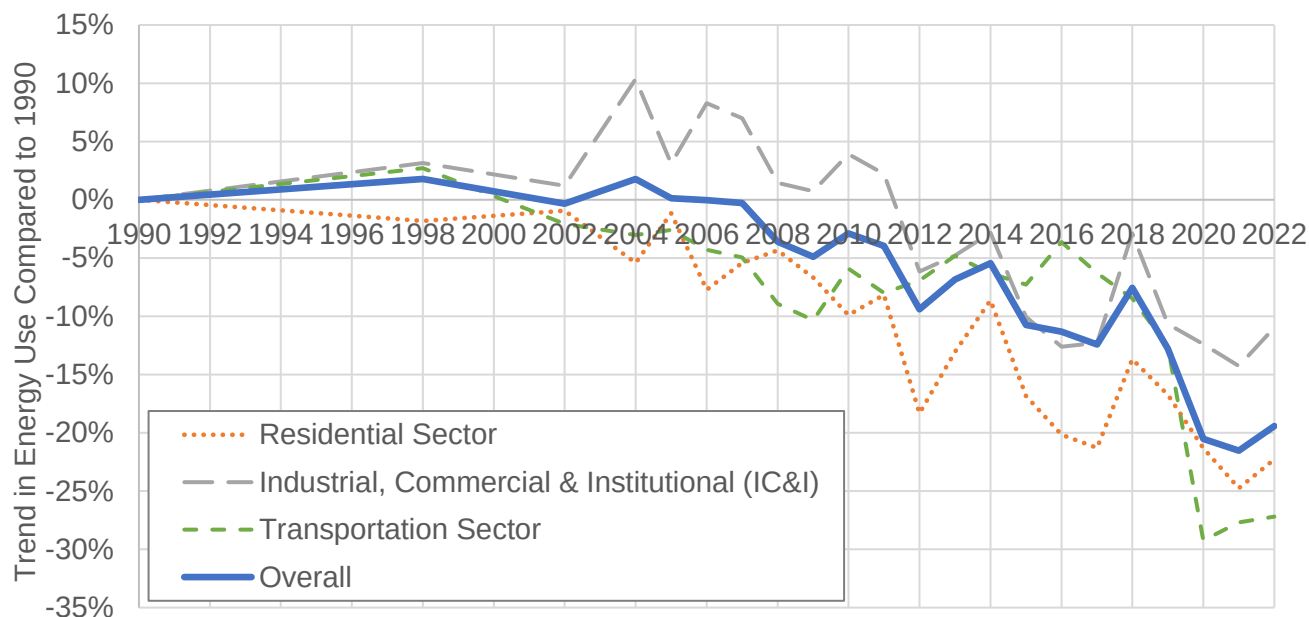


Figure 2 illustrates the change in energy consumption in London by sector on a per person basis, using 1990 as the baseline year. Overall, since the mid 2000s, the trend has been downwards, with the weather-related impacts of the “Winter that Wasn’t” of 2012 (very warm winter), the “Polar Vortex” of 2014 (very cold winter), and the combination of a colder winter and warmer summer in 2018 being clearly visible, especially for the residential sector. The major impact of the COVID-19 pandemic on transportation energy use in 2020 and 2021, combined with the warmer than average winter temperatures for those years, is also very apparent.

4.1. Transportation Energy Use

In the early 2010s, transportation energy use was increasing, with the volume of fuel sold in London increasing year-over-year between 2011 and 2016. However, this trend reversed in 2017 and the volume of fuel sold continued to drop through to 2019. This trend may not have been driven by fuel prices since the average fuel prices at the pumps decreased by about 10 cents per litre between 2018 and 2019. Therefore, this could be due to a combination of fewer trips by car and improving vehicle fuel economy.

As noted earlier, the COVID pandemic continued to have a significant impact on transportation energy use in 2022, with the total volume of fuels sold at gas stations being 15 per cent lower in 2022 than it was in 2019.

4.1.1. Registered Vehicles in London

The City started to track local vehicle registration data beginning with 2010 data to try to gain additional insight into transportation energy use.

Prior to COVID-19, vehicle ownership in London had grown by over four per cent every year on average between 2010 and 2019, much faster than London's overall population growth. As of December 2019, there were almost 292,000 light-duty vehicles registered in London – an increase of almost 89,000 since 2010. When compared to Census data on Londoners, vehicle registration increased from 557 vehicles for every 1,000 people in 2010 up to 711 vehicles in 2019.

However, as of December 2022, the number of light-duty vehicles registered in London dropped to over 268,000 vehicles. This works out to 617 vehicles for every 1,000 people.

The vehicle registration data shows a mix of positive and negative trends. On the positive side:

- fuel-efficient compact cars remain the most-popular vehicle segment in London;
- the number of hybrid and/or electric vehicles in London were almost nine times higher in 2022 compared to 2010;
- There are now almost 2,100 electric vehicles registered in London; and.
- 3.2% of new 2022/23 Model Year vehicles registered were electric vehicles and 4.9% were mild hybrid (i.e., no plug) vehicles.

On the negative side, high gas consumption sport utility vehicles and large pick-up trucks continue to gain in popularity as the relative number of minivans and mid-sized sedans declines. Additional detail is provided in Table 5 below.

Table 5 – Vehicle Ownership Statistics for London

Item	2010	2022	Change
Total registered vehicles	202,800	268,400	32%
London's population	364,000 (estimate)	435,000 (estimate)	20%
Vehicles per 1,000 people	557	617	11%
Hybrid gas-electric vehicles (excluding plug-in hybrids)	840	5,320	+ 4,480
Plug-in electric vehicles	0	2,075	+ 2,075
Fuel use per vehicle (GJ/year)	71	47	-34%
Top five vehicle segments (share of vehicle registrations)	compact car (22%) mid-size car (14%) minivan (10%) compact SUV (10%) full-size car (7%)	compact car (20%) compact SUV (18%) mid-size car (8%) large pickup (8%) upper mid-size SUV (7%)	

4.1.2. Transportation Data from Google's Environmental Insights Explorer

The City of London was among the first group of Canadian cities to participate in Google's Environmental Insights Explorer project. This project made use of Google Maps data such as building shapes and mobility data (from tracking the movement of smart phones equipped with GPS) to estimate greenhouse gas emissions from cities.

There are some limitations to this data, in that not everyone travels with a smart phone on hand or with location services enabled on their phone. However, their transportation data has provided some useful insights, namely that trips to/from London (inbound/outbound) have a large impact on emissions even though they are far fewer in number of trips.

The Environmental Insights Explorer tool has provided data up to 2021, which confirmed the impact that COVID-19 has had on transportation. Table 6 summarizes the 2019 to 2021 transportation trip information for London from the Environmental Insights Explorer.

Table 6 – Total Trip Distance Travelled by Mode and Destination for 2019 to 2021

Travel Mode	Destination	2019 Total Trip Distance (km)	2020 Total Trip Distance (km)	2021 Total Trip Distance (km)	2021 Change from 2019
Automobile	Inbound	791,000,000	585,000,000	680,000,000	-14%
Automobile	Outbound	795,000,000	583,000,000	675,000,000	-15%
Automobile	In-Boundary	1,402,000,000	999,000,000	1,167,000,000	-17%
Cycling	In-Boundary	12,000,000	14,500,000	15,300,000	27%
Walking	In-Boundary	53,700,000	42,100,000	46,400,000	-13%
Transit	In-Boundary	56,200,000	39,100,000	31,900,000	-43%
Railway	Inbound	15,200,000	n/a	n/a	n/a
Railway	Outbound	16,600,000	n/a	n/a	n/a

Note that the latest Environmental Insights Explorer data splits the distance travelled for inbound and outbound trips evenly between the origin and destination to avoid double-counting. For example, the distance covered by an automobile trip from London to Toronto would be split evenly between London and Toronto.

Cycling has seen strong growth in total distance travelled, with a 27 per cent increase from 2019 levels in 2021. Increases in cycling were also seen in other Ontario cities with Environmental Insights Explorer data. This has been noted in cities world-wide, with the reduction of vehicle traffic on roads encouraging more people to use bicycles for transportation, along with the emerging popularity of electrically assisted bicycles (e-bikes). Trips made by automobile did increase in 2021 compared to 2020 but were still below pre-pandemic levels of 2019.

This highlights the importance of City-led transportation initiatives such as rapid transit and the Cycling Master Plan. According to London's *Smart Moves 2030 Transportation Master Plan*, around 74 per cent of all personal trips made in London during the weekday peak periods in 2009 were made in personal vehicles, and 86 per cent of these vehicles only have one occupant – the driver.

4.2. Energy Use and the Local Economy

Energy use per person related to the industrial, commercial, and institutional sector in 2022 was 11 per cent lower than 1990. London Hydro and Enbridge have also been increasing efforts to promote energy conservation and demand management with their business client base.

Another way to measure improvements in energy efficiency of the local economy is to compare it to Gross Domestic Product (GDP). Since 1990, London's GDP has grown significantly. Using

statistics from the London Economic Development Corporation (LEDC) and the Conference Board of Canada, London's GDP (in constant 2012 dollars – i.e., excluding inflation) has grown by 100 per cent between 1990 and 2022.

Using these GDP estimates for 1990, London's energy productivity - GDP generated per unit energy used in London's employment sector - has improved by 58 per cent. Table 7 illustrates this in more detail. This means that local businesses are producing products and services more efficiently and/or moving towards producing products and services of higher value for the same amount of energy used.

