TD Canada Trust LEED Platinum Branch at Wonderland and Southdale (Source: TD Canada-Trust)

CITY OF LONDON

2013 Community Energy & Greenhouse Gas Inventory

July 2014

London
CANADA

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EXECUTIVE SUMMARY

The purpose of this document is to provide an overview on energy consumption in London and associated greenhouse gas emissions during the period from 1990 to 2013. The details in the document provide a useful source of information to strengthen existing projects/programs, or to help identify new business and academic opportunities for energy efficient products and technologies, energy conservation and demand management products and services, biofuels, and renewable energy generation.

Energy use literally powers the modern city. There are many factors that influence how much energy a modern city uses to function and thrive:

- Land use and development
- Urban design
- Transportation
- Buildings
- Personal choices and actions
- Local climate & economy

COMMUNITY ENERGY USE INVENTORY

The three most common benchmarks being used for reporting on overall progress are:

- 1990 – the baseline year used for the Province of Ontario's greenhouse gas (GHG) reduction targets
- 2007 – the year energy use and greenhouse gas emissions reached their peak in London
- 2010 – the first year for which total energy cost data has been determined

Total community energy use in London in 2013 was 57,000 terajoules, 14 percent above 1990 levels, but two percent below the peak in 2007. Between 2007 and 2012, decreases in energy use were most noted for industrial, commercial, and institutional buildings (4 percent drop).

Given that 2013 experienced more normal winter temperatures compared to the unusually warm winter of 2012, overall natural gas use was up by nine percent in London.

Energy use by sector in London in 2013 was as follows:

- 43 percent from the industrial, commercial, and institutional buildings and facilities;
- 33 percent from cars and trucks on London's roads, most of which is associated with personal vehicle use; and
- 24 percent from single-family residential homes

In 2013, energy use per person in London was six percent below 1990 levels.

The biggest improvements can be seen in residential energy use per person, which was 11 percent lower than 1990. This may be attributed to improvements in the energy efficiency of consumer appliances, space heating and cooling systems, home retrofits and new home construction.

Transportation energy use per person was also six percent below 1990 levels. This may reflect the shift in vehicle use and vehicle preferences associated with the oil price spike of 2008, and the subsequent higher fuel prices above the $1.00 per litre range. However, compared to 2012, fuel use was up five percent. The reason for this increase is not known, although Kent Marketing suspects that the relatively low retail prices for fuel in London may be encouraging out-of-town commuters to fill up in London more often.

Energy use per person related to the local economy in 2013 was three percent lower than 1990. In recent years, energy use by local employers has dropped significantly; with energy use per person being 14 percent lower than it was at its peak in 2004. Part of this can be attributed to the slow recovery from the recession. However, local utilities such as London Hydro and Union Gas have also been increasing efforts to promote energy conservation and demand management with their business client base.

Sources of Energy Used in London

In terms of sources of energy, natural gas is the largest source of energy used in London, accounting for 43 percent of all energy used in London in 2013. Gasoline was the second largest source of energy, accounting for 25 percent of London's energy use. Electricity accounted for 21 percent of all of the energy used in London.

Translating Energy Use Into Economic And Business Development Opportunities

It is estimated that Londoners spent about $1.5 billion on energy in 2013. Gasoline and electricity are the most prominent costs, accounting for 36 and 34 percent respectively of the total cost. Due to low natural gas prices, natural gas use accounts for only 16 percent of energy costs, even though it is the largest source of energy we use.

Every percentage that Londoners reduce their energy use results in around $12 million staying in London. For example, retrofitting existing buildings and constructing new green buildings creates jobs for energy-saving product and service providers, and increases the skills and knowledge base of London service providers. Numerous examples of these activities occur in London.

Energy Generation in London

Between 2008 and 2013, embedded electricity generation purchases (i.e., locally produced electricity) have increased from 0.2 percent to 1.2 percent of London's electricity needs.

London has over 53 megawatts of local electricity generation capacity installed to date. Most of this local capacity is associated with combined heat and power cogeneration plants, including the 2013 expansion of the cogeneration plant at Victoria Hospital.

As of April 2014, there was 3.3 megawatts of solar photovoltaic (PV) in operation in London. In addition, Harvest Power's 2.85 megawatt biogas facility was commissioned in 2013. Fanshawe Dam also provides 0.675 megawatts of hydro-electric power.

Translating Energy Use to Greenhouse Gas Impact

The total energy-based greenhouse gas emissions in London for 2013 were 2.9 million tonnes, expressed in terms of equivalent carbon dioxide (CO_2e). This represents 96 per cent of the total human activity based greenhouse gas emissions from London (3.1 million tonnes) in 2013.

Greenhouse gases are created by burning fossil fuels such as gasoline, diesel, and natural gas. In addition, electricity use still contributes to greenhouse gas emissions, although electricity is much cleaner than it was ten years ago.

The remaining four percent of greenhouse gas emissions associated with human activity are produced during the anaerobic decomposition of organic materials in the active and closed landfills located in London.

Total greenhouse gas emissions from London have decreased compared to the "peak" in 2007, as seen in Figure i. In 2013, greenhouse gas emissions were 18 percent lower than 2007. In fact, London's emissions in 2013 were seven percent lower than the 1990 level used to benchmark emission reduction efforts. This is below the Kyoto Protocol objective (six percent below 1990) that Canada had previously committed to.

Greenhouse gas emissions associated with electricity are significantly lower in 2013 (about 70 percent) than their peak in 2003. In 2013 only two percent of Ontario's electricity demand was generated by burning coal, and 11 percent was generated by burning natural gas. The rest of Ontario's electricity demand was met with emissions-free generation:

- 59 percent nuclear
- 23 percent hydroelectric
- 4 percent wind and other renewables

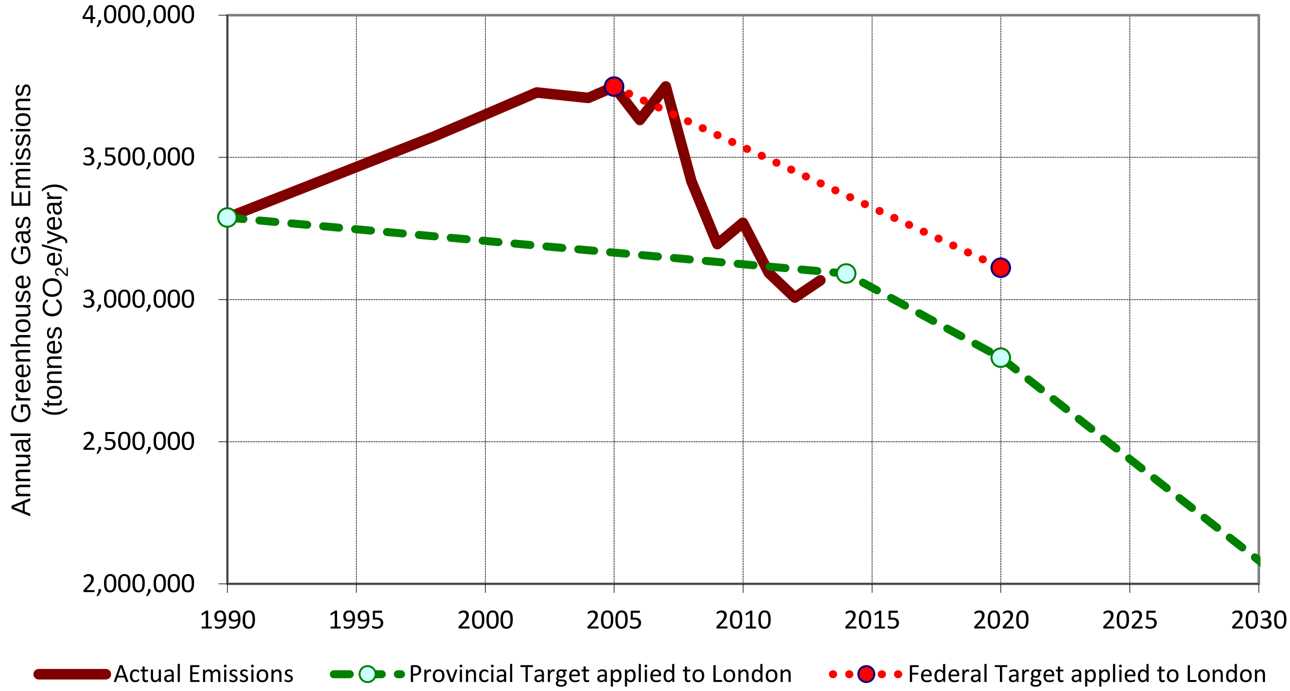
Conservation and peak demand reduction programs also contribute to lower emissions from power generation. Unfortunately, lower demand from the economic slow-down in manufacturing sector also contributes to lower emissions.

