TORONTO

STAFF REPORT
ACTION REQUIRED

Toronto's 2012 Greenhouse Gas and Air Quality Pollutant Emissions Inventory

Date:	June 9, 2014
To:	Parks and Environment Committee
From:	Chief Corporate Officer
Wards:	All
Reference Number:	P:\2014\Internal Services\E&E\Pe14006e&e – (AFS17642)

SUMMARY

This report provides an update on the City's progress towards meeting the greenhouse gas and air quality pollutants reduction targets adopted by City Council in the 2007 report entitled, *Climate Change, Clean Air and Sustainable Energy Action Plan: Moving from Framework to Action* (the "Climate Change Action Plan") by reporting on estimated levels of emissions for 2012.

The information presented in this report is based on electricity and natural gas consumption, as well as, solid waste production in 2012, but there is no new data since 2008 respecting community transportation available for analysis. In addition, this report updates the previous report regarding emission levels in 2011 based on more recent information from Environment Canada.

Results show that greenhouse gas emissions in 2012 compared to 1990 levels were 49% lower for the City Government and 25% lower for the City Community. These results show that Toronto has exceeded its 2012 target of a 6% reduction from 1990 greenhouse gas levels. Air quality pollutant emissions, however, in 2012 were only 2.8% lower than the 2004 benchmark set by City Council in 2007, which is below the target of a 20% reduction in locally generated air pollutants by 2012. The majority of the locally generated air pollutant emissions (80.5%) in Toronto are from road vehicles: 35.5% are from cars and light trucks, 7% are from heavy gasoline trucks and 38% are from heavy diesel trucks.

RECOMMENDATIONS

The Chief Corporate Officer recommends that City Council:

1. Direct the Director of the Environment and Energy Division to collaborate with relevant City Divisions, Toronto Hydro and Enbridge Gas to identify and implement actions that address the following technical recommendations made by the project consultants (Canadian Urban Institute and Halsall Associates):

    a. Improve the accuracy of the City's building data file to address the issue that a significant percentage (28%) of the buildings gross floor area is not classified and, therefore, a significant percentage (34%) of the City's total electricity consumption is unassigned;
    b. Improve the accuracy of the City's estimates of emissions from transportation sources by surveying what car and truck types, and in what numbers, use the highways and roads in Toronto;
    c. Identify, in partnership with Enbridge Gas and Toronto Hydro, ways to address data privacy issues, so that more detailed and accurate information can be provided to the City;
    d. Standardize the building classification and aggregating schemes between the City and the energy utilities; and
    e. Identify and estimate forecast electricity demand to support the identification of the geographic areas or sectors where the City and the utilities may wish to focus their energy conservation and emission reduction programming.

2. Direct the Director of the Environment and Energy Division to publish future annual greenhouse gas and air quality inventories in the fourth quarter of the year and to include utility consumption trends in the absence of applicable emission factors for the most recent years

3. Direct the Director of the Environment and Energy Division to explore opportunities to partner with other municipalities and the Province, as well as other relevant organization to advocate for improved vehicle emission standards that will result in improved air quality in Toronto and all Canadian cities.

Financial Impact

This report has no financial impact. The proposed actions are consistent with the five-year business plan of the Environment and Energy Division.

The Deputy City Manager and Chief Financial Officer has reviewed this report and agrees with the financial impact information.

DECISION HISTORY

At its meeting of July 16 - 19, 2007 City Council adopted the *Climate Change, Clean Air and Sustainable Energy Action Plan: Moving from Framework to Action* (the "Climate Change Action Plan"). The web link to this report (item EX10.3 on page 25 of the Council minutes) is: http://www.toronto.ca/legdocs/mmis/2007/cc/minutes/2007-07-16-cc11-mn.pdf.

Included in the Climate Change Action Plan were directives (see recommendation #14) that the City continue to report on air quality and greenhouse gas emissions and monitor progress in meeting its climate change and clean air targets.