A number of London's major employers have taken a leadership position on energy management, but there are still many opportunities to reduce energy use in the employment sector, particularly amongst small-to-medium sized enterprises who may not have the human, financial, and/or technical resources to manage their energy use effectively.

Table 7 – 1990-2022 Energy Productivity of London's Employment (IC&I) Sector

Indicator	1990	1998	2007	2022
Gross Domestic Product (\$ millions GDP ¹)	\$10,600 ²	\$12,800 ²	\$16,900	\$21,200
Energy Used by IC&I Sector (Terajoules - TJ)	20,200	22,500	25,100	25,500
Energy Productivity (\$GDP per Gigajoules - GJ) ³	\$524	\$569	\$675	\$830
Improvement in Productivity Since 1990		9%	29%	58%
Average Annual Productivity Improvement		1.0%	1.9%	1.3%

4.3. Energy Commodities Used in London

The breakdown of energy use and GHG emissions by commodity is outlined in Table 8. Natural gas was the largest source of energy used in London in 2022, accounting for 47 per cent of all energy used. Gasoline was the second largest source of energy, accounting for 21 per cent of London's energy use. Electricity accounted for 20 per cent of all the energy used in London.

1 – GDP data based on the London Census Metropolitan Area (includes St. Thomas & Strathroy), prorated by 77% based on population of London, and adjusted to constant 2012 dollars based on the Consumers Price Index (CPI) for Ontario

2 – Extrapolated from 2007 GDP data for London CMA based on changes to Ontario's real GDP for 1990 and 1998

3 – London's GDP divided by energy used in IC&I sector

Compared to 2021, 2022 had an overall colder winter, which increased the demand for natural gas used for heating.

For electricity, it is important to note that about 90 per cent of the electricity generated in Ontario comes from emissions-free sources. In 2022, as reported by the Ontario Energy Board, 51 per cent of Ontario’s electricity was supplied by nuclear generating stations, while hydroelectric generating stations supplied 25 per cent and other renewable sources of electricity (wind, biomass, solar) provided 14 per cent of our electricity needs. Natural gas-fired generating stations provided ten per cent of Ontario’s supply.

Table 8 – 2022 Community Energy Use by Energy Commodity

Energy Commodity	Total Used	Energy (Terajoules)	Energy (%)
Natural Gas	738,300,000 m ³	27,500	47%
Gasoline ¹	349,500,000 L	12,100	21%
Electricity	3,254,000 MWh	11,700	20%
Diesel ^{1,2}	124,000,000 L	4,800	8%
Aviation fuel ²	17,000,000 L	600	1%
Propane ¹	33,300,000 L	800	> 1%
Ethanol (blended into gasoline)	32,900,000 L	600	1%
Fuel Oil ¹	13,200,000 L	500	1%
	Total	58,800	

NOTE: due to rounding of numbers, individual numbers may not add up to the total

1 – includes some data prorated from Ontario consumption data provided by Statistics Canada; 2019 data

2 – aviation and freight fuel data prorated from Canada consumption data provided by Statistics Canada; 2020 data

However, one important concept that needs to be understood is thermal efficiency. Whenever any fuel is burned in an engine to create mechanical energy or used to make steam to spin a turbine to generate electricity, only a small portion of thermal energy ends up being converted to mechanical or electrical energy. The rest of the energy often ends up being lost as “waste heat”. For example, the amount of thermal energy converted into power by steam-driven turbines in electricity generating stations is usually about 33 per cent, or in other words you need to use three units of heat energy to make one unit of electrical energy. The conversion rate is higher for combined cycle gas-fired power plants, which can reach about 50 per cent conversion of heat energy into electricity.

This is the same for internal combustion engines used in vehicles, which are about 35 per cent efficient when running in highway driving, and about 20 per cent efficient overall when you take

into account the fuel wasted in city driving associated with waiting at stop lights and other situations where the engine idles. Replacing internal combustion vehicles with battery-powered electric vehicles is more efficient overall, even more so when sources like hydroelectricity are used.

When the thermal efficiency of converting heat into power in electricity generating stations is considered, a different picture of energy needs emerges, as seen in Table 9.

Table 9 – 2022 Energy Use in Electricity Generation Accounting for Thermal Efficiency

Source of Energy ¹	Energy (Terajoules)	Energy (%)
Uranium ²	18,300	72%
Hydroelectric	3,000	12%
Natural Gas ³	2,400	10%
Wind	1,180	5%
Solar ⁴	290	1.2%
Biofuels ²	140	0.6%
Total	25,000	

NOTE: due to rounding of numbers, individual numbers may not add up to the total

1 – Based on IESO 2019 annual electricity generation data from transmission-connected sources

2 – Assumed 33% thermal efficiency for generating electricity

3 – Assumed 50% thermal efficiency for generating electricity

4 – IESO data for solar only includes large transmission-connected solar farms. The Ontario Energy Board estimates that solar PV accounts for over 2% of power generation when smaller, local embedded generation is included

Table 9 helps illustrate the fact that electricity is not an energy resource, but the conversion of one form of energy (e.g., thermal energy in the case of nuclear and natural gas, gravitational potential energy in the case of hydroelectricity, kinetic energy in the case of wind) into electrical energy. In most cases, the remaining heat from large electricity generation plants is wasted. For London's electricity needs, 25,000 terajoules of energy resources were consumed to provide London with 11,700 terajoules of electricity – the remaining 13,300 terajoules of energy was waste heat that was not utilized. However, this table helps to illustrate that greater use of cogeneration (or combined heat and power) and non-fuel renewables (hydro, wind, solar) will help to reduce this waste. Note that there are other "losses" that occur in energy distribution, such as line losses from power transmission, which have not been quantified.

Table 10 outlines the trend in per person energy commodity use since 1990.

Table 10 – 1990-2021 per Person Energy Use by Energy Commodity (GJ per Person)

Energy Commodity	1990 (Pop. 307,000)	2005 (Pop. 349,000)	2022 (Pop. 435,000)	Change from 1990
Natural Gas	67	69	63	-5%
Gasoline (including ethanol-blended gasoline)	41	40	29	-28%
Electricity	34	37	27	-22%
Diesel	13	13	11	-14%
Fuel Oil	7.2	4.2	1.2	-84%
Aviation fuel	3.2	2.6	1.5	-53%
Propane	2.4	1.7	1.9	-20%
Total	168	168	135	-20%

NOTE: due to rounding of numbers, individual numbers may not add up to the total

5. Energy Expenditures and Energy Generation

5.1. Energy Expenditures in London

Using information on utility billing rates and fuel price data from Kalibrate (formerly Kent Group), the total cost of energy use can be estimated. Note that these costs also include costs for the distribution and delivery of the energy commodity, as well as taxes on these commodities. A full description of the methodology is outlined in Appendix A (Section A.3). Energy use and associated expenditures on energy are a significant operating cost for many businesses. In addition, for many Londoners, the rising costs of gasoline and electricity have put pressure on day-to-day household expenses, often requiring households to cut back on discretionary purchasing.

Understanding how much is collectively spent on energy, and the opportunities arising from energy conservation, is important for London. Table 11 outlines the total estimated costs associated with the energy commodities used in London.

Table 11 – Total Estimated Cost by Energy Commodity in 2022

Energy Commodity ¹	Cost (\$ million)	Share (%)	Energy (terajoules)	Price per gigajoule
Gasoline (including ethanol-blends)	\$619	33 %	12,800	\$48
Electricity	\$515	28 %	11,700	\$44
Natural Gas	\$447	24 %	27,500	\$16
Diesel ¹	\$214	12 %	4,800	\$45
Propane	\$25	1 %	800	\$32
Fuel Oil	\$30	2 %	500	\$59
Total	\$1,850		58,800¹	\$31

NOTE: due to rounding of numbers, individual numbers may not add up to the total

1 – excludes diesel for railway freight transportation and aviation fuels

In recent years, it was estimated that Londoners normally spend around \$1.5 billion per year on energy. However, with the high global fossil fuel costs triggered by the Russian invasion of Ukraine, it is estimated that Londoners spent \$1.85 billion on energy in 2022, an increase of 37 per cent from 2021.

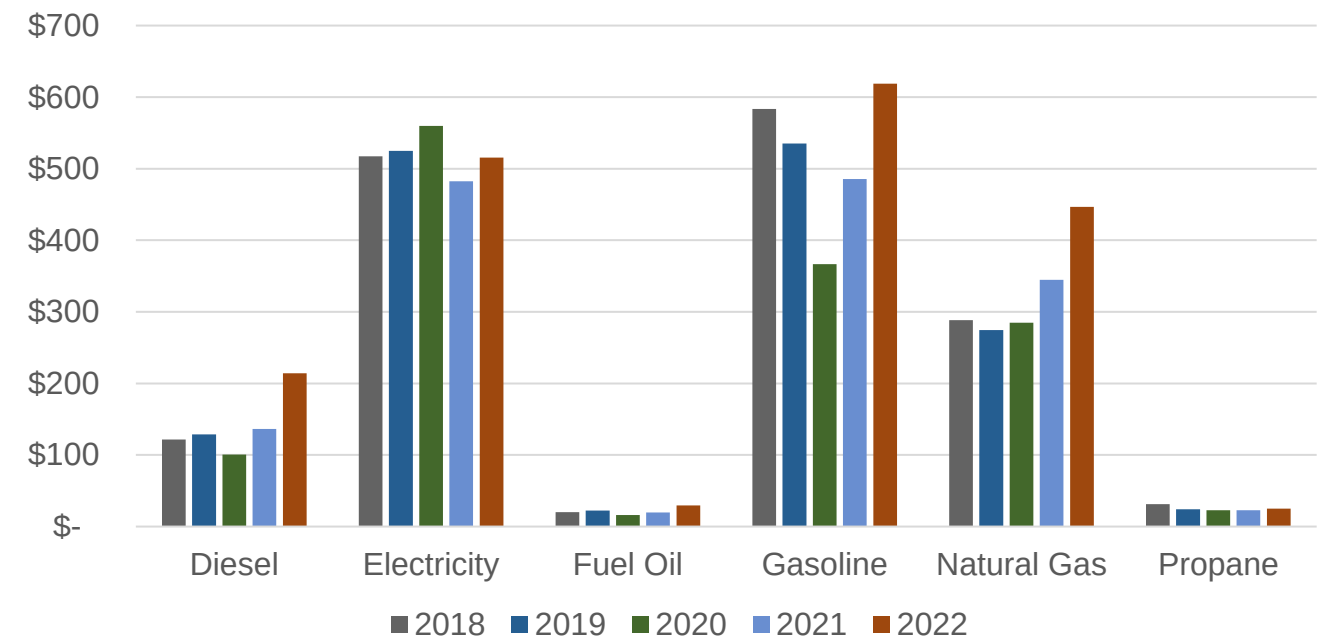
The average price for gasoline in 2022 increased by 28 per cent from the previous year. In total, Londoners spent about \$130 million more on gasoline in 2022 than they did in 2021.