To date, London has followed the greenhouse gas emission reduction goals of the Province of Ontario, namely a six percent reduction from 1990 levels by 2014, a 15 percent reduction from 1990 levels by 2020, and a long-term goal of an 80 percent reduction from 1990 levels by 2050.

The trend observed in 2013 would seem to suggest that this 2014 goal is within reach, although the colder than normal winter experienced in 2014 will increase the demand for natural gas and electricity for space heating.

Whether emissions continue to decrease depends upon the impact of energy and fuel conservation efforts, provincial electricity generation plans, climate trends, economic growth, and consumer choices.

Figure i – London's Greenhouse Gas Emission Trend versus Federal and Provincial Reduction Targets



1 PURPOSE OF THIS DOCUMENT

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

- energy consumption in London (a high level inventory of energy use) during the period from 1990 to 2013;
- associated greenhouse gas emissions; and
- energy expenditures in London.

Looking ahead, emerging from the recent recession poses many challenges for local households and residents. As the economy begins to grow again, this also provides an opportunity for it to grow in a more sustainable manner.

Energy efficiency and conservation provides important opportunities to reduce costs. The majority of money spent on energy leaves London, but money spent on energy efficiency and conservation stays in London in more ways than one. It supports local businesses offering these products and services, while the resulting money saved from energy efficiency and conservation can then be used for more productive uses.

Many people benefit from the use of energy efficiency, renewable energy, and energy conservation products and services:

- Households can help the environment and typically save more money in the long run.
- Business owners and managers can reduce operating costs, become role models for corporate social responsibility, and position themselves with a competitive advantage.
- Students and teachers can benefit from learning about our current, unsustainable demand for energy and how energy conservation, energy efficiency and renewable energy technologies can help our environment and replace fossil fuels that are being depleted.
- Innovators can create new energy-efficient and renewable energy products and services, and become architects of change.

2 BACKGROUND

Energy use literally powers the modern city. There are many factors that influence how much energy a modern city uses to function and thrive:

Land use and development – planning city growth sets the framework for how much energy is needed for the modern 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 to community services, retail, and places of employment.

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 sidewalks and bike lanes/paths, connectivity between residential and other land uses, streetscape design, and street orientation.

Transportation – transportation planning has to account 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 modern city's transportation network often has to serve both needs at the same time. An energy efficient transportation system is one that provides a number of competitive choices for the movement of people and goods.

Buildings – The design, construction, and maintenance of all building types (homes, office buildings, industrial buildings) has a significant impact on the energy consumed by that building. New buildings can be designed that approach net-zero energy use, but the vast majority of London's building stock are old, inefficient designs that often have unseen problems with their building envelope. 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 heating than for summer space 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.

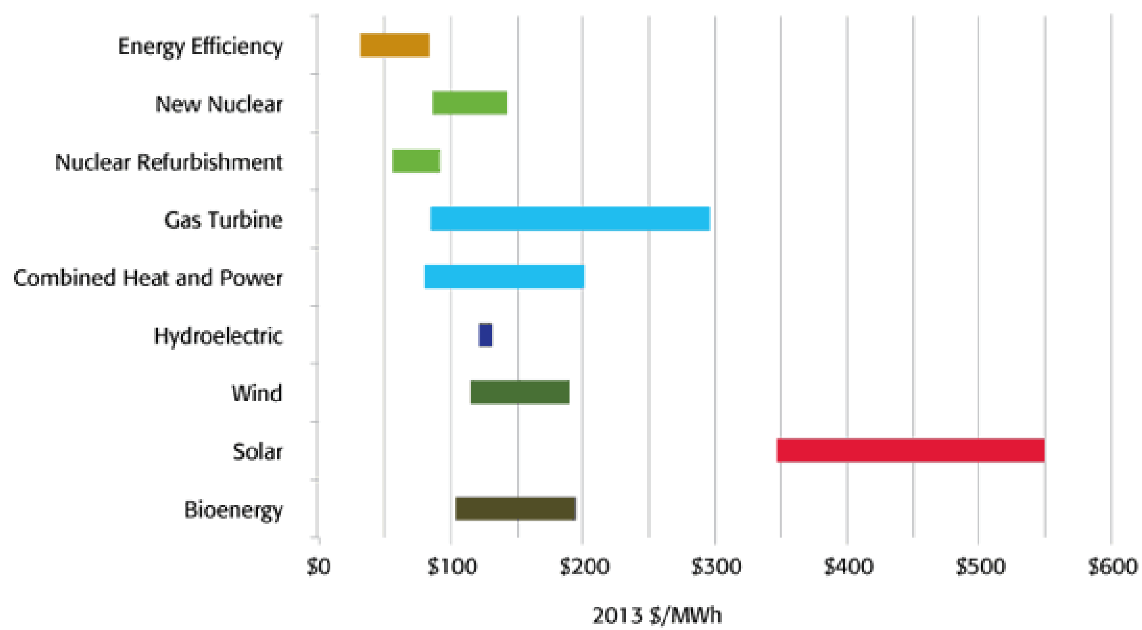
Seasonal weather variations can affect energy use and associated emissions. London's climate is one that is dominated by the heating demand during cold weather months.

On average, heating season starts in late September and ends in early May. With climate change, the energy demands for heating are 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 demand for air conditioning is expected to increase.

Ontario currently relies heavily on petroleum fuels and natural gas to meet most of its energy needs. Fossil fuels are non-renewable, finite resources that will eventually be depleted. However, national and international energy boards and agencies do not report any immediate concerns about the ability to supply oil and other key energy commodities for the next 20 years. However, they do assume that oil and other energy commodities will become more expensive over time.

In contrast, renewable energy resources — such as wind and biomass energy — which have been expensive to utilize, are starting to become competitive with conventional energy.



Source - Conservation First: A Renewed Vision for Energy Conservation in Ontario, Province of Ontario, 2013

3 PREVIOUS INVENTORY REPORTS

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

- *2012 Community Energy & Greenhouse Gas Inventory: Challenges & Opportunities,* prepared by the City of London for the Civic Works Committee in October 2013.

- *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.

- *Air Emissions and Energy Use in the City of London*, prepared for the London Energy/Air Emissions Reduction Strategy Task Force in March 2000.

- *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.

In addition, 2011 data was highlighted in the *Environmental Programs Update,* prepared for the Civic Works Committee meeting on May 14, 2012.

4 COMMUNITY ENERGY USE INVENTORY

Total community energy use in London in 2013 was 57,000 terajoules, 14 percent above 1990 levels, but two percent below the recent peak in 2007, as seen in Figure 1 and Table 1. As seen from Figure 1, London's total energy use has dropped below the forecasted "business as usual" track forecasted in the 1990s. This illustrates the impact that recent energy conservation activities have had.