At its meeting of June 24, 2013, the Parks and Environment Committee considered a report (item #PE21.5), based on 2011 data, that provided an update on the City's progress in meeting the greenhouse gas and air quality pollutants reduction targets. At that time the Committee requested a report be provided every year for the Parks and Environment Committee on the status of Toronto's greenhouse gas and air quality pollutant emissions.

The web-link to this report and to the decision of the committee can be found at: http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PE21.5.

This report addresses the directives of City Council and the Parks and Environment Committee.

ISSUE BACKGROUND

In 2007, the City published the report *"Greenhouse Gasses and Air Pollutants in the City of Toronto"* based on data from 2004, in collaboration with Inner City Fund (ICF) International and the Toronto Atmospheric Fund. This work informed the preparation of the City's *Climate Change Action Plan* adopted in July 2007 as well as the *Power To Live Green*: *Toronto's Sustainable Energy Strategy* (Sustainable Energy Strategy) adopted in November 2009.

The purpose of the greenhouse gas and air quality inventory monitoring program, maintained by the City's Environment and Energy Division, is to:

a) Identify the amount of emissions occurring in Toronto, both City Community and those associated with the City Government;
b) Identify the primary sources of those emissions and whether there are changes occurring in the sources; and
c) Provide the information necessary to help inform and set priorities in the development and implementation of appropriate policies and programs required to encourage and support greenhouse gas and air pollutant emission reductions.

When completing the analysis for the greenhouse gas and air quality inventory in 2007 and when undertaking the more detailed analysis required for the 2009 Sustainable Energy Strategy, it was identified that the current level of analysis was limited in its ability to inform energy program and policy development. There is a need to link energy consumption data to the characteristics of sector, land use type and geographic areas if the City wishes to be able to develop more focused and targeted programming.

The Environment and Energy Division (EED) engaged external consultants in 2012 to:

a) Evaluate and identify the maximum usefulness of the privacy limited data sets available;
b) Recommend what could be achieved with currently available data access and with improved data access and how the latter could be best achieved; and
c) Identify what benefits would accrue if there was better access to energy consumption data and how that may facilitate better informed energy conservation programs and help the city to achieve its long term greenhouse gas and air quality reduction targets.

The consultants, the Canadian Urban Institute and Halsall Associates, completed their work in early 2014 and the findings and recommendations of their technical report are discussed in this report.

COMMENTS

1.0 Connection between Energy Use, Smog and Greenhouse Gas Issues

The issues of energy use, smog and greenhouse gases are distinct with different problems, but all three are interwoven and the solutions to the different issues are common ones. Burning fuel, as in the consumption of gasoline, diesel, or natural gas or electricity derived from natural gas or coal produces greenhouse gasses, air quality pollutants and the reduction of emissions is also linked through the application of appropriate energy conservation responses.

Energy consumption, smog-causing emissions and greenhouse gas emissions go hand-in-hand whenever people use electricity, natural gas or vehicle fuels. Electricity is used for lighting, appliances and air conditioning. Natural gas is used for space heating and water heating. Vehicle fuels are used to transport people and goods. Conservation of energy reduces local air pollution (air contaminants) and global atmospheric pollution (greenhouse gases), and reduces the costs of maintaining and operating homes, offices and vehicles.

2.0 Toronto's Greenhouse Gas & Air Quality Emission Reduction Targets

The primary purpose of the greenhouse gas and air quality inventory program is to track the progress of the City Community and the City Government (the latter as a subset of the City Community) towards achieving its adopted greenhouse gas and air quality emission reduction targets outlined in Table 1.

The targets are absolute targets rather than relative targets, meaning they are independent of population growth or decline, economic growth or decline, or weather variability (e.g., hot summers that lead to more electricity consumption for air conditioning, and cold winters that lead to more natural gas consumption for space heating).

Table 1: The City of Toronto's Emission Reduction Targets[1]

Year	Air Quality Contaminants (2004 Baseline)	Greenhouse Gases (1990 Baseline)
2012	20%	6%
2020	--	30%
2050	--	80%

Note 1: Targets Adopted by City Council in July 2007.