These high prices may have contributed to gasoline sales remained well below pre-pandemic levels in 2022.

Electricity accounted for 28 per cent of total energy costs in 2022. In total, Londoners spent about \$33 million more on electricity in 2022 than they did the previous year.

Natural gas use accounts for 24 per cent of energy costs, even though it was the largest source of energy we used. Natural gas is still the lowest cost energy source, even with the \$50 per tonne carbon price in place during 2022. However, natural gas prices overall were 19 per cent higher than the previous year. Colder winter weather in 2022 increased the demand for natural gas for building heat.

Figure 3 – Trend for Total Energy Commodity Costs (Millions) by Commodity in London



It is important to note that costs could have been higher. If 2010 is used as a baseline year in terms of energy use per capita, as noted in Figure 4, recent improvements in energy efficiency have created ongoing savings. In 2022, it is estimated that \$510 million in energy costs were avoided through energy efficiency as well as continued COVID-19-related reductions in transportation fuel use. Added up year-over-year, London has avoided almost \$2.3 billion in energy costs due to improved efficiency since 2010.

On average, every percentage that Londoners reduce their energy use results in around \$12 million staying in London every year.

Information from utility billing rates and fuel price data can also be used to provide a reasonable estimate where the money is spent by Londoners on energy, as illustrated in Table 11. Out of the \$1.85 billion spent on energy in 2022, it is estimated that 15 per cent of this money stayed in London, most of which goes towards London Hydro’s and Enbridge’s local operations. The rest leaves London.

With the high global oil commodity prices due to the Russian invasion of Ukraine, Western Canada's share of our energy dollars increased. In 2022, Londoners and London businesses sent about \$460 million of their energy dollars to Western Canada compared to about \$180 million in 2020.

About \$370 million of our energy dollars also go to electricity generators in Ontario like Bruce Power and Ontario Power Generation, as well as Ontario's primary electricity transmitter, Hydro One.

Figure 4 – Trend for London's Total Energy Costs (Millions) Compared to 2010 Energy Efficiency Baseline

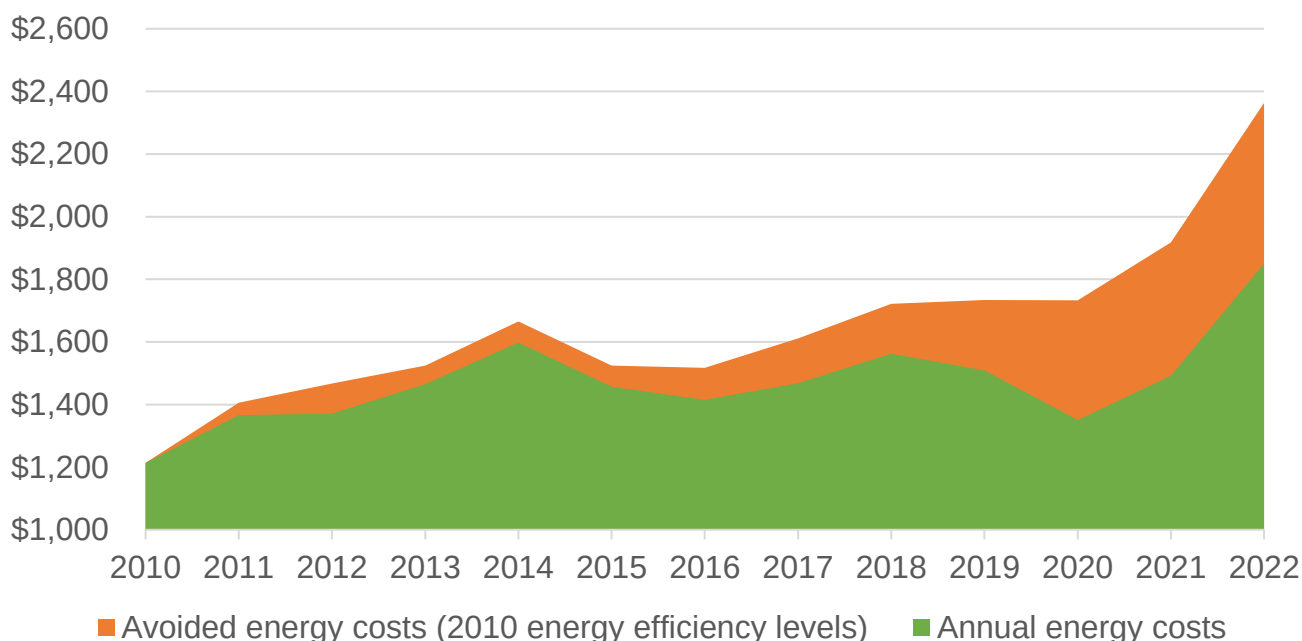


Table 11 – Estimated Share of Energy Revenue (2022)

Commodity	London Region	Ontario - Business	Ontario - Government	Western Canada	Canada - Government	United States
Diesel	1%	3%	2%	5%	1%	-
Electricity	4%	20%	3%	-	1%	-
Fuel Oil	<1%	<1%	<1%	<1%	<1%	-
Gasoline	3%	6%	5%	15%	3%	-
Natural Gas	5%	2%	5%	4%	1%	6%
Propane	<1%	<1%	<1%	-	<1%	-
Total	15%	33%	15%	25%	6%	6%

NOTE: due to rounding of numbers, individual numbers may not add up to the total

A portion of the money collected from federal and provincial taxes and other utility bill fees does help pay for other government services in London. For example, the City of London gets a portion of the gasoline tax to help pay for improvements to local transportation, other infrastructure, and environmental projects. Also, energy conservation incentives offered by utility companies are funded through utility bills, as it is usually more economical to invest in conserving energy rather than build new power plants.

The federal government also applies their carbon pollution pricing backstop in Ontario given that Ontario no longer has a carbon pricing system in place. Most of the funds collected by the backstop are used for the Climate Action Incentive provided when filing personal income tax returns, with the remaining used for funding federal climate action programs such as the Incentives for Zero-Emission Vehicles program. City staff estimate that about \$125 million was collected through the carbon pricing backstop in 2021.

5.2. Energy Generation in London

London has 93.2 megawatts (MW) of local electricity generation and 8.2 megawatts of battery electricity storage system capacity installed to date. Currently, there are 68.4 megawatts of gas-fired cogeneration, 20.3 megawatts of solar photovoltaic (PV), 3.8 megawatts of biogas, and 0.68 megawatts of hydro-electric power generation in operation in London.

Most of London's local generating capacity is associated with natural gas combined heat and power cogeneration plants, used in four different applications:

- **District energy** - London District Energy is a “merchant plant” that sells the power to the Independent Electricity System Operator and the thermal energy (steam for heating, chilled water for cooling) to buildings in downtown and central London. London District Energy has recently doubled its capacity to deliver combined heat and power at its Colborne Street facility.
- **Industrial** – Ingredion and Labatt Brewery generate steam as well as electricity “behind-the-meter” for use in their operations.
- **Hospital campus** – the London Health Sciences Centre Victoria Hospital campus generates both steam and electricity for hospital buildings, including the ability to keep the heat and power infrastructure operational in the event of an emergency.
- **Micro-scale** – small scale combined heat and power systems (under 100 kilowatts) are in use at the Canada Games Aquatic Centre for pool heating as well as electricity “behind-the-meter” for use in their operations.

6. Translating Energy Use into Greenhouse Gas Impact

6.1. Greenhouse Gas Emissions for 2022

Energy use in London was responsible for almost 2.6 million tonnes of greenhouse gas (GHG) emissions (expressed in terms of equivalent carbon dioxide, or CO₂e) in 2020. Table 12 provides additional information on GHG emissions associated with the various sources of energy used in London.