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

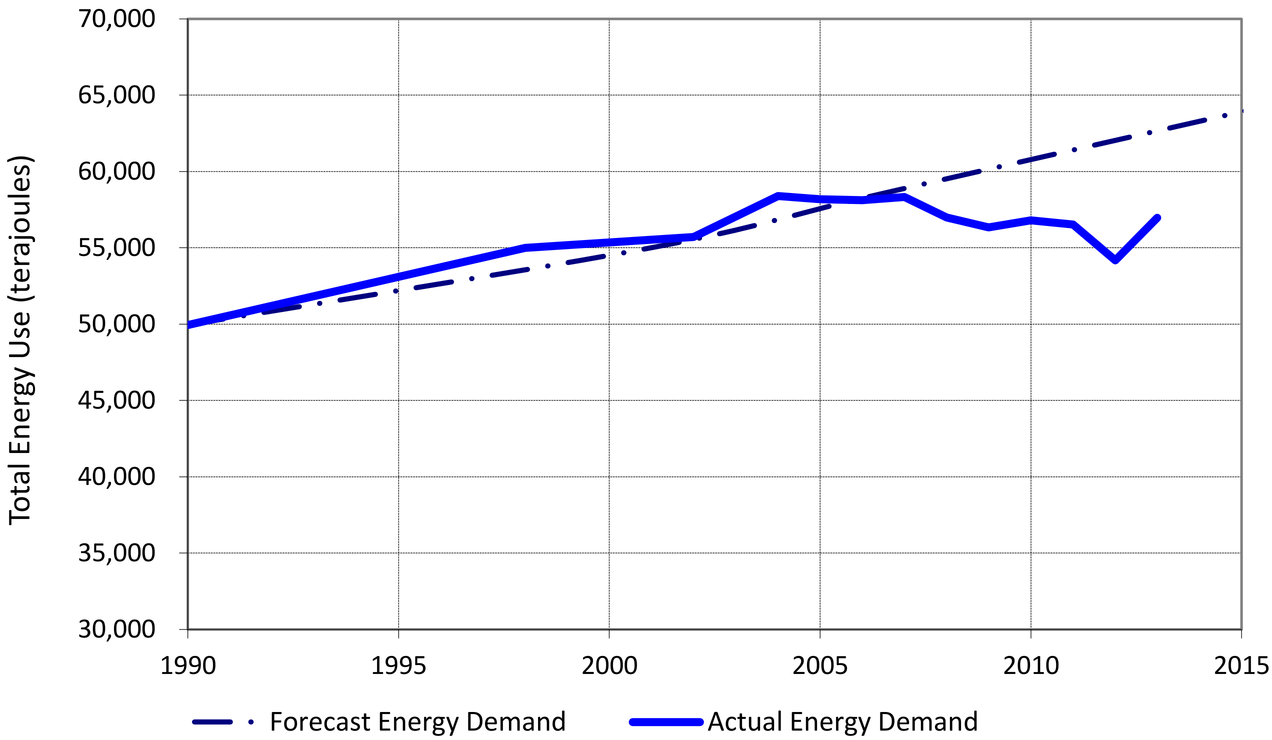


Table 1 – 1990-2013 Community Energy Use Trend by Sector

Sector	Total Energy Use (Terajoules/year) and Share of Total Energy Demand		
	1990	**2007**	**2013**
Transportation	16,600 (33%)	19,500 (33%)	19,000 (33%)
Residential	13,100 (26%)	14,000 (24%)	14,200 (24%)
Industrial, Commercial & Institutional (IC&I)	20,200 (41%)	24,800 (43%)	23,800 (43%)
Total	**50,000**	**58,300**	**57,000**

NOTE: due to rounding of numbers, individual numbers may no add up to the total

London's industrial, commercial, and institutional buildings and facilities accounted for 43 percent of all energy used in London. London Hydro and Union Gas include multi-unit residential buildings (apartment buildings and condominiums) under the category of commercial buildings. Cars and trucks on London's roads accounted for 33 percent of all energy used in London, most of which is associated with personal vehicle use. Single family residential homes accounted for 24 percent of all the energy used in London.

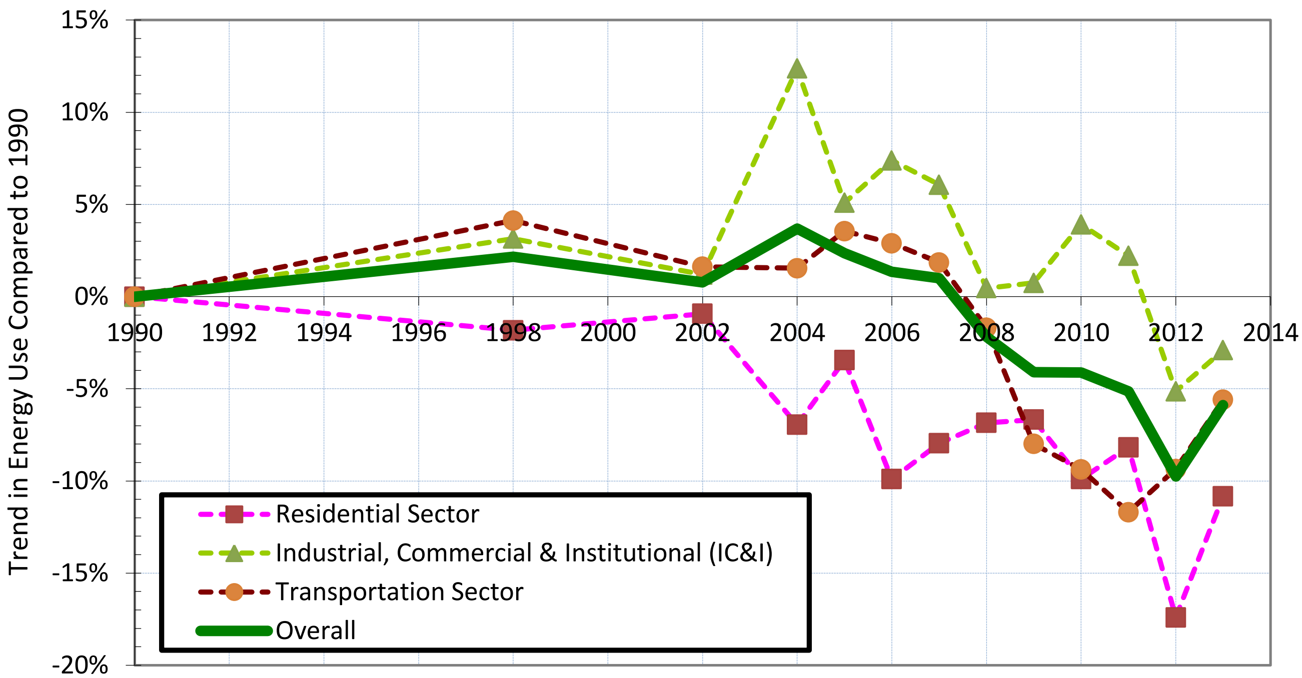
In the same time period (1990-2013), London's population has increased by 21 percent. Energy use per person in London was 153 gigajoules (GJ) per year in 2013, down seven percent from 2007 and down six percent from the 1990 baseline level (Table 2).

Table 2 – 1990-2013 Per Person Energy Use Trend by Sector

Sector	Per person Energy Use (GJ/person)			
	1990 (Pop. 307,000)	2007 (Pop. 355,000)	2013 (Pop. 372,000)	Change from 1990
Transportation	54	55	51	-6%
Residential	43	39	38	-11%
Industrial, Commercial & Institutional (IC&I)	66	70	64	-3%
Total	**163**	**164**	**153**	**-6%**

Figure 2 illustrates the change in energy consumption in London by sector on a per person basis, using 1990 as the baseline year.