The targets apply equally to the City Community and the City Government alike, but progress toward achieving the targets is cumulative. If a sector within the City Community overachieves it may be offset by a sector that underachieves, and vice versa. Equally, if a Division of City Government overachieves it will offset those that do not.

The greenhouse gas reduction targets relate to emissions of carbon dioxide or other greenhouse gases such as methane and nitrous oxide (N_2O). The smog reduction targets relate mainly to ozone, particulate matter, nitrogen dioxide (NO_2) and other gases.

This inventory update report is based on 2012 data regarding energy consumption and related emissions and solid waste management and related methane emissions and transportation data from 2008 (the most recent date for which transportation data is available). An analysis is provided of changes in emission levels and sources since 1990, including previous evaluations carried out utilizing 2004, 2008, and 2011 data.

Estimated emission levels are calculated as "end of pipe" emissions (e.g., emissions from vehicle's tail pipes do not include all the emissions due to exploration, crude oil extraction and refining, or its shipment to market) rather than "lifecycle" emissions (also known as "well-to-wheel" emissions, which do include all the emissions associated with extraction, refining and delivery), because of the complexity involved in calculating "lifecycle" emissions and because there is no standard measurement protocol.

3.0 Greenhouse Gas Emission Reductions

The following section provides a discussion of greenhouse gas emissions from the City Community, including all of the emissions associated with the operations of the City Government and provides a discussion of how well the City Government is leading by example in reducing the emissions associated with its own operations.

3.1 City Community

The amount of greenhouse gases released is calculated from fuel consumption data associated with electricity and natural gas use, from traffic volume data and from data of the solid waste (by material subtype) delivered to landfill sites.

The greenhouse gas emissions are derived and estimated based on how much energy the City Community used in 2012. The electricity and natural gas usage is identified based on sales data derived from Toronto Hydro and Enbridge annual total sales data. Transportation data is estimated from road count data extrapolated to vehicle-kilometers-travelled (VKT). The transportation data set is amended in part every year, but the complete data set is neither revised nor fully updated on an annual basis. This means that the transportation data, as used in this inventory, is from the most recent multi-year data set, which includes data up to and including 2008.

Greenhouse gas emissions associated with waste collection and management are estimated according data maintained about the amount of annual waste collected by the City of Toronto and how much is sent to landfill. With respect to the amount of waste collected that is privately collected and taken elsewhere, very largely to unspecified landfills, there are no accurate records. For the purposes of the inventory it is estimated that volume of waste being collected privately is about twice the amount picked up by the City.

To estimate the amount of greenhouse gases generated from this energy use, emissions intensity data as derived from the National Inventory Report prepared by Environment Canada are applied. This information is developed and updated on an annual basis by Environment Canada.

As seen in Table 2, greenhouse gas emissions in Toronto in 2012 are estimated to be almost 25% lower then when compared to levels in 1990. This has largely been achieved due to a:

a) 52% reduction of emissions from electricity production (largely due to the removal of electricity generation using coal) and a reduction of electricity consumption; and

b) 61% reduction from improved waste management practices (that limits methane production in landfills - with its 21 to 25 times greater global warming potential) and includes on-site methane collection and flaring.

The 25% overall community reduction in greenhouse gas emissions, between 1990 and 2012 clearly exceeds the City Council adopted 2012 reduction target of 6%, and suggests that with continued effort, the target of 30% for 2020 is achievable.