Table 12 – 2022 GHG Emissions by Energy Commodity

Energy Commodity	Energy (Terajoules - TJ)	GHG Emissions (kilotonnes CO ₂ e)	GHG (%)	GHG Intensity (tonnes/TJ)
Natural Gas	27,500	1,400	50%	51
Gasoline (including ethanol)	12,800	810	29%	63
Diesel	4,800	340	12%	70
Electricity	11,700	140	5%	12
Aviation Fuel	600	40	2%	68
Propane	800	50	2%	61
Fuel Oil	500	40	1%	70
Total	55,400	2,820		

NOTE: due to rounding of numbers, individual numbers may not add up to the total

Energy use is responsible for 95 per cent of all GHG emissions from human activity in London. Not only does burning fossil fuels such as gasoline, diesel, and natural gas produce carbon dioxide – the most common GHG associated with human activity – but the use of electricity also contributes to GHG emissions.

About 90 per cent of Ontario's electricity was generated from emissions-free sources in 2022, such as nuclear and hydro-electric generating stations as well as renewable sources (wind and solar). However, as reported by the Ontario Energy Board, Ontario relied on fossil fuels such as natural gas to generate over ten per cent of the electricity we use, a higher share than in recent years.

The remaining five per cent of GHG emissions are methane emissions from the anaerobic decomposition of organic materials in the active and closed landfills located in London as well

as commercial sector waste disposed in landfills outside London, and nitrous oxide emissions from sewage sludge incineration.

The City of London's new Climate Emergency Action Plan has set new, science-based GHG reduction targets for community-wide emissions:

- a 55% reduction from 2005 levels by 2030;
- a 65% reduction by 2035;
- a 75% reduction by 2040; and
- net-zero emissions by 2050.

The Climate Emergency Action Plan adopted 2005 (versus 1990) as the new baseline year for community GHG emissions reduction targets given that:

- 2005 is the baseline year used for target setting by the Government of Canada and the Province of Ontario; and
- 2005 represents a year where per-person emissions in London were close to their peak (the basis for setting a 1.5°C science-based target).

In April 2021, the federal government revised its 2030 target to aim for a 40 to 45 per cent reduction in GHG emissions from 2005 levels as well as net-zero emissions by 2050. To date, the provincial government has not revised its 2030 target for a 30 per cent reduction from 2005 levels and has not established an emission reduction target beyond 2030.

In 2022, total GHG emissions were estimated to be 2.96 million tonnes of equivalent carbon dioxide, or 24 per cent lower than the 2005 level. However, it is important to note the extraordinary impact of the COVID-19 pandemic on emissions.

As mentioned earlier, the COVID-19 pandemic continued to have a significant impact on transportation fuel use, with transportation GHG emissions in 2022 12 per cent below pre-pandemic levels.

Colder winter weather in 2022 compared the year before increased the demand for natural gas used for heating, with an associated 12 per cent increase in residential GHG emissions. Seasonal weather variations can affect energy use and associated emissions significantly. However, over the last ten years, winter average temperatures and most summer average temperatures have been warmer than normal (as defined by Environment Canada's 1971-2000 climate data for London - see Appendix B).

In 2022, it is estimated that every 1,000 kilowatt-hours of electricity generated in Ontario produced 43 kilograms of carbon dioxide emissions. This is significantly better than it was 20 years ago (2003), when electricity generated in Ontario produced around 300 kilograms of carbon dioxide emissions. However, this does represent an increase in electricity emissions intensity from recent years when emissions were at or below 30 kilograms per 1,000 kilowatt-hours. As a result, this increase in emissions intensity is responsible for an additional 45,000 tonnes of emissions attributable to London in 2022 – 1.6 per cent higher.

Figure 5 illustrates the total GHG emission trend since 2005 in comparison to the targets used for London, for Ontario, and for Canada (with the minimum 40 per cent reduction target shown in the chart). Since 2005, there has been a downward trend driven by a combination of cleaner electricity generation and improved energy efficiency. However, since 2018, emissions to date have been above the trendline needed to meet our new science-based targets.

The cancellation of provincial renewable electricity contracts and electric vehicle incentives may have contributed to the loss of momentum. As noted earlier, London’s emissions in 2022 would have been 45,000 tonnes lower had the emissions intensity of Ontario’s electricity grid remained unchanged. For 2022 electric vehicle sales, as of the third quarter of 2022, Ontario’s EV market share of 6.0 per cent was below the national average of 7.7 per cent and far behind British Columbia and Quebec at 15.6 per cent and 11.8 per cent respectively. London’s EV market share is even lower, at 3.2 percent in 2022, due to the low availability of EVs in smaller markets like London.

Figure 5 - Targets vs. Actual GHG Emissions from London

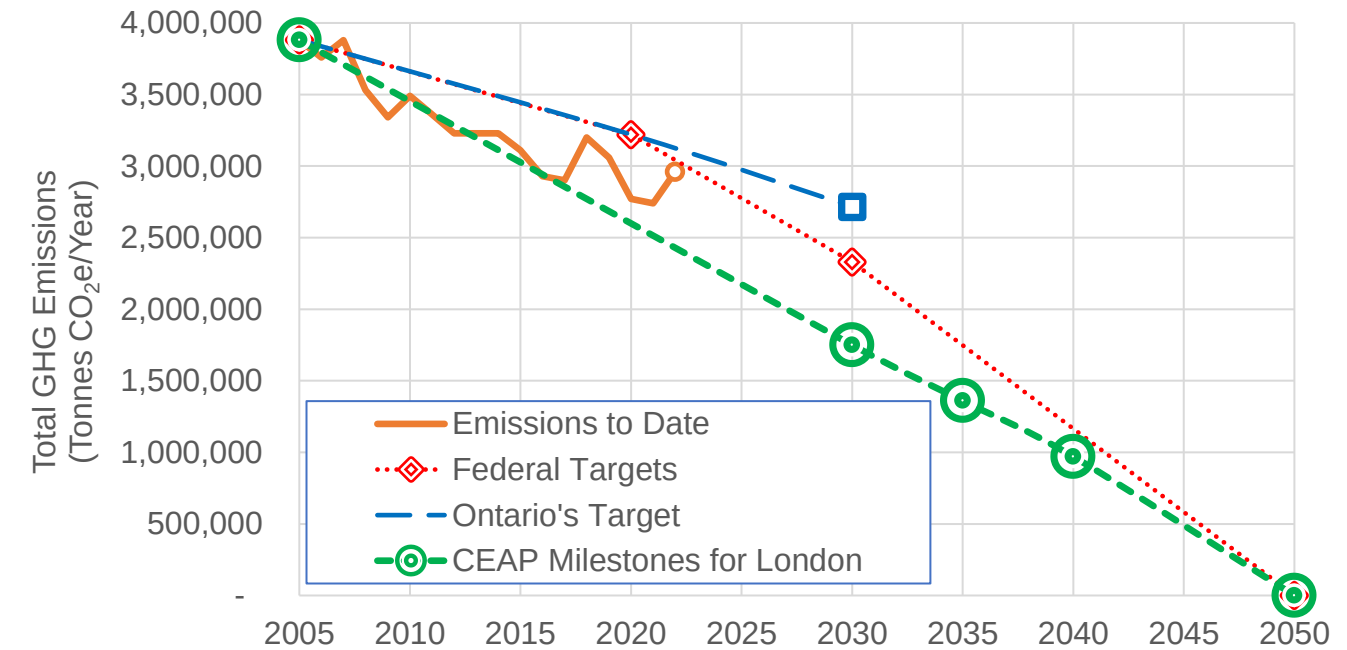


Table 13 illustrates the GHG emissions trends by sector, including landfill gas emissions. As seen in Table 13, transportation and the industrial, commercial, and institutional sectors have the greatest contribution.

Table 13 – 2005-2022 Community GHG Inventory in London (kilotonnes CO₂e per year)

Sector	2005	2015	2022
Transportation	1,400	1,420	1,220
Residential	850	570	570
Industrial, Commercial & Institutional	1,380	900	1,020
Landfill Gas Emissions & Sewage Incineration	250	220	140
Total	3,880	3,100	2,960

NOTE: due to rounding of numbers, individual numbers may not add up to the total

The community energy model developed by the Canadian Urban Institute for the Integrated Energy Mapping for Ontario Communities project, combined with provincial Broader Public Sector (BPS) energy data, was used to estimate a more-detailed breakdown of GHG emissions by building type, as shown in Table 14.

In terms of per person emissions, as illustrated in Table 15 and Figure 6, emissions today are 39 per cent lower than they were back in 2005 (11.1 tonnes per person in 2005 versus 6.8 tonnes per person in 2022).

This reduction in GHG emissions resulted from reduced GHG intensity of Ontario's electricity grid, improved home energy efficiency, reduced energy use in the business sector, and the improvement of the City of London landfill gas collection and flaring system at the W12A Landfill. Transportation emissions were also lower due to improved fuel efficiency, reductions in commuting due to the COVID-19 pandemic, the use of ethanol-blended gasoline (10% ethanol by volume), as well as vehicle tailpipe emission controls that reduced emissions of nitrous oxide.