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



The impact of the unusually warm winter of 2012 can be seen clearly in Figure 1, especially for the residential sector. However, residential energy efficiency has still seen improvements that may be attributed to improvements in the energy efficiency of consumer appliances, space heating and cooling systems, home retrofits and new home construction (e.g., ENERGY STAR® New Homes). There are still many more opportunities for household energy conservation. According to Natural Resources Canada, homes that are more than 25 years old have the potential to save an average of 35 percent of their energy use on space heating alone. Homes that are more than 50 years old could achieve even greater savings – an average of 38 percent.

The retail sales of fuel in London increased by seven percent in 2013 compared to 2012. This trend was not observed in the rest of Ontario, where overall retail fuel sales increased by only 0.6 percent. Kent Marketing notes that London has of the lowest margins (and thus most competitive prices) of any market in Ontario, and they suspect that people who do commute in to London are more likely to buy their gas in London due to lower prices here.

Nevertheless, transportation fuel efficiency is still better than it was in 2005, which can be attributed to a combination of higher fuel prices and improved fuel efficiency in newer vehicles. However, there are still many opportunities for energy conservation on the road. According to London's *Transportation Master Plan*, around 84 percent of all personal trips made in London during the weekday afternoon peak period are made in personal vehicles, and most of these only have one occupant – the driver.

4.1 Energy Use and the Local Economy

Energy use per person related to the industrial, commercial, and institutional sector in 2013 was two percent lower than 1990. Since 2007, energy use per person by local employers has been trending lower, with energy use per person being eight percent lower. Part of this can be attributed to the impact of the 2008-2009 recession. However, local utilities such as London Hydro and Union Gas 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). According to statistics from the London Economic Development Corporation (LEDC) and the Conference Board of Canada, London's GDP grew 33 percent between 1995 and 2005, but then only three percent between 2006 and 2013. Based on GDP estimates for 1990, energy use per unit GDP from London's employment sector has dropped by almost 30 percent. This means that local industries 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. Table 3 illustrates this in more detail.

Table 3 – 1990-2013 Energy-Efficiency of London's Employment (IC&I) Sector

	1990	1998	2006	2013
Gross Domestic Product ($ millions GDP[1])	$8,600[2]	$10,500[2]	$13,600	$13,900
Energy Used by IC&I Sector (TJ)	20,200	22,500	25,000	23,800
Energy Efficiency (GJ per $ million GDP) [3]	2,400	2,100	1,800	1,700
Improvement in Efficiency Since 1990		13%	25%	29%

1 – GDP data based on the London Census Metropolitan Area (includes St. Thomas & Strathroy), prorated by 77% based on population of London

2 – Extrapolated from 1995 and 2000 figures

3 – Energy use divided by London's GDP

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 (SMEs) who may not have the human, financial, and/or technical resources to manage their energy use effectively.

4.2 Energy Commodities Used in London

The breakdown of energy use and greenhouse gas emissions by commodity is outlined in Table 4.

As seen from the table, natural gas is the largest source of energy used in London, accounting for 43 percent of all energy used in London in 2013. The increase in natural gas demand can be attributed primarily to the increased demand from London's industrial sector, which doubled between 1990 and 2012. Some of this demand can be contributed in part to the increased use of natural gas for co-generation of heat and electricity in London. Cogeneration significantly increases energy efficiency, in that waste heat from electricity generation is used to provide heat for space heating and industrial processes.

Gasoline was the second largest source of energy, accounting for 23 percent of London's energy use. Electricity accounted for 21 percent of all of the energy used in London.

For transportation fuels, at least 80 percent of all of the gasoline sold in gas stations in London was ethanol blended gasoline (10% ethanol).

Table 4 – 2013 Community Energy Use by Energy Commodity

Energy Commodity	Total Used	Energy (Terajoules)	Energy (%)
Diesel[1]	104,700,000 L	4,050	7%
Electricity	3,327,000 MWh	12,000	21%
Fuel Oil[1]	31,300,000 L	1,210	2%
Gasoline[1]	391,300,000 L	13,580	23%
Ethanol (in ethanol-blended gasoline)	30,700,000 L	720	1%
Natural Gas	656,900,000 m^3	24,460	43%
Propane[1]	43,300,000 L	1,100	2%
	Total	**57,000**	

1 – includes some data prorated from Ontario consumption data provided by Statistics Canada; 2012 data

For electricity, it is important to note that a mix of energy sources is used in Ontario to generate electricity. In 2013, 59 percent of Ontario's electricity was supplied by nuclear generating stations, while hydroelectric generating stations supplied 23 percent. The natural gas fired generating stations provided 11 percent of Ontario's supply in 2012, surpassing coal fired generating stations that supplied only two percent. Wind turbines, biomass fired generating stations, and other renewable sources of electricity provided over four percent of our electricity needs.

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 energy released by fuel combustion (or nuclear fission in the case of nuclear power plants) ends up being converted to mechanical or electrical energy. The rest of the energy often ends up being lost as "waste heat". For example, converting heat into power in electricity generating stations is usually about 33 percent (higher for combined cycle gas-fired power plants – about 50%).

It is also important to note that the same thermal efficiency issue comes in to play with the internal combustion engines used in vehicles, which are about 35 percent efficiency when running in highway driving, and about 20 percent 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 technically more efficient overall, even more so when sources like hydroelectricity are used.

Almost all large power generating stations in Ontario do not recover waste heat. When the thermal efficiency of converting heat into power in electricity generating stations is taken into account, a different picture of our energy needs emerges, as seen in Table 5.

Table 5 – 2013 Energy Use in Electricity Generation Accounting for Thermal Efficiency

Source of Energy	Energy (Terajoules)	Energy Mix (%)
Natural Gas[1]	2,660	9%
Uranium[2]	21,490	76%
Hydroelectric	2,800	10%
Coal[2]	760	3%
Wind	410	1.4%
Biomass[2] & Other Renewables	100	0.3%
Total	**28,210**	

1 – Assumed 50% thermal efficiency for generating electricity
2 – Assumed 33% thermal efficiency for generating electricity

Table 5 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, natural gas or coal) into electrical energy. In most cases, the remaining heat from large electricity generation plants is wasted. For London's electricity needs in 2013, around 28,200 terajoules of energy resources were consumed to provide London with 12,000 terajoules of electricity – the remaining 16,200 terajoules of energy was waste heat that was not utilized. There are other "losses" that occur in energy distribution, such as line losses from power transmission which have not been quantified. However, this table helps to illustrate that greater use of cogeneration (or combined heat and power) plants will help to reduce this waste.

Table 6 outlines the trend in per person energy commodity use since 1990.

Table 6 – 1990-2013 Per Person Energy Use Trend by Energy Commodity

Energy Commodity	Total Energy Use Per Person (Gigajoules/person)			
	1990	2007	2013	Change from 1990
Diesel	11	12	11	2%
Electricity	34	35	32	-6%
Fuel Oil	7.2	3.5	3.3	-55%
Gasoline (including ethanol-blended gasoline)	41	41	38	-7%
Natural Gas	67	68	66	-2%
Propane	2.4	2.1	3.0	23%
Total	**163**	**164**	**153**	**-6%**

Most of the energy London uses comes from sources outside London. However, the local production of energy – electricity in particular – has been increasing. Between 2008 and 2013, and amount of embedded electricity generation purchased in London increased from 6,300 megawatt-hours to 40,700 megawatt-hours. Additional information on local generation can be found in Section 5.2.

5 ENERGY EXPENDITURES AND ENERGY GENERATION

5.1 ENERGY EXPENDITURES IN LONDON

Using information on utility billing rates and fuel price data from the Ontario Ministry of Energy, 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 we collectively spend on energy, and the opportunities arising from energy conservation, is important for London. Table 7 outlines the total estimated costs associated with the energy commodities used in London.