Table 2: Sources of Greenhouse Gas Emissions (tonnes) - City Community[1]

Source	1990	2004	2008	2011[5]	2012
Electricity	5,569,300	5,622,760	5,217,000	2,656,829	2,699,629
Natural Gas	8,741,625	8,225,060	8,385,928	7,947,639	7,087,464
Transportation [2] (No Rail, Planes or Boats)	7,293,440	8,099,914	8,383,396	8,383,396[2]	8,383,396[2]
Waste Collected by City (1/3 of Total)	1,815,751	1,009,545	875,757	727,066	707,150
Waste Collected Privately (2/3 of Total) [3]	3,631,502	2,018,098	1,751,513	1,454,131	1,414,300
Public Waste Transported post City Collection	--	35, 507	18,062	6,480	7,041
Private Waste Transported post Private Collection [4]		71,014	36,119	12,961	14,081
Total	27,051,617	25,082,889	24,667,773	21,188,502	20,313,061
Change from 1990	**--**	**-7.28%**	**-8.81%**	**-21.67%**	**-24.91%**
Change from 2004	--	--	-1.65%	-15.53%	-19.02%

Note 1: The City Community includes the emissions from the City Government.

Note 2: Year-specific transportation data are not available. The transportation data shown for 2008, and 2012 is the "2008 data" which is a combination of data for several years up to and including 2009. The next update is expected in 2015 at the earliest. Data for 2008 is used here to permit inclusion of transportation emissions within the combined overall totals of this report.

Note 3: In the previous Inventory of 2007, only the waste that was collected by City Government was included. Following subsequent analysis and agreement with Toronto Solid Waste, it was decided to fully include all waste generated in Toronto and include the privately collected waste component based on a consistent one-third (City) to two-thirds (Private) standard for all years in future Inventories.

Note 4: These data (where shown) are estimated. The emissions generated by trucking waste outside of Toronto by the City Government are a known estimate. But the emissions generated by the trucking of waste to destinations outside of Toronto as by the Private sector is unknown, and there is no similar fuel or distance travelled data to base an estimate on. Here the unknown estimate is based on the same 1/3 to 2/3 ratio of waste haulage between City and Private haulers (see Note 3). This shows the private sector haulers as having the same improvement as the City haulers who sequentially used a shorter trip to Green Lane. It is likely that the real data of private waste haulers emissions in 2004, 2008, 2011 and 2012 are at least as high as, or even much higher than, the City Government waste haulers emissions, as they haul waste further afield. The data for all years are based on Green Lane Truck counts.

Note 5: The data shown in the column for 2011differs from that which was reported in the last annual update published in 2013. That report included the then best available emission factors from the National Inventory Report (NIR) of 2010, which was preliminary data. The present report incorporates the final emissions factors from the NIR of 2011 as released later in 2013 and provides sanctioned emissions factors. As such, comparison of data from Table 1 of the previous EED report with the data of Table 1 of the present EED report should not be made.

3.2 City Government

The greenhouse gas emissions produced by the activities of the City Government are estimated to represent 5.7% of all emissions in Toronto. The City Government can provide leadership to the community by taking action to reduce the greenhouse gas emissions associated with its activities.

Greenhouse gas emissions data regarding electricity consumed in City operated facilities, office buildings and by streetlights, as well as emissions related to natural gas consumption, are taken from billing and payment records as maintained by the Environment and Energy Division in its eCAP system. Emissions relating to vehicles used in City operations are derived from fuel consumption records.

Historically, emissions relating to all waste from all community sources are "counted" as City Government emissions. It is an assumed protocol that the City has care and control of the waste and is responsible for programs to reduce its contribution. As such all community emissions related to waste are counted as City Government emissions. When the City undertakes detailed emissions assessments - this is continued, but by adopted protocol, any waste management program that leads to a quantifiable reduction in GHG emissions is counted as a benefit to the City Community and not to City Government.

The greenhouse gas emissions produced by the actions of the City Government in providing services to the public in 2012 decreased by 49% compared to 1990, as is indicated in Table 3.

Table 3: Sources of Greenhouse Gas Emissions (tonnes) - City Government.