Table 14 – 2022 Breakdown of GHG Emissions by Subsector

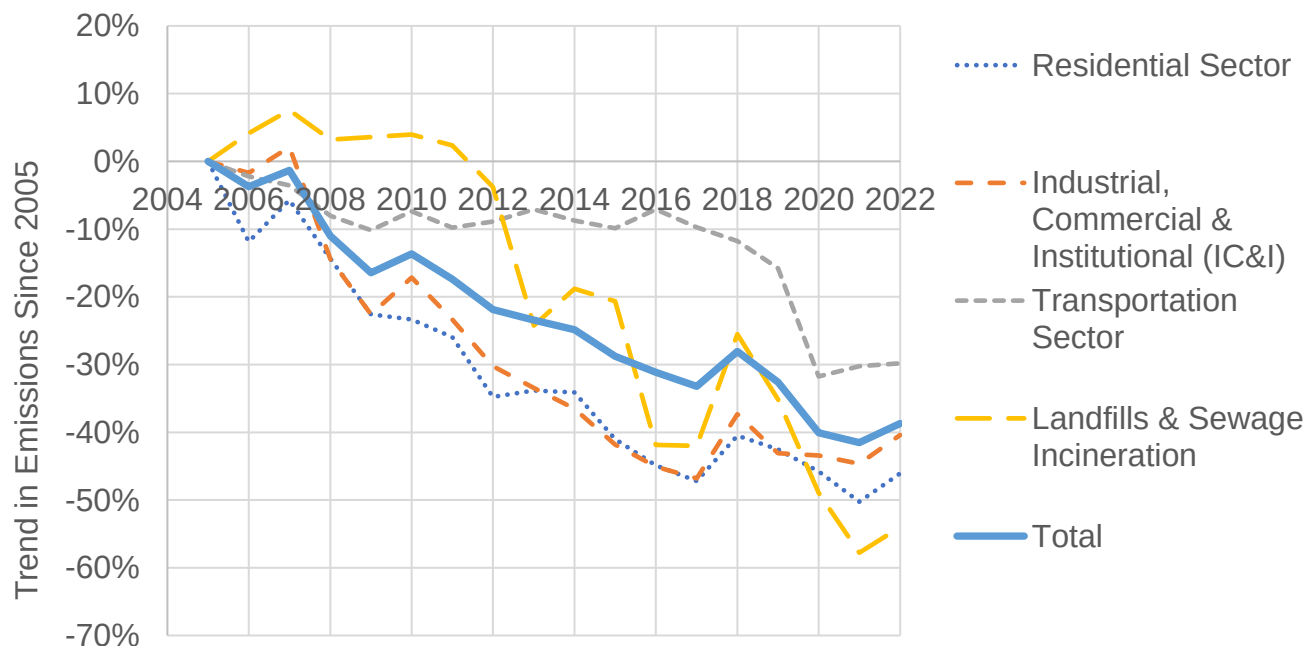
Sector	Sub-sector	GHG Emissions (kilotonnes per year)
Transportation	Fuel sold at gas stations	790
Transportation	Road freight transport	250
Transportation	Corporate fleets	80
Transportation	London Transit	20
Transportation	Railway freight transport	40
Transportation	Domestic aviation	40
Residential	Low-density homes	490
Residential	Medium-density townhomes	80
Industrial, Commercial & Institutional	High-density residential buildings	40
Industrial, Commercial & Institutional	Commercial – office buildings	130
Industrial, Commercial & Institutional	Commercial – retail & warehouses	210
Industrial, Commercial & Institutional	Industrial & other	500
Industrial, Commercial & Institutional	Institutional - schools	20
Industrial, Commercial & Institutional	Institutional - hospitals	50
Industrial, Commercial & Institutional	Institutional - colleges & universities	60
Industrial, Commercial & Institutional	Institutional - municipal energy use	10
Waste Management	W12A Landfill	80
Waste Management	Closed landfills	30
Waste Management	IC&I waste disposed outside London	20
Wastewater Treatment	Sewage sludge incineration	8

Table 15 – 2005-2022 per Person GHG Inventory in London (tonnes per person)

Sector	2005 (Pop. 349,000)	2015 (Pop. 381,000)	2022 (Pop. 435,000)	Change from 2005
Transportation	4.00	3.60	2.81	-30%
Residential	2.45	1.44	1.32	-46%
Industrial, Commercial & Institutional	3.94	2.30	2.35	-40%
Landfill Gas Emissions & Sewage Incineration	0.70	0.56	0.32	-54%
Total	11.1	7.9	6.8	-39%

NOTE: due to rounding of numbers, individual numbers may not add up to the total

Figure 6 – Change in GHG Emissions in London, Per Person by Sector, Since 2005



It is important to note these GHG emissions estimates do not include emissions (indirect emissions) associated with the extraction, production, and transportation of materials, fuels, food, and consumer products (e.g., emissions from produce grown and transported from California, consumer products made and transported from China). This is consistent with the approach taken by other Canadian cities reporting GHG emissions through the Partners for Climate Protection program. However, it is important to recognize the fact that the production and transportation of consumer goods purchased do have an environmental impact, and that some types of goods (e.g., meat and dairy products) do have a larger impact than others. Additional information on consumption-related household GHG emissions is provided in Section 7 – Household Energy Use and Emissions.

6.2. Publicly Reported Local Emitters

The provincial government requires facilities that emit more than 10,000 tonnes of greenhouse gases per year to report their emissions on an annual basis. The most recent data available is 2021. In London, there are eight facilities that have reported their emissions, including Fanshawe College who report voluntarily, as shown in Table 16. Note that these are direct “Scope 1” emissions from stationary fossil fuel use only, and do not include emissions associated with electricity use or vehicle fuel use.

The district heating steam plant at Western University provides heat for buildings on the Western University campus as well as the neighbouring London Health Sciences Centre University Hospital. In the case of London District Energy, reported emissions are associated with providing steam heating and chilled water to buildings, as well as generating electricity. Many building owners served by London District Energy, including the City of London and St. Joseph’s Health Care, include their share of these emissions within their energy and GHG reporting to the Province of Ontario through Ontario Regulation 397/11, as shown in Table 17.

It is important to note that these “large emitters” accounted for 16 per cent of London’s total GHG emissions.

Table 16 – Annual GHG Emissions from Reporting Facilities (tonnes CO₂e per year)

Reporting Facility	2010	2015	2021
Fanshawe College of Applied Arts and Technology	3,143	2,927	2,564
3M Canada	N/A	N/A	10,811
Ingredion Canada Incorporated	124,320	124,263	127,987
Labatt Breweries of Canada LP	26,594	25,352	24,148
London Health Sciences Centre (Victoria Campus)	37,108	47,263	54,539
Western University (steam plant)	51,364	52,615	47,708
London District Energy	39,844	47,554	81,350
Great Lakes Copper	N/A	12,866	12,940
Kaiser Aluminum	N/A	N/A	17,901
W12A Landfill – Corporation of the City of London	160,430	155,873	73,000
Greenway Pollution Control Centre – Corporation of the City of London	N/A	N/A	3,797
Total	442,803	468,713	456,745
Percentage of total emissions from London	13%	15%	16%

The institutional sector – municipal government, colleges and universities, schools, hospitals – is also required to report its energy use and associated GHG emissions to the Province of

Ontario through Ontario Regulation 397/11. These emissions are for the organization as a whole, not just one specific facility or building. Table 17 summarizes the data reported for 2020, the most recent information available from the provincial government. Note that this information will include emissions from electricity use but does not include emissions from vehicle fuels. Also, in the case of the City of London, the Province's reporting requirements do not require electricity use for street lighting and sports field lighting to be reported.

Table 17 – Ontario Regulation 397/11 Reporting Organizations in London

Reporting Organization (based on building electricity and fuel use)	Annual GHG Emissions 2020 (tonnes CO₂e)
University of Western Ontario	49,342
London Health Sciences Centre	50,841
Thames Valley District School Board	11,643
St. Joseph's Health Care London	13,700
City of London	8,930
Fanshawe College	4,560
London District Catholic School Board	3,808
Conseil scolaire de district des écoles catholiques du Sud-Ouest	424
County of Middlesex (buildings in London)	501
Conseil scolaire de district du Viamonde	251
Collège Boréal	2
total	144,003
Percentage of industrial, commercial, and institutional emissions	15%
Percentage of total emissions from London	5%

7. Household Energy Use and Emissions

Providing estimates of energy use and greenhouse gas emissions for an average household in London offers a clearer understanding of the current situation (i.e., what to focus efforts on) and identifies opportunities for improvements. These estimates can be made using the following assumptions:

- For electricity and natural gas, divide the total residential customer energy use by the number of customers;
- For gasoline, divide the total retail sales of gasoline by the number of households in London; and
- For propane, divide the estimated total residential use of propane by the number of households in London.

Electricity and natural gas use can be broken down further based on provincial data on typical energy use breakdown in Ontario homes. Greenhouse gas emissions from organic waste in curbside waste can be estimated by dividing the annual GHG emissions from the W12A Landfill by the number of households in London. Note that these estimates best reflect those Londoners who live in single-family homes.