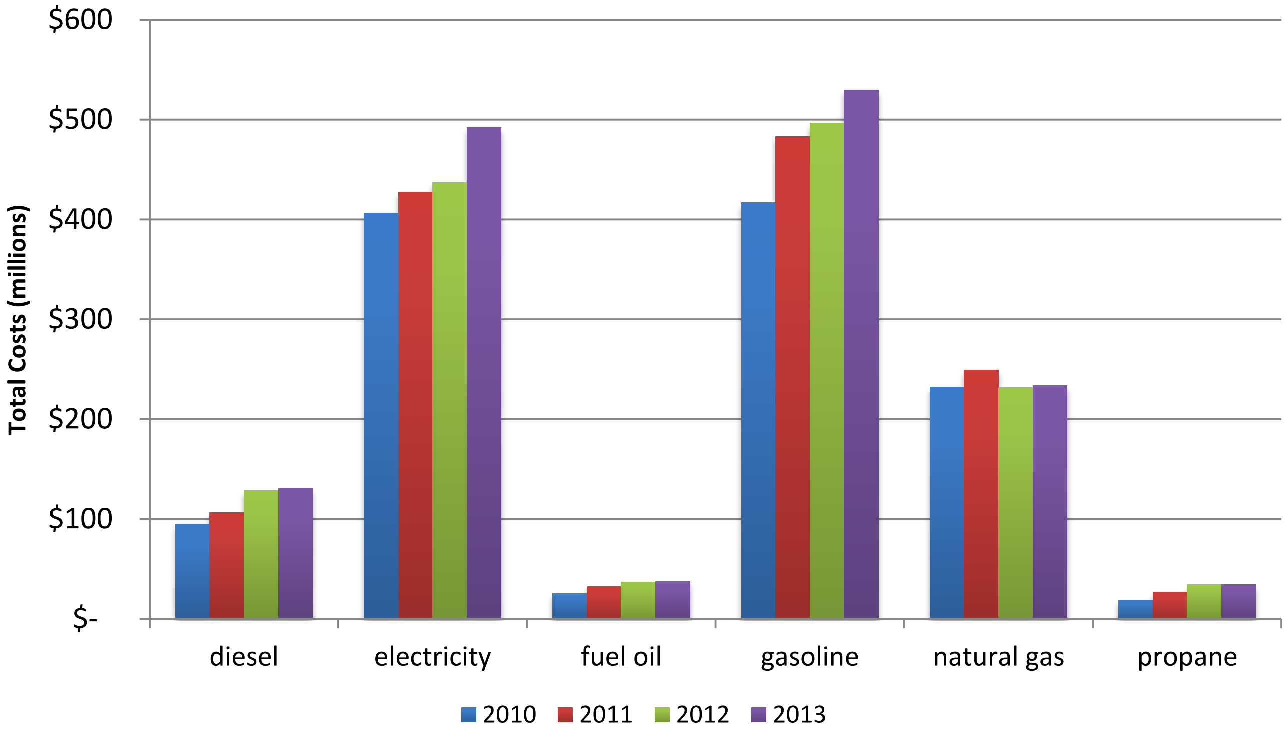
Table 7 – Total Estimated Cost by Energy Commodity in 2013

Energy Commodity	**Estimated Energy Cost**			
	Cost ($ million)	**Share (%)**	**Energy (TJ)**	**Price ($/GJ)**
Diesel	$ 131	9 %	4,050	$ 32
Electricity	$ 492	34%	12,000	$ 41
Fuel Oil	$ 38	3 %	1,210	$ 31
Gasoline (including ethanol-blended gasoline)	$ 530	36 %	14,170	$ 37
Natural Gas	$ 234	16 %	24,460	$ 10
Propane	$ 35	2 %	1,100	$ 31
Total	**$ 1,459**		**57,000**	**$ 26**

In total, London spent about $1.5 billion on energy in 2013, with gasoline and electricity both being a significant share of the cost. This represents about ten percent of London's GDP.

Over the last four years, total gasoline and electricity costs have been rising the most, while total natural gas costs have remained relatively flat with the recent lower prices, as seen in Figure 3.

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

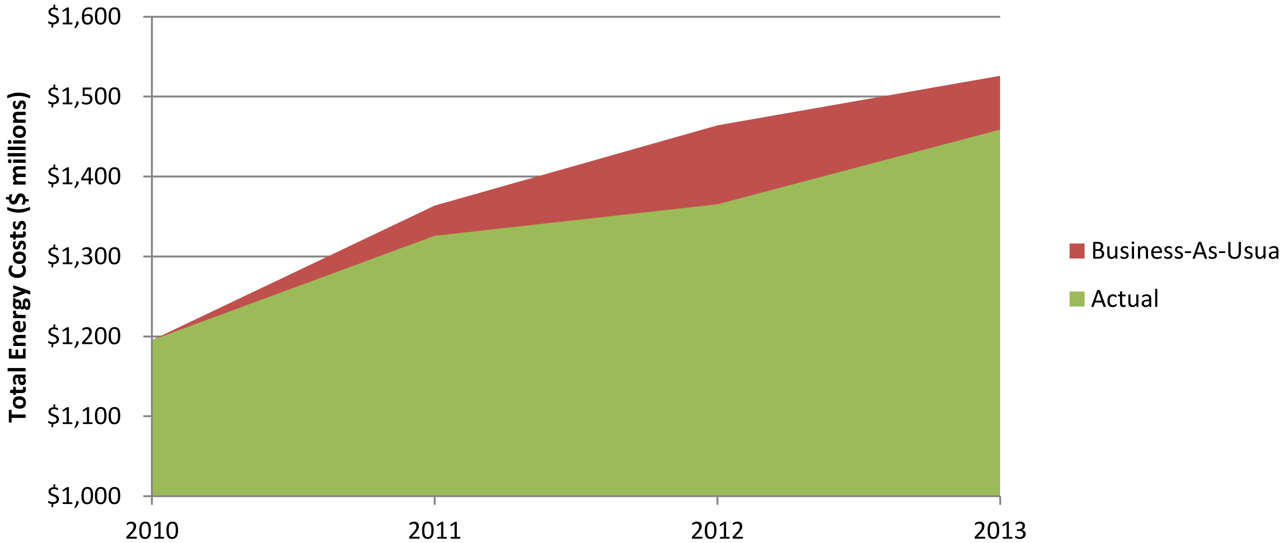


Electricity cost increases have been driven primarily by the increased price for electricity. In 2013, the "all-in" price (commodity costs, distribution costs, other charges and taxes) for electricity for residential customers was around 16.5 cents per kilowatt-hour, compared to 13.5 cents per kilowatt-hour in 2010.

Gasoline costs have also been driven by higher gasoline prices in recent years (around $1.25/L in 2012 and 2013) compared to 2010 (around $1.03/L). The increased in gasoline use in 2013 also contributed to increased costs.

However, it is important to note that costs could have been higher. If we use 2010 as a baseline year in terms of energy use per capita, we can see in Figure 4 that recent improvements in energy efficiency have created ongoing savings. In 2013, it is estimated that almost $70 million in energy costs were avoided though energy efficiency.

Figure 4 – Trend for Total Energy Costs Compared to 2010 Energy Efficiency Baseline



Information from utility billing rates and fuel price data can also be used to provide a reasonable estimate where the money spent by Londoners on energy ends up, as illustrated in Table 8. Out of the $1.5 billion spent on energy in 2013, it is estimated that about 12 percent of this money stayed in London, most of which went towards London Hydro's and Union Gas's local operations. The rest ends up leaving London.