Source	1990	2004	2008	2011	2012
City Owned Buildings	174,537	467,775	466,059	342,503	312,490
Toronto Water	202,900	144,150	123,340	80,912	312.490
Streetlights	37,786	25,639	21,947	12,290	12,341
City Vehicles (fleet)	46,236	29,471	38,270	43,364	38,655
Waste Management (1/3 of Total)	1,815,751	1,009,479	875,757	727,066	707,150
Total	2,277,210	1,676,580	1,525,373	1,206,135	1,153,379
Change from 1990	**--**	**-26.38%**	**-33.02%**	**-47.03%**	**-49.35%**

4.0 Greenhouse Gas Emission Sources - City Community

4.1 Electricity

Electricity consumption has been consistently higher in the years since 1990 than it was in 1990. However, and despite, population increases, as well as such factors as higher plug load draws from increased use of electricity powered appliances, and higher air conditioning loads - peak annual electricity consumption occurred in 2008 and has declined ever since (see Table 4).

Table 4: City Community Electricity Consumption & Greenhouse Gas Emissions.

	Electricity Consumption (kWh)	Change from 1990	Electricity Emissions Factors (gCO2e / kWh)	Electricity Emissions (tCO2e)	Change from 1990
1990	25,314,997,857	--	220	5,569,300	
2004	25,558,000,709	0.96%	220	5,622,760	0.96%
2008	27,898,394,277	10.21%	187	5,217,000	-6.33%
2011	26,253,247,548	3.71%	101	2,658,829	-52.30%
2012	25,833,769,360	2.05%	105	2,699,629	-51.53%

Of greater significance, however, is that the greenhouse gas emissions are declining even more significantly due to the mix of sources used to generate that electricity. The reduction in the amount of electricity being generated by coal in Ontario was significantly reduced in 2012. The data in Table 4 shows a 52% improvement in greenhouse gas emissions related to electricity consumption in Toronto in 2012 compared with Toronto's 1990 baseline year. The improvement from a 6% reduction in 2008 to a 52% improvement in 2011 and 2012 is clear and an obvious consequence of the reduction in the amount of coal being used to generate electricity in Ontario and the conservation, measures adopted to reduce the need for electricity.

4.2 Natural Gas

Toronto's consumption of natural gas for space and water heating has declined since 1990, albeit with a 2% increase in 2008, but with an overall decrease of 14% between 1990 and 2012 (see Table 5). As with electricity, consumption and emissions are not a direct relationship as emission factors that reflect the carbon content of the source fuel which vary with source location come into play. The trend direction and it variation between adjacent years shows a wide annual fluctuation in the consumption of natural gas in Toronto.

Table 5. City Community Natural Gas Consumption & Greenhouse Gas Emissions

	Natural Gas Consumption (m^3)	Change from 1990	Natural Gas (grams CO_2 eq. / m^3)	Natural Gas Emissions (tonnes CO_2e)	Change from 1990
1990	4,355,568,000	--	2007	8,741,625	--
2004	4,323,001,973	-0.75%	1903	8,225,060	-5.91%1
2008	4,435,527,684	1.84%	1891	8,385,928	-4.07%
2011	4,203,705,477	-3.49%	1891	7,947,639	-9.08%
2012	3,748,737,413	-13.93%	1891	7,087,464	-18.92%

Note 1: The previous summary report of 2013 regarding 2011 data, indicated values of 1993 and -1.46% respectively. The NIR 2013 (which was published after the previous 2013 summary report was prepared) back-casts a significant change to the emission factor for natural gas in 2008 thus changing the previously reported data.

The community's greenhouse gas emissions associated with the use of natural gas has declined by 19% in comparison to. However, a long-term trend line over future years may yet reveal annual fluctuations above and below the trend of the past two years (2011 and 2012). As such the size of percentage improvement may well change in coming years, but it is likely that the will remain as in excess of the 2012 target of a 6% reduction in greenhouse gas emissions.

4.3 Car and Trucks

In the 2007 inventory, truck emissions in 2004 were estimated using expert estimates of emission factors to apply to car and truck volumes by class and distance travelled. The same estimates have been applied to the latest data available, which is for 2008.

It is important to note that no similar estimates of emissions factors or of car and truck volumes by class and distance travelled could be made for the base year of 1990. This means that the base data for emissions from vehicles in 1990, is very weak and therefore estimates of change in emissions against 1990 levels are qualified.