Table 18 – Estimated Average Household Energy Use and Emissions in London for 2022

Household Activity	Average Monthly Use over the Year	Average Monthly Cost over the Year	Average Annual Cost	Average GHG Emissions (tonnes CO _{2e})
Gasoline use (vehicles)	162 litres	\$275	\$3,300	4.0
Natural gas use	175 m ³	\$112	\$1,340	4.0
<i>Home heating</i>		\$86	\$1,030	3.1
<i>Hot water heating</i>		\$26	\$310	0.9
Electricity use	680 kWh	\$120	\$1,440	0.35
<i>Air conditioning</i>		\$16	\$190	0.05
<i>Appliance & plug load</i>		\$39	\$470	0.11
<i>Lighting</i>		\$12	\$140	0.03
<i>HVAC fan motor</i>		\$54	\$650	0.16
Propane use	5 litres	\$11	\$130	0.1
Food waste in garbage		n/a	n/a	0.6
Total		\$518	\$6,210	9.2

NOTE: due to rounding of numbers, individual numbers may not add up to the total

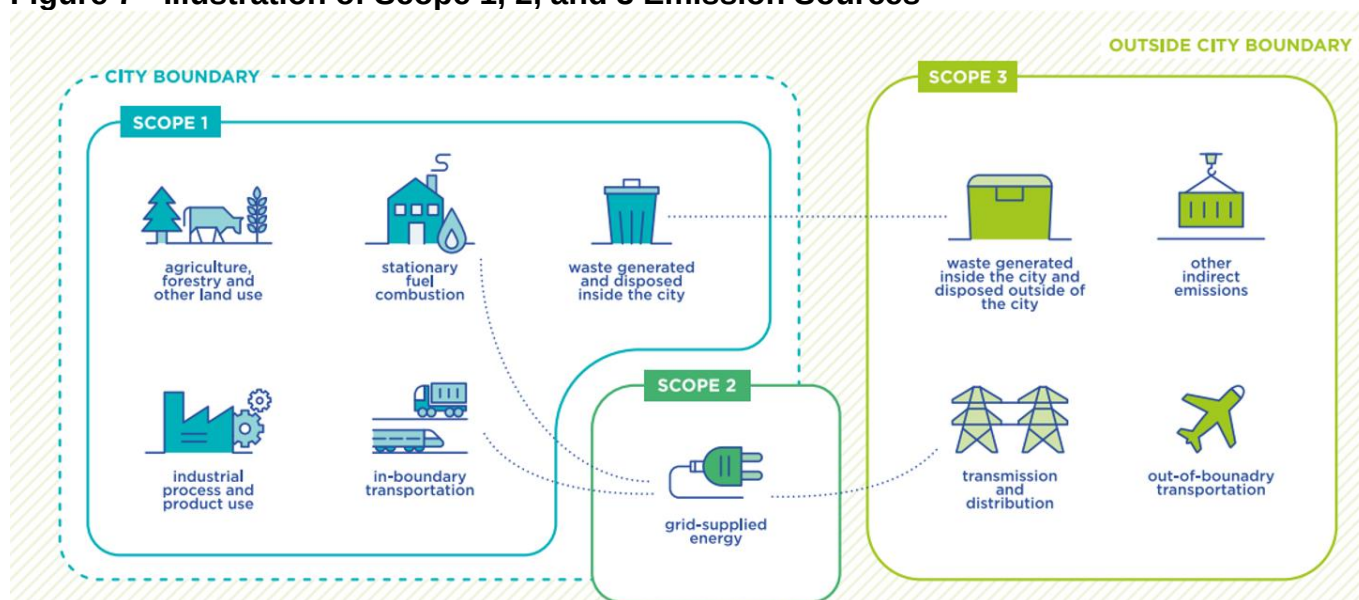
7.1. Consumption (Scope 3) Greenhouse Gas Emissions

Scope 1 and 2 community greenhouse gas emissions from energy used by Londoners and London's businesses and institutions, as well as other local sources of greenhouse gas emissions (i.e., methane from landfills and nitrous oxides from wastewater treatment) are what is traditionally reported by municipalities.

However, this does not provide the full picture regarding the impacts Londoners have on our climate. Many of the goods and services Londoners use, such as gasoline refined from synthetic oil extracted from Alberta's tar sands and produce grown in California, create emissions all along their supply chains on the way to London. These emissions are referred to as Scope 3 emissions for London.

A consumption-based inventory includes the emissions embedded in the goods and services consumed in the city. This includes the direct emissions of households and personal transportation in the city (i.e., Scope 1 emissions), plus the emissions embedded in the goods and services consumed within the city, regardless of where the goods and services are produced.

Figure 7 - Illustration of Scope 1, 2, and 3 Emission Sources

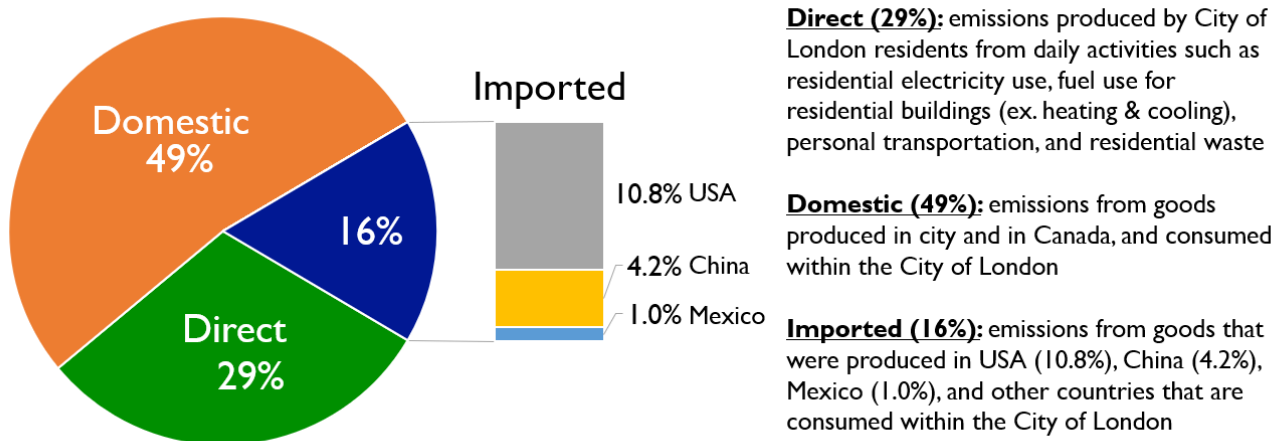


(Source: Consumption-Based GHG Emissions of C40 Cities)

The calculation of detailed consumption-based inventories is a complex undertaking. However, Corporate Knights, a Canadian sustainable-economy media and research corporation, has developed a simplified method for developing a high-level estimate of consumption-based emissions at the city scale. City staff worked with Corporate Knights to apply their methodology to London, Ontario. For more information on consumption-related emissions were, please refer to the Consumption-based Greenhouse Gas (GHG) Emissions - City of London report in Appendix D of the Climate Emergency Action Plan 2022 Progress Report.

As shown in Figure 8 below, London’s total consumption-based greenhouse gas emissions per person are estimated to be over three times higher than a person’s direct (Part 1) emissions. About half of the consumption-based emissions are associated with domestic goods and services, including those within London. Imported goods and services accounted for 16 per cent, with the United States and China making up the majority of import-related emissions.

Figure 9 - Breakdown of London's Consumption-Related GHG Emissions in 2019



(Source: Corporate Knights - Consumption-based Greenhouse Gas (GHG) Emissions - City of London report)

The Corporate Knights report does not provide details regarding what contributes to London’s consumption-related emissions. However, the Environmental Commissioner of Ontario report (March 2019), *Climate Pollution: Reducing My Footprint*, included estimates of consumption related GHG emissions per person for Ontario residents as shown in Table 19. Note that these estimates do not include broader economy-related emission sources that were included within the Corporate Knights report.

Table 19 – Estimated Average Household Consumption-Relation GHG Emissions in London

Household activity or purchases	Average Annual Lifecycle GHG Emissions (tonnes CO ₂ e per household)
Air travel – domestic	0.4
Air travel – international	2.7
Food – beef (e.g., enteric fermentation, processing, transportation)	1.1
Food – other (e.g., fertilizer, farm fuel use, processing, transportation)	2.0
Home – raw material extraction & processing, home construction	0.7
Home – natural gas extraction & processing, pipeline transportation	1.2
Other purchased goods & services (e.g., clothing, electronics, internet)	7.0
Vehicle – raw material extraction & processing, parts manufacturing & assembly	1.6
Vehicle fuel – oil extraction, fuel refining, pipeline transportation	1.0
Total Consumption (Scope 3) Emissions	17.7

In summary, greenhouse gas emissions associated with the manufacturing and delivery of goods and services used by Londoners is larger than the emissions from the direct use of energy and from waste. This highlights the climate change mitigation significance of several environmental initiatives such as:

- Food waste reduction;
- Buying durable products;
- Buying local products;
- Recycling and the circular economy (end-of-product-life material recovery and reuse); and
- Repurposing and renovating existing buildings.

8. Hydrofluorocarbons

Hydrofluorocarbons (HFCs) are refrigerants that were introduced to replace ozone-depleting refrigerants such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) under the Montreal Protocol. However, HFCs are potent greenhouse gases with a 100-year Global Warming Potential ranging up to 14,800 times higher than carbon dioxide. As a result, there is now a gradual phaseout of HFCs mandated under the Kigali Amendment to the Montreal Protocol, which came into force in 2019.

Emissions from local HFC use are not included in emissions inventories at the community scale as per the Federation of Canadian Municipalities' Partners for Climate Protection Program.

Canadian HFC use data is derived from bulk imports, and imports and exports of manufactured items such as refrigerators and air conditioners.

Surveys were performed by Environment Canada in 2012 to document practices in HFC use and disposal and to support the development of country-specific emission factors that are representative of Canada's circumstances for use in Canada's National Inventory Report.

Using the HFC emissions data for Ontario from Canada's National Inventory Report, the average per capita emissions from HFC use was estimated to be around 0.29 tonnes of equivalent carbon dioxide per person in 2021. This is lower than it was back in 2019, when it was estimated to be around 0.32 tonnes of equivalent carbon dioxide per person. Applying this to London's population works out to approximately 122,000 tonnes per year of equivalent carbon dioxide.

9. Summary and Conclusions

9.1 Energy Use

The impact of the COVID-19 pandemic on transportation energy use in 2022 remained significant, which was 12 per cent lower overall compared to 2019. In particular:

- The local retail sales of gasoline and diesel at gas stations was 15% lower than 2019 because of many London workplaces shifting to work from home as well as reduced discretionary trips associated with stay-at-home orders and similar restrictions.
- The estimated total distance of trips taken by bike in London were 27% longer in 2021 (latest data available) compared to 2019.
- The number of vehicles registered for every 1,000 people in London in 2022 was still 13% lower than in 2019.