Table 8 – Estimated Share of Energy Revenue (2013)

	Where the Money Goes (% share)					
Commodity	**London Region**	**Ontario - Business**	**Ontario - Government**	**Western Canada**	**Canada - Government**	**United States**
Diesel	1%	2%	2%	4%	1%	-
Electricity	5%	23%	5%	-	1%	-
Fuel Oil	<1%	1%	<1%	1%	<1%	-
Gasoline	1%	7%	7%	17%	4%	-
Natural Gas	4%	3%	1%	4%	1%	3%
Propane	1%	1%	<1%	-	<1%	-
Total	**12%**	**36%**	**15%**	**26%**	**7%**	**3%**

Over one-third of this money ends up going to other parts of Ontario, for power generators and transmission lines, petroleum refineries in Sarnia, and regional natural gas storage and transmission. Londoners and London business send about $390 million (26%) of their energy payments to Western Canada with a large portion landing in the Province of Alberta.

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 and other infrastructure. Also, energy conservation incentives offered by utility companies are also funded through utility bills, as it is usually more economical to invest in conserving energy rather than it is to build new power plants.

5.2 Energy Generation in London

Between 2008 and 2013, embedded electricity generation purchases (i.e., locally produced electricity) have increased from 0.2 percent to 1.2 percent of London's electricity needs.

London has over 53 megawatts of local electricity generation capacity installed to date. Most of this local capacity is associated with combined heat and power cogeneration plants at London District Energy, Ingredion, London Health Sciences Centre, and Labatt Brewery. In 2013, LHSC expanded the cogeneration plant at Victoria Hospital from 6.4 megawatts to 9.6 megawatts.

For local renewable energy generation, as of April 2014, there was 3.3 megawatts of solar photovoltaic (PV) in operation, and Harvest Power's 2.85 megawatt biogas facility is being commissioned. Fanshawe Dam also provides 0.675 megawatts of hydro-electric power. An additional 5.4 megawatt s of solar PV projects in London has been approved by the Ontario Power Authority under the Feed-In Tariff FIT 2.1 round of procurement.

6 TRANSLATING ENERGY USE INTO GREENHOUSE GAS IMPACT

Energy use in London was responsible for over 2.9 million tonnes of greenhouse gas emissions (expressed in terms of equivalent carbon dioxide, or CO_2e) in 2013. Table 9 provides additional information on greenhouse gas emissions associated with the various sources of energy used in London.

Table 9 – 2013 Greenhouse Gas Emissions by Energy Commodity

Energy Commodity	Energy (Terajoules)	GHG (kilotonnes CO_2e)	GHG (%)	GHG Intensity (tonnes/TJ)
Diesel	4,050	296	10%	73
Electricity	12,000	299	10%	25
Fuel Oil	1,210	86	3%	73
Gasoline	3,990	271	9%	68
Gasoline (10% ethanol)	10,180	659	23%	65
Natural Gas	24,460	1,137	43%	51
Propane	1,100	67	2%	61
Total	**57,000**	**2,920**		

Energy use is responsible for 96 per cent of all greenhouse gas 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 greenhouse gas associated with human activity – but the use of electricity also contributes to greenhouse gas emission.

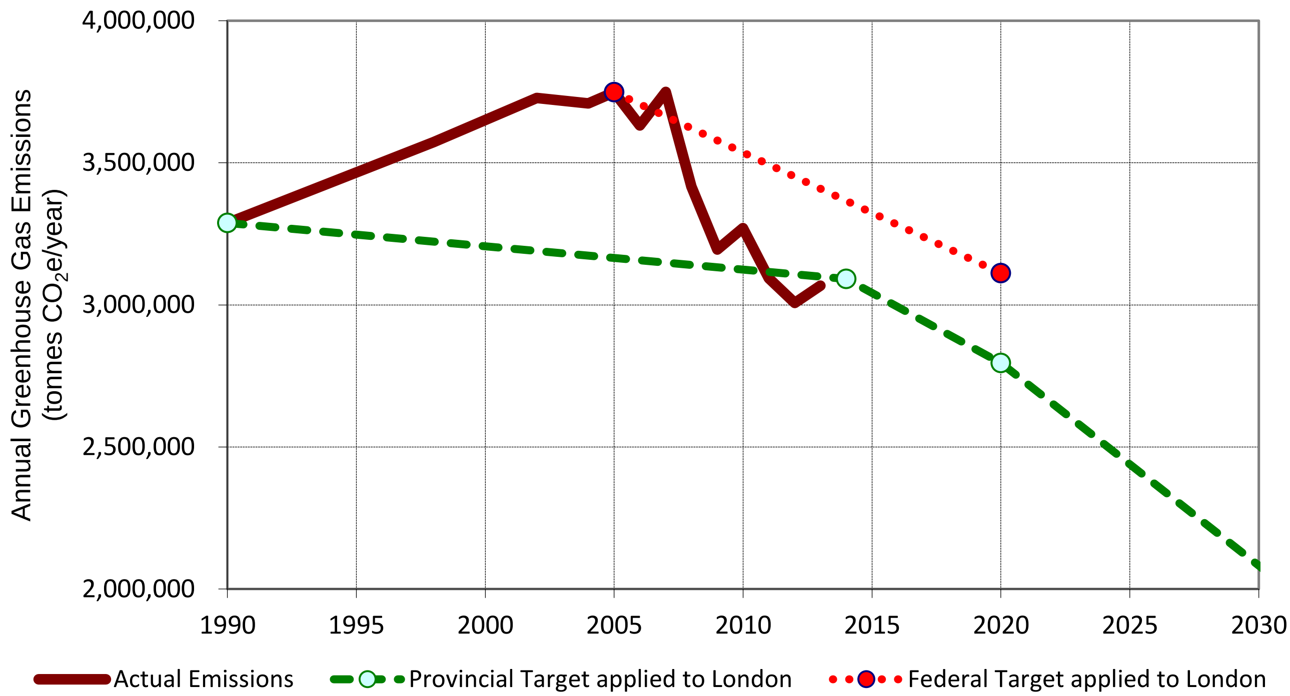
Over 80 percent of Ontario's electricity is generated from emissions-free sources, such as nuclear and hydro-electric generating stations. However, Ontario still relies on fossil fuels such as natural gas and coal to generate about one-eighth of the electricity we use. In 2013, every 1,000 kilowatt-hours of electricity generated in Ontario produced around 90 kilograms of carbon dioxide emissions. This is significantly better than it was 10 years ago (2003), when electricity generated in Ontario produced around 300 kilograms of carbon dioxide emissions.

The remaining five percent of greenhouse gas emissions from human activity in London comes from the anaerobic decomposition of organic materials in the City of London's active and closed landfills. This brings London's total greenhouse gas emissions to 3.07 million tonnes, expressed in terms of equivalent carbon dioxide.

Figure 5 illustrate the total greenhouse gas emission trend since 1990, including landfill gas emissions.

To date, London has followed the greenhouse gas reduction goals of the Province of Ontario, namely a six percent reduction from 1990 levels by 2014, a 15 percent reduction from 1990 levels by 2020, and a long-term goal of an 80 percent reduction from 1990 levels by 2050.

Figure 5 - Targets vs. Actual Greenhouse Gas Emissions from London



The increase in greenhouse gas emissions began to stabilize around 2002 after a continued climb from 1990. Since 2005 there has been a downward trend (Figure 3).

Seasonal weather variations can affect energy use and associated emissions. In 2012, the unusually warm winter reduced energy needs for heating buildings. In 2009, we experienced an unusually "cool" summer. As a result, the demand for electricity for air conditioning was lower, which reduced the need for fossil fuel generating stations that are normally used to provide electricity for air conditioning. Overall, 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).

The 2008 to 2010 economic recession also contributed to reduced energy demand, which would also have contributed to the reduced need for fossil fuel generating stations.

Table 10 illustrates the greenhouse gas emission trends by sector, including landfill gas emissions from active and closed landfills. As seen in table 10, transportation and the industrial, commercial, and institutional sectors have the greatest contribution.