Estimating greenhouse gas emissions from motor vehicles is also difficult because of a lack of data regarding:

a) The number of vehicles and the distance they travel; and
b) The proportion of different vehicle types (e.g. trucks versus cars) within the vehicle count or fleet of vehicles and the varying emissions from each group type.

Vehicle counts and kilometer travelled estimates are not fully updated on an annual basis but rather on an as needed basis in response to congestion and accident issues by Transportation Services. The vehicle count data set includes data collected since 1987 but is mostly populated with more recent data. Updated multi-year data sets are produced every few years. As it remains, these annual summary updates reports will always be constrained by data provision in the "in between years" - but though not ideal, this is not considered to be a significant limitation.

The much more significant limitation is the absence of adequate estimates of the proportion of different vehicle types within the vehicle count. In simple terms, it is obvious that an average truck emits far more than an average car, and as such the proportion of trucks to cars makes a significant difference to the total emissions released.

Trucks on Toronto's arterial roads comprise approximately 5% of all road vehicles on those roads. That 5% is very roughly estimated to produce 25% of the emissions from vehicles on arterial roads. Trucks on the provincial 400 series highways (Hwy. 401 and Hwy. 427) comprise approximately 15% of all road vehicles on those roads. That 15% is very roughly estimated to produce 50% of the emissions from vehicles on those highways.

There is also a very considerable differential in the estimated emissions produced by 4-wheel cube vans and trucks and 18-wheeler trucks (and larger) and everything in between. Knowing the fleet breakdown of cars and trucks is considered an imperative to improve GHG and AQ reporting and efforts to improve the City's knowledge of these emissions are being evaluated.

However, and cognisant of the limitations identified above, in the period between 1990 and the 2008 data point, greenhouse gas emissions associated with the combustion of gasoline and diesel in road vehicles are estimated to have increased by 15% (see Table 6). In the 4-year period from 2004 to 2008, the increase in these emissions was 3.5%.

Table 6: Total Greenhouse Gas Emissions from Cars and Trucks in Toronto

	Car and Truck Emissions (tonnes CO_2 equivalent)	Change from 1990	Change from 2004
1990	7,293,440	--	--
2004	8,099,914	11.06%	--
2008	8,383,396	14.94%	3.50%
2011	8,383,396[1]	14.94% [1]	3.50% [1]
2012	8,383,396[1]	14.94% [1]	3.50% [1]

Note 1: Transportation data from 2011 is not yet available. The next update should be available in 2015. Data from 2008 is used here to permit inclusion in the combined overall totals of this report.

5.0 Greenhouse Gas Emission Sources – City Government

5.1 Electricity Use – City Government

Between 2004 and 2012 there has been a 2.6% improvement in the overall reduction of electricity use by City Government (see Table 7). But between 1990 and 2004 there was an apparent and significant increase, with emphasis here on "apparent", of 371% in electricity consumption by the City Government. In part this reflects the missing data and quality of back-casted estimates associated with 1990 and the subsequent improvement in record keeping, and in part it reflects the inclusion of buildings and other facilities that were not part of the City Government's building stock in 1990.

For example, the inclusion in 2002 of the Toronto Community Housing Corporation alone, which was formed by combining three former housing organizations following the downloading of social housing responsibilities to municipalities by the Province of Ontario, more than doubled the greenhouse gas emissions of the City Government if the 1990 figure were a true reflection of all emissions from City Government at that time.