It is anticipated that the shift to working-from-home will remain in place at London's workplaces after the COVID-19 pandemic is over, although this is not likely to be a full-time shift for everybody. It is also anticipated that the interest in cycling for transportation will continue to grow.

Residential (single-family home) energy efficiency has seen improvement, driven by energy conservation programs such as the former federal and provincial home energy audit and retrofit programs, along with utility conservation and demand management programs. New home construction in London has seen energy efficiency improvements driven by voluntary participation in efficiency programs such as Energy Star New Homes, as well as the 2012 Ontario Building Code.

Over the last ten years, energy efficiency for London's industrial, commercial, and institutional sector has been improving. London has many examples of local employers who have acted on energy efficiency and conservation.

In summary, specific highlights of recent community energy use progress and longer-term trends, include:

- Londoners are using energy more efficiently – on a per person basis, Londoners and London businesses used 20% less energy overall in 2022 than used in 2005.
- London is producing more goods and services for every unit of energy used – on a dollar gross domestic product (GDP adjusted for inflation) per unit energy basis, London's industrial, commercial, and institutional sector improved the value of goods and services produced per unit of energy used by 58% between 1990 and 2022.

- \$1.85 billion was spent by Londoners and London businesses on energy in 2022, higher than in recent years due to higher global energy prices. About 85% of this money left London.
- London is spending less money on energy – improvements in energy efficiency compared to 2010 levels of efficiency (on a per person basis and applied to activity in 2022) avoided about \$510 million in energy costs had there been no improvements.
- The number of “green” vehicles in London (i.e., hybrids and electric vehicles) is about nine times higher than it was in 2010. There are now over 2,000 electric vehicles registered in London. However, the number of “gas guzzling” SUVs and pick-up trucks in London has also increased.

9.2 Greenhouse Gas Emissions

From a greenhouse gas emissions reduction perspective, credit should be given to the previous Government of Ontario for following through on its plans to replace coal-fired power generation plants with cleaner sources, such as nuclear, hydroelectric, natural gas, and renewables, as well as encouraging electricity conservation. Since 2005, there has been a downward trend driven by a combination of cleaner electricity generation and improved energy efficiency.

The reductions in energy use noted above are also a contributor to London’s significant reductions in greenhouse gas emissions. Federal vehicle emission standards and provincial ethanol in gasoline requirements have also helped to reduce transportation greenhouse gas emissions. Finally, the City of London’s landfill gas collection and flaring system represents the largest source of greenhouse gas emissions reduction directly under municipal government control.

However, the cancellation of provincial renewable electricity contracts and electric vehicle incentives may have contributed to the loss of momentum. As noted earlier, London’s emissions in 2022 would have been 45,000 tonnes lower had the emissions intensity of Ontario’s electricity grid remained unchanged. For 2022 electric vehicle sales, as of the third quarter of 2022, Ontario’s EV market share of 6.0 per cent was below the national average of 7.7 per cent and far behind British Columbia and Quebec at 15.6 per cent and 11.8 per cent respectively. London’s EV market share is even lower, at 3.2 percent in 2022, due to the low availability of EVs in smaller markets like London.

In summary: the use of energy in London has had the following greenhouse gas impacts:

- Total GHG emissions in 2022 were 2.96 million tonnes of equivalent carbon dioxide – the top three sources were personal vehicles (27%), low- and medium-density housing (19%), and local industry (16%).
- London's total GHG emissions in 2022 were 24% below 2005 levels – higher than the previous year due to the impact of colder winter weather compared to the previous year.
- Londoners' per-person GHG emissions are significantly lower – on a per person basis, Londoners and London businesses released 39% fewer GHG emissions in 2022 than they did in 2005.

In terms of household GHG emissions, the average household emitted 9.2 tonnes per year. Almost half (43%) of this came from burning gasoline. Natural gas used for space heating and water heating accounted also accounted for 43 per cent of emissions. Organic waste in the landfill accounted for about seven per cent. Given Ontario's relatively clean electricity grid, using electricity in the home accounted for four per cent of household GHG emissions.

Whether emissions continue to decrease depends upon the impact of energy and fuel conservation efforts, provincial and federal climate change policies, climate trends, economic growth, and consumer choices. It is also important to note that these actions also contribute to reductions in air pollution emissions (e.g., nitrogen oxides, volatile organic compounds) from fossil fuel use.

The quantification of GHG emissions from the consumption of goods and services used by Londoners and London's employers is a growing area of interest for the City of London and has been included as an action within London's Climate Emergency Action Plan. Almost all these GHG emissions occur outside London. For consumer goods, most of these emissions occur outside of Canada. However, Londoners and London's employers can influence these emissions by the choices made regarding the goods and services they use.

Appendix A - Methodology

This document builds upon two foundational energy use and GHG emissions inventories that have been developed for London and related data, specifically:

- The 1995 *City of London Air Emissions Study*, prepared by SENES Consultants in association with Proctor & Redfern Limited and Torrie Smith Associates. It provided the baseline inventory for the community (1990) and municipal operations (1992).
- The London Energy/Air Emissions Reduction Strategy Task Force report in March 2000 titled *Air Emissions and Energy Use in the City of London*. This report revised the baseline 1990 community inventory and provided an update to the community inventory using 1998 data. It also provided an emissions and energy use business-as-usual forecast for 2001, 2006, 2012, and 2016.

Since 2003, City of London (Environmental Programs) staff has maintained and updated the community energy use and GHG emissions inventory on an annual basis.

The methodology employed is consistent with the GHG emission inventory protocol provided by ICLEI Canada for participants in the Federation of Canadian Municipalities' Partners for Climate Protection (PCP) program. The *2012 Community Energy & Greenhouse Gas Inventory: Challenges & Opportunities* report was reviewed by ICLEI and FCM staff as part of the City of London's Milestone 5 recognition for the PCP program.

The GHG inventory includes Scope 1 and Scope 2 emission sources, plus those Scope 3 emission sources required by the Global Covenant of Mayors:

- Scope 1 - GHG emissions from fuel use and landfills within the boundary of the city
- Scope 2 - Indirect GHG emissions that occur outside of the city boundary because of electricity consumption within the city
- Scope 3 - Other indirect emissions that occur outside of the city boundary because of activity within the city:
 - solid waste disposal (IC&I waste disposed in landfills outside London)
 - domestic aviation
 - railways

The remaining Scope 3 emissions, other indirect emissions and embodied emissions that occur outside of the city boundary because of activities of the city, are not included in the inventory, such as:

- marine transportation of goods
- embodied emissions upstream of power plants
- embodied emissions in fuels
- embodied emissions in imported construction materials
- embodied emissions in imported goods
- embodied emissions in imported food

A.1. Community Inventory Data Collection

Data for the community inventory is available for 1990, 1998, 2002, and 2004-2022 unless otherwise noted below. The inventory information used for the residential sector is based on the following:

- Annual electricity use data was provided by London Hydro. Note that this excludes multi-unit residential buildings, which are considered to be commercial accounts by London Hydro.
- Annual natural gas use data was provided by Enbridge Gas. Note that this excludes multi-unit residential buildings, which are considered to be commercial accounts by Union Gas.
- Other home heating fuel data (e.g., propane, fuel oil) was obtained from Statistics Canada end-use energy data for Ontario prorated by population to estimate use within London. Note that the latest information is from 2021.

The inventory information used for the business and institutional sector is based on the following:

- Annual electricity use was provided by London Hydro. Note that this includes General Service < 50 kW , General Service > 50 kW , Large Users > 5000 kW, Users with Embedded Services (e.g., co-generation plants), sentinel lights, and street lighting.
- Annual natural gas use was provided by Enbridge Gas. Note that this includes industrial, commercial, and institutional accounts.
- Other fuel data (e.g., fuel oil, kerosene) developed from Statistics Canada end-use data for Ontario prorated by population to estimate use within London. Note that the latest information is from 2021.

The inventory information used for the transportation sector is based on the following:

- Annual retail transportation fuel sales data for gasoline, ethanol-blended gasoline (E10) and diesel was provided by Kalibrate Canada. Given that London is a self-contained urban area, it is assumed that all transportation fuel used by London residents and businesses are purchased within London. This information has the benefit of being current (2022 data).
- Diesel use for public transit was provided by London Transit.
- Diesel use for road freight transportation was estimated using national-level 2021 data from Statistics Canada, prorated by population, to provide estimates that reflected the impact of the COVID-19 pandemic on road freight transportation.
- Diesel used for railways was developed from Statistics Canada energy end-use data for Ontario prorated by population to estimate use within London. Note that the latest information is from 2021.
- Community non-retail (i.e., commercial and other institutional) transportation fuel data developed from Statistics Canada end-use energy data for Ontario prorated by population to estimate use within London. Propane identified as being used in the commercial and industrial sector is assumed to be used as transportation fuel only. Note that the latest information is from 2021.
- Aviation fuel use was estimated using Ontario-level domestic aviation emissions data from *Canada's National Inventory Report 1990-2021*, prorated by population. Note that the latest information is from 2021.