Table 10 – 1990-2013 Community Greenhouse Gas Inventory Trend

Sector	Greenhouse Gas Emissions (kilotonnes/year)		
	1990	2007	2013
Transportation	1,188	1,340	1,271
Residential	743	789	630
Industrial, Commercial & Institutional	1,135	1,410	1,019
Landfill Gas Emissions	223	209	148
Total	**3,290**	**3,750**	**3,070**

In terms of per person emissions, as illustrated in Table 11, emissions today are 24 percent lower than they were back in 1990 (10.7 tonnes per person in 1990 versus 8.2 tonnes per person in 2013).

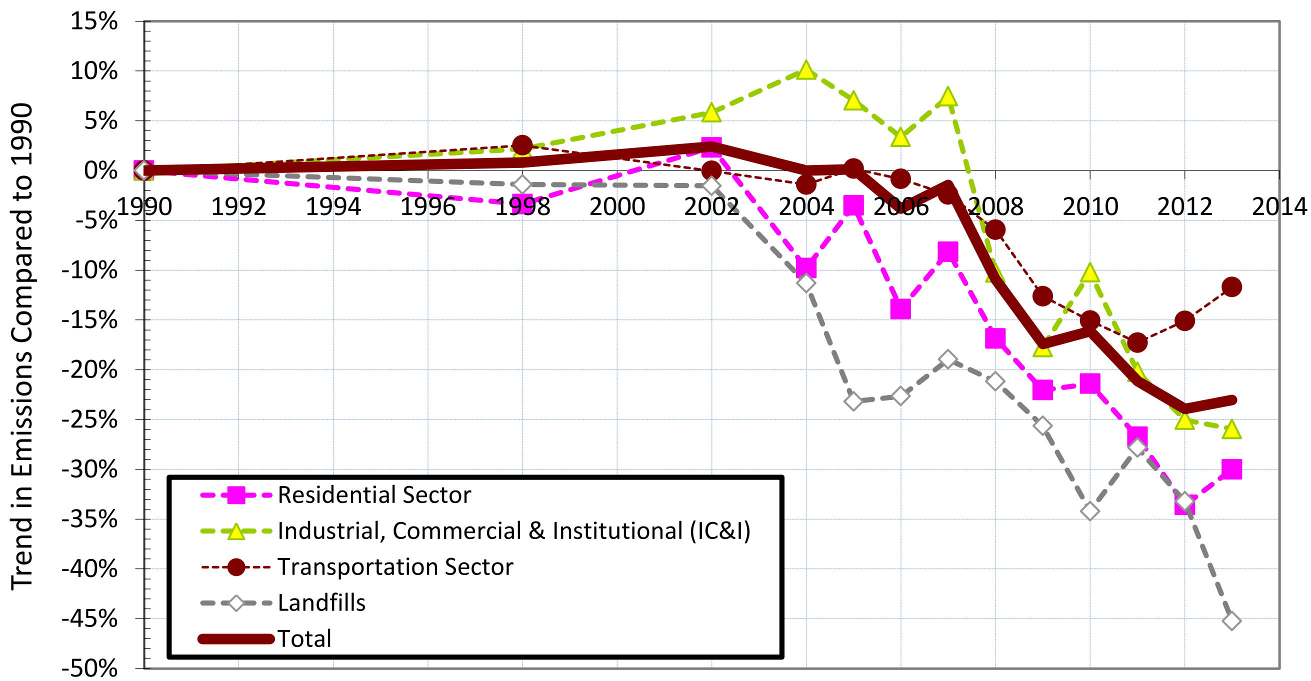
Table 11 – 1990-2013 Per Person Greenhouse Gas Inventory Trend

Sector	Greenhouse Gas Emissions (tonnes/person)			
	1990 (Pop. 307,000)	2007 (Pop. 355,000)	2013 (Pop. 372,000)	Change from 1990
Transportation	3.9	3.8	3.4	-12%
Residential	2.4	2.2	1.7	-30%
Industrial, Commercial & Institutional	3.7	4.0	2.7	-26%
Landfill Gas Emissions	0.7	0.6	0.4	-45%
Total	**10.7**	**10.6**	**8.2**	**-23%**

As discussed before, reduced greenhouse gas intensity of Ontario's electricity grid, reduced energy use in the business sector, reduced transportation fuel use, and the City of London landfill gas collection and flaring system at the W12A Landfill have all contributed to this reduction of greenhouse gas emissions, as illustrated in both Table 10 and Table 11.

It is important to note these greenhouse gas emission estimates only cover Tier 1 emissions (direct – fuel combustion such as natural gas, gasoline, etc.) and Tier 2 emissions (indirect – emissions from electricity use associated with Ontario's generation supply mix). There is currently no simple methodology for calculating, at the community scale, Tier 3 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, air travel, etc.)

Figure 6 – Change in GHG Emissions in London, Per Person by Sector, Since 1990



7 CONCLUSIONS

7.1 Energy Use

Since 2005, London has seen its total energy use break away from the trend which was heading upwards. At first, total energy use leveled off. However, starting in 2008, total energy across the city began to decline. Higher fuel prices, combined with the impact that recent Government of Canada fuel efficiency standards have had on newer cars, have resulted in lower retail sales of fuel here in London.

Residential (single family home) energy efficiency has seen a gradual improvement starting around 2004. This was initially driven by previous energy conservation programs such as 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 initially by voluntary participation in efficiency programs such as Energy Star New Homes. With the 2012 Ontario Building Code, Energy Star level performance has now been made standard for all new homes.

The data suggests that energy efficiency for London's industrial, commercial, and institutional sector have lagged behind. However, data from 2013 shows this sector catching up. London has many examples of local employers who have taken action on energy efficiency and conservation, some of which were highlighted in the 2013 Celebrating Progress magazine produced by the City of London and the Mayor's Sustainable Energy Council.

7.2 Opportunities for London

Out of the $1.5 billion spent on energy in 2013, it is estimated that about 12 percent of this money stayed in London. London would be better off keeping more of its money in London. Every percentage that Londoners and London business reduce energy use keeps about $12 million from leaving our economy. Money saved through energy efficiency and conservation can be used for other purposes, whether that's paying down debts faster or purchasing other goods and services. Investing in energy saving retrofits, local sustainable energy projects and local energy production creates local jobs.

7.3 Greenhouse Gas Emissions

The reductions in energy use noted above are a main driver for London's significant reductions in greenhouse gas emissions. Credit should also be given to the Government of Ontario for following though in 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. Greenhouse gas emissions from the province's electricity grid are now over two-thirds lower than they were ten years ago. The contribution from the Government of Canada's vehicle fuel efficiency standard has also had a noticeable impact. Finally, the City of London's landfill gas collection and flaring system represents the largest source of greenhouse gas emissions directly under municipal government control. Municipal Council has made significant investments to reduce emissions from this source.

APPENDIX A - METHODOLOGY

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

- The 1995 *City of London Air Emissions S*tudy, prepared by SENES Consultants in association with Proctor and Redfern Limited and Torrie Smith Associates. This report 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 have maintained and updated the community energy use and greenhouse gas emissions inventory on an annual basis.

The methodology employed is consistent with the greenhouse gas 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.

A.1. Community Inventory Data Collection

Data for the community inventory is available for the 1990, 1998, 2002, and 2004-2013 unless otherwise noted below. The inventory information used for the residential sector is based on the following:

- Annual electricity use 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 was provided by Union 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 2012.

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 Union 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 2012.

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 Kent Marketing. 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 (2013 data). It is also able to reveal fuel consumption patterns associated with changes to personal vehicles, such as the observed increase in retail diesel fuel sales over recent years.

- Diesel use for public transit was provided by London Transit.

- Community non-retail (i.e., road transport, 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 and diesel 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 2012, and that Statistics Canada revised its data for 2011.