Table 7: City Government Electricity Consumption per year (MWh)

Category	1990	2004	2008	2011	2012
Facilities & Real Estate		110,890	102,989	93,978	97,345
Parks & Recreation		113,297	106,240	113,531	114,861
Toronto Community Housing Corp		405,494	394,803	400,306	393,738
Toronto Transit Commission		110,162	107,211	94,729	104,732
Toronto Water		559,282	540,858	529,101	534,329
Transportation Services		124,906	128,549	127,058	132,762
All other Agencies, Corporations & Divisions		241,636	236,778	235,833	244,992
TOTAL	**353,492**	**1,665,669**	**1,617,427**	**1,594,537**	**1,622,759**
Change from 1990		**371.2%**	**357.6%**	**351.1%**	**359.1%**
Change from 2004		**--**	**-2.90%**	**-4.27%**	**-2.58%**

Note 1: Due to missing records post amalgamation - the only available combined estimate for 1990 is a partial estimate of ... 353,492,356 kWh, or approximately 22% of the consumption reported in 2004 to 2012. No 1990 data respecting the individual sub-categories is known to exist.

5.2 Natural Gas Consumption – City Government

The record of increased consumption of natural gas by the City Government between 1990 and 2004 is a consequence of inadequate 1990 data. The building energy data for 1990 reflects an incomplete data record, and subsequent data reflects the inclusion of buildings and facilities that were not part of the building stock in 1990.

Table 8: City Government Natural Gas Consumption (1000 m^3).

Category	1990	2004	2008	2011	2012
Parks & Recreation		13,363	12,404	11,705	11,195
Toronto Community Housing Corp		75,480	98,909	87,086	70,135
Toronto Water		11,094	11,742	14,475	14,231
All others Agencies, Corporations & Divisions		29,083	28,715	25,338	23,793
Total	48,215	129,021	151,771	138,604	119,354
Change from 1990		167.59%	214.77%	187.47%	147.54%
Change from 2004		--	17.63%	7.43%	-7.49%

Note 1: Due to missing records post amalgamation - the only available combined estimate for 1990 is a partial estimate of ... 48,215,491 m^3, or approximately 35% of the average consumption reported in 2004 to 2012.

As seen in Table 8, between 2004 and 2012 there has been a 7.5% reduction in the consumption of natural gas by City Government. The pattern of changes has not been consistent between categories within all individual years. In 2008 compared to 2004, natural gas consumption increased for TCHC and Toronto Water but decreased for Parks & Recreation and all other City Divisions and Agencies. In 2011compared to 2004, natural gas consumption increased for Toronto Water but decreased for all others. In 2012 compared to 2011, natural gas consumption decreased for all categories.

A fuller evaluation of the variability and influence of other factors such as weather, economics, lifestyles and population characteristics is being undertaken and will be explored in the next annual summary report in 2015 regarding 2013 data.

5.3 Electricity and Natural Gas Emissions – City Government

Since 2004 the emissions related to the City Government's consumption of electricity has diminished from year to year - with the small increase in 2012 (over 2011). Underlying this estimated decrease of almost 54% is the actions taken to reduce the use of coal in the generation of electricity and the increased use of conservation measures in City facilities (see Table 9).

Table 9: Summary of Emissions resulting from City Government Electricity and Natural Gas Consumption (tonnes CO_2 equivalent)					
	1990	**2004**	**2008**	**2011**	**2012**
ELECTRICITY	77,768	366,447	302,459	161,367	169,578
Change from 1990	--	371.20%	288.92%	107.50%	118.06%
Change from 2004	--	--	**-17.46%**	**-55.96%**	**-53.72%**
NATURAL GAS	96,768	245,478	286,941	262,048	225,654
Change from 1990	--	153.68%	196.52%	170.80%	133.19%
Change from 2004	--	--	**16.89%**	**6.75%**	**-8.08%**

However, the emissions that are related to the City Government's consumption of natural gas, was higher in both 2008 and in 2011 than it had been in 2004. That trend was reversed in 2012, which saw a reduction from 2004.

6.0 Air Quality Improvement

The City adopted air quality improvement target specifies a reduction target for locally generated smog-causing pollutants of 20% from 2004 levels by 2012. Smog causing pollutants include ozone, particulate matter, and nitrogen oxides – among several others that are less commonly recognized (volatile organic compounds, aldehydes, nitrates, and sulphates among others). Ozone is not a primary pollutant – it is a secondarily created pollutant (i.e., a secondary pollutant that is not emitted but created in the presence of sunlight and other pollutants). Particulate matter is not a chemistry specific substance but rather a physically specific sized particle. Such particulate matter is typically a product of combustion processes as found in vehicle engine exhaust, furnace or boiler exhaust, wood heating and industrial exhaust emissions.