The inventory information used for landfills is based on the following:

- Annual waste quantities placed within the landfills for each calendar year. Note that in 2022, City staff reviewed and revised the waste quantity values used within the Scholl Canyon model used by City staff for estimating methane generation in the landfill.
- For the W12A landfill, the emission reductions associated with the landfill gas collection and flaring system are based on continuously measured landfill gas flow rate and methane concentration at the landfill flare.
- The global warming potential (GWP) of methane of 25, as per the Intergovernmental Panel on Climate Change's *Fourth Assessment Report* and used by the federal government in recent GHG emissions reporting. Note that the City of London will apply the methane GWP of 28 from the *Fifth Assessment Report* in next year's 2023 Community Energy Use and Greenhouse Gas Emissions Inventory, in line with the federal government's GHG emissions report submissions for 2022 data.

The inventory information used for waste generated in London and disposed outside of London is based on the following:

- GHG emissions were estimated by taking the reported GHG emissions from the Twin Creek Landfill and Ridge Landfill for 2016 and dividing it by London's share of the annual fill rate at these landfills. City of London Solid Waste Management staff estimated the volume of London's industrial, commercial, and institutional (IC&I) sector solid waste disposed outside of London to be around 83,000 tonnes – 45,000 tonnes to the Twin Creek Landfill and 8,000 tonnes to landfills in Michigan.
- For the 1990 to 2016 period, the amount of IC&I waste per capita was assumed to be the same as reported last year, namely 0.31 tonnes per person. GHG emissions were estimated based on the Ontario Waste Management Association's Cap & Trade Research spreadsheet model for Ontario waste sector; based on the model's estimated 0.75 tonnes CO₂e emitted per tonne waste disposed at large landfills. It was assumed 50% landfill gas capture from 2002 to 2022, only 25% landfill gas capture for 1998, and no landfill gas capture for 1990.

As a result of London having joined the Global Covenant of Mayors in 2015, it is recommended that nitrous oxide emissions from sewage treatment be included within London's energy and GHG emissions inventory as per the Global Protocol for Community-Scale GHG Emissions Inventories (GPC). Nitrous oxide is a combustion by-product from the incineration of sewage sludge and its formation is influenced by incinerator operating conditions (i.e., combustion temperature).

Since 2008, annual stack testing at the Greenway Wastewater Treatment Plant sludge incinerator has included the measurement to nitrous oxide alongside other air pollutants. Table A-1 summarizes the nitrous oxide stack test results.

As can be seen from the table above, measured emissions of nitrous oxides can vary from year to year.

Table A-1: Summary of 2008 – 2022 Stack Test Results for Nitrous Oxide (N₂O) Emissions from the Greenway WWTP Sewage Sludge Incinerator

Year	Measured average emissions g/s	Measured average emissions kg/hour	Estimated annual emissions tonnes/year	Estimated annual CO ₂ e tonnes/year
2008	0.1	0.4	3	1,000
2009	1.1	3.9	28	8,800
2010	1.1	3.9	28	8,700
2011	1.2	4.4	32	9,900
2012	1.0	3.5	26	7,900
2013	0.2	0.6	4	1,400
2014	1.1	4.1	29	9,100
2015	1.0	3.7	26	8,200
2016	0.3	1.1	7	2,300
2017	2.4	8.6	65	20,000
2018	1.7	6.0	43	13,000
2019	1.5	5.5	33	10,200
2020	0.8	3.0	18	5,500
2021	0.5	1.6	9	2,800
2022	1.2	4.4	26	8,100

A.2. Greenhouse Gas Emission Factors for Energy Commodities

Greenhouse gas emissions associated with energy use were calculated based on the emission factors provided by *Canada's National Inventory Report 1990-2021*, except for the 2022 grid-average emission factors for Ontario, which have been estimated based on the 2022 system-wide electricity supply mix for Ontario reported by the Ontario Energy Board, combined with the data from *Canada's National Inventory Report 1990-2021*. A summary of emission factors has been provided in Table A-2.

All GHG emissions are expressed in terms of equivalent carbon dioxide (CO₂e), based on the global warming potentials (GWP) of the various GHG emissions provided by *Canada's National Inventory Report 1990-2021*.

Table A-2 – Greenhouse Gas Emission Factors and Energy Conversions

Source of Emission	Emission Factor (CO₂e)	Information Source
Electricity - Ontario 2022	0.043 kg/kWh	Estimated based on OEB information for 2022
Electricity - Ontario 2021	0.030 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2020	0.028 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2019	0.029 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2018	0.030 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2017	0.020 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2016	0.041 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2015	0.043 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2014	0.042 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2013	0.077 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2012	0.110 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2011	0.110 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2010	0.140 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2009	0.120 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2008	0.170 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2007	0.240 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2006	0.210 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2005	0.250 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2004	0.220 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2003	0.300 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
Electricity - Ontario 2002	0.290 kg/kWh	National Inventory Report, 1990-2021 - ANNEX 11
natural gas	1.90 kg/m ³	National Inventory Report, 1990-2021 - ANNEX 11
fuel oil	2.76 kg/L	National Inventory Report, 1990-2021 - ANNEX 11
propane	1.55 kg/L	National Inventory Report, 1990-2021 - ANNEX 11
gasoline	2.30 kg/L	National Inventory Report, 1990-2021 - ANNEX 11
diesel	2.71 kg/L	National Inventory Report, 1990-2021 - ANNEX 11
gasoline (E-10)	2.07 kg/L	National Inventory Report, 1990-2021 - ANNEX 11

A.3. Cost Estimates for Community Energy Use

Information on the cost of using petroleum products is based on information available from Kalibrate Canada, specifically:

- Annual retail prices (including tax) and wholesale prices for regular-grade gasoline, mid-grade gasoline, premium-grade gasoline, diesel, and furnace oil;
- Crude oil price component associated with retail fuels, allocated to Western Canada (Alberta and Saskatchewan) which is the source of oil for refineries in Sarnia;
- The refiners operating margin, which is the difference between annual crude oil prices and wholesale prices, allocated to Ontario (refineries in Sarnia);
- The Harmonized (Federal and Provincial) Sales Tax and Federal Fuel Excise Tax; and
- The marketing operating margin, which is the difference between annual retail prices the wholesale prices and federal and provincial taxes, allocated to London (gas stations).

This allocation method was reviewed and accepted as being reasonable in 2013 by Kent Marketing (now Kalibrate Canada).

Information on the cost of using electricity is based on customer rate structure information available on London Hydro's website, specifically:

- The Rate Component (\$/kWh), the Loss Adjustment Factor, and (where applicable) the Global Adjustment, which is allocated to Ontario reflect the cost to generate electricity in Ontario;
- Delivery-related costs (Distribution Variable Charge, Network Charge, Connection Charge, Rate Rider for Tax Change, and Rate Rider for Variance Account), which is allocated to London to reflect London Hydro's operations;
- Transmission-related costs, which is allocated to Ontario to reflect Hydro One's operations; and
- Regulatory-related and Government-related charges (e.g., Ontario Hydro Debt Retirement, HST).

This allocation method was reviewed and accepted as being reasonable in 2013 by Wattsworth Analysis, the City of London's energy procurement advisor.

Information on the cost of using natural gas is based on customer rate structure information available on Enbridge Gas's website, specifically:

- The Gas Commodity Rate, the Gas Price Adjustment, and Transportation, which is allocated to a mix of Western Canada (conventional gas wells) and United States (shale gas) to reflect the sources of natural gas supply and transporting this gas to Ontario;

- Storage-related costs, which is allocated to Ontario to reflect Enbridge Gas's regional and Ontario-wide storage and distribution operations;
- Delivery-related costs, which is allocated to London to reflect Enbridge Gas's local operations to supply natural gas to customers in London; and
- The HST.

This allocation method was reviewed and accepted as being reasonable by Wattsworth Analysis.

Appendix B - 2003-2019 Heating & Cooling Degree Days for London

A heating degree day (HDD) is a measurement tool used to estimate energy demand needed to heat a home or business. A similar measurement, a cooling degree day (CDD), reflects the amount of energy used to cool a home or business.

It is based on the average outdoor air temperature over an entire day. The heating needs for a home or a building are generally directly proportional to the number of HDD at that location. Heating degree days are defined relative to a base temperature; the outside temperature above which a building needs no heating. For homes, a daily average temperature of 18 °C is used as this base. Therefore, if the average temperature for a day was 8 °C, then the HDD would be 10 for that day. Similarly, if the average temperature for a day was -2 °C, then the HDD would be 20 for that day. A typical winter month would have about 700 HDDs in London.

Environment Canada produces Climate Normal data ranges over a historic 30-year period. Over the last 10 years, most winters and summers have been warmer than they were over the 1971-2000 period.

Table B-1 – Annual Residential Heating and Cooling Degree-Days for London

Year	Heating Degree-Days	Cooling Degree-Days	Heating - Difference from 30 Year Average	Cooling - Difference from 30 Year Average
2012	3,297	381	-19%	62%
2013	3,951	276	-3%	17%
2014	4,309	201	6%	-15%
2015	3,971	254	-2%	-8%
2016	3,615	343	-11%	46%
2017	3,597	271	-11%	15%
2018	3,836	392	-5%	66%
2019	3,937	277	-3%	17%
2020	3,562	347	-12%	47%
2021	3,449	336	-15%	42%
2022	3,793	295	-7%	25%
<i>Average</i>	3,756	307	-7%	30%
Climate Normal (1971-2000)	4,058	236		

Using this data, it can be assumed that, over the last 10 years, building heating needs were about seven per cent lower than they would have been back in the 1971-2000 period, and that air conditioning needs were 30 per cent higher.

Figure B-1 – Annual Residential Heating and Cooling Degree-Days for London