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

- Annual waste quantities placed within the landfills for each calendar year.

- 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 of methane was changed from 21 to 25, as per the Intergovernmental Panel on Climate Change's *Fourth Assessment Report*

A.2. Greenhouse Gas Emission Estimates

Greenhouse gas emissions associated with energy use were calculated based on the emission factors provided by *Canada's National Inventory Report 1990-2012*, except for the 2013 grid-average emission factors for Ontario, which have been estimated based on the 2013 electricity supply mix for Ontario reported by the IESO, combined with the data from *Canada's National Inventory Report 1990-2012*. A summary of the emission factors has been provided in Table A-1.

All greenhouse gas emissions are expressed in terms of equivalent carbon dioxide (CO_2e), based on standard information on global warming potentials (GWP) of the various greenhouse gas emissions, as provided by *Canada's National Inventory Report 1990-2012*.

Table A-1 – Greenhouse Gas Emission Factors and Energy Conversions

Source of Emission	Emission Factor (CO_2e)	Information Source
Electricity - Ontario 2013	0.090 kg/kWh	Estimated based on IESO supply mix information for 2013
Electricity - Ontario 2012	0.110 kg/kWh	National Inventory Report, 1990-2012 - Greenhouse Gas Sources and Sinks in Canada ANNEX 13: EMISSION FACTORS
Electricity - Ontario 2011	0.100 kg/kWh	
Electricity - Ontario 2010	0.150 kg/kWh	
Electricity - Ontario 2009	0.120 kg/kWh	
Electricity - Ontario 2008	0.170 kg/kWh	
Electricity - Ontario 2007	0.240 kg/kWh	
Electricity - Ontario 2006	0.210 kg/kWh	
Electricity - Ontario 2005	0.240 kg/kWh	
Electricity - Ontario 2004	0.220 kg/kWh	
Electricity - Ontario 2003	0.300 kg/kWh	
Electricity - Ontario 2002	0.290 kg/kWh	
Electricity - Ontario 1998	0.230 kg/kWh	
Electricity - Ontario 1990	0.230 kg/kWh	
natural gas	1.89 kg/m^3	
fuel oil	2.73 kg/L	
propane	1.54 kg/L	
gasoline	2.36 kg/L	
diesel	2.83 kg/L	
gasoline (E-10)	2.15 kg/L	TSA's Canadian Cities GHG Emissions Strategy Software
Source of Energy	**Energy Content**	**Information Source**
electricity	0.0036 GJ/kWh	Natural Resources Canada CO_2 Calculator
natural gas	0.0372 GJ/m^3	
fuel oil	0.0388 GJ/L	
propane	0.0253 GJ/L	
gasoline	0.0347 GJ/L	
diesel	0.0387 GJ/L	
gasoline (E-10)	0.0332 GJ/L	TSA's Canadian Cities GHG Emissions Strategy Software

A.3. Cost Estimates for Community Energy Use

Information on the cost of using petroleum products is based on information available from Kent Marketing Services, 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 by MJ Ervin and Associates.

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 by Wattsworth Analysis.

Information on the cost of using natural gas is based on customer rate structure information available on Union 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 Union Gas's regional and Ontario-wide storage and distribution operations;

- Delivery-related costs, which is allocated to London to reflect Union 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 - 2003-2013 HEATING & COOLING DEGREE DAYS FOR LONDON

Heating degree day (HDD) is a measurement tool used to estimate energy demand needed to heat a home or business. A similar measurement, 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.

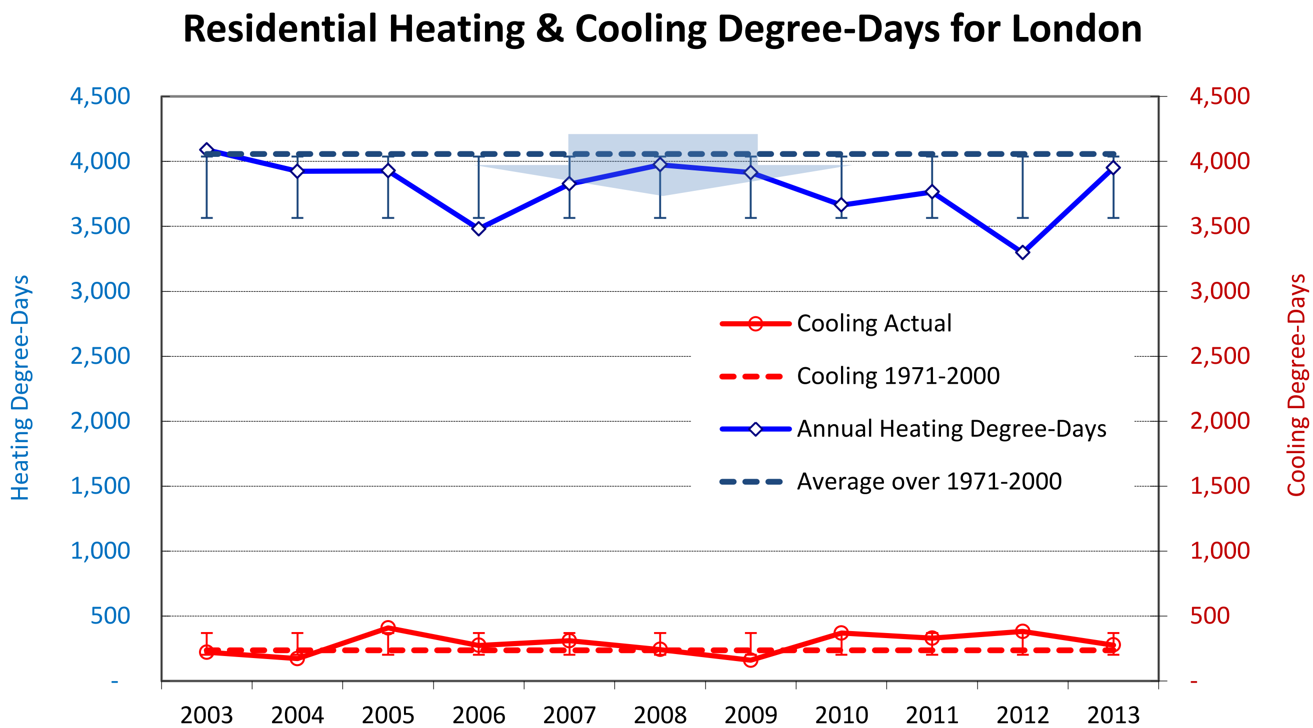
Environment Canada produces Climate Normal data ranges over a historic 30 year period. The most recent set available is the 1971-2000 period. Over the last 10 years, most winters and summers have been warmer than they were over the 1971-2000 period,

Year	Degree-Days		Difference from Normal	
	Heating	Cooling	Heating	Cooling
2003	4,089	221	1%	-6%
2004	3,924	171	-3%	-27%
2005	3,928	408	-3%	73%
2006	3,481	274	-14%	16%
2007	3,827	310	-6%	32%
2008	3,974	241	-2%	2%
2009	3,914	159	-4%	-33%
2010	3,664	369	-10%	57%
2011	3,766	330	-7%	40%
2012	3,297	381	-19%	62%
2013	3,951	276	-3%	17%
average	*3,801*	*285*	*-6%*	*21%*
Normal	4,058	236		

Notes:
1. Climate Normal data based on the 1971-2000 period
2. Heating and cooling degree-days based on the daily average difference from 18°C

Using this data, it can be assumed that, over the last 10 years, building heating needs were about six percent lower than they would have been back in the 1971-2000 period, and that air conditioning needs were about 21 percent higher.

Environment Canada updates its Climate Normal data every ten years. The most recent set available is the 1971-2000 Climate Normal period, which was warmer than the 1961-1990 Climate Normal period.



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