Smog events occur mainly in the summer months and are most commonly called based on ozone concentrations, but they can also occur during the winter months when they are most commonly called based on fine particulate matter concentrations. Smog is a result of concentrations and not of emissions. Also, smog conditions are not continuous throughout the year. Linking year-long emissions data to non-continuous events without specific modelling of weather and air quality and matching the smog events to the specific times of the events plus precursor days (which varies with smog duration and intensity) is both a difficult task and a dubious one given the nature and quality of available emissions data. Furthermore, most smog events often owe more to upstream conditions than local conditions. As such, a surrogate indicator of general year round air quality, as based on emissions rather than concentrations, is here provided instead.

Nitrogen oxides (NOx) are the emissions selected in preference to using fine particulate matter as the distribution of resultant NOx concentrations is arguably more certain and more ubiquitous across Toronto. The significant sources of emissions related to air quality are from the combustion of natural gas, transportation fuels and some industrial activities. Data related to these activities are shown in Table 10. NOx (nitrogen oxides) emissions are used here as a general indicator of year round air quality, and in 2008 they were less than 1% more than in 2004.

Given that air quality targets were set against 2004 as a baseline, it is disconcerting that emissions have increased slightly since then, but better data for transportation emissions may result in more accurate and favourable results.

Table 10: City Community NOx Emissions[1], 2004, 2008 and 2011

	2004		2008		2011		2012	
Source	**tonnes**	**%**	**tonnes**	**%**	**tonnes**	**%**	**tonnes**	**%**
Natural Gas - Data From Enbridge [2]	5,047	16.5	5,884	19.0	5,177	17.0	4,752	15.6
Portlands Energy Centre	--		--		289	1.0	250	0.8
NPRI - All other sources [3]	2,138	7.0	1,361	4.4	1,298	4.26	1,040	3.4
Cars & Light Trucks [4]	10,720	35.0	11,446	37.0	11,446	37.6	11,446	38.8
Heavy Diesel Trucks [4]	12,697	41.6	12,251	39.6	12,251	40.2	12,251	41.5
Total	**30,602**		**30,942**		**30,461**		**29,739**	
Change from 2004	**--**	**--**	**1.11%**	**--**	**0.46%**	**--**	**2.82%**	

Notes 1: NOx is used here as a surrogate indicator of general year round air quality, as based on emissions rather than concentrations.

Notes 2: Includes the Portlands Energy Centre for 2011 and 2012.

Notes 3: Includes all sources reporting to the National Pollution Release Inventory.

Notes 4: Next Updated Community Transportation Data Set is not available until 2014.
Data from 2008 is used here to also represent 2011and 2012 emissions to permit inclusion in the combined overall totals of this report.

It is clear that the major local contributor to the presence of nitrogen oxides in Toronto's air are Toronto's trucks and cars which contributed an estimated 80.5% of emissions to Toronto's general year round air quality in 2008 (the most recent year transportation data is available for). The emissions from vehicle tailpipes typically include benzo[a]pyrene, benzene, particulate matter less than 10 microns diameter, particulate matter smaller than

2.5 microns diameter, 1.3 butadiene, acrolein (a form of aldehyde), cadmium, carbon monoxide, formaldehyde, and mercury as well as nitrogen oxides. The variation in the emissions of smog causing particulate matter can be assumed to closely follow the trend revealed in the local emissions of nitrogen oxides.

The improvement of air quality (as based on emissions not concentrations) of nitrogen oxides) is clearly minor (see Table 10). A small increase of 1.1% was seen between 2004 and 2008, and an equally small but an improvement of 0.5% was seen between 2004 and 2011. A larger improvement of 2.8% is seen between 2004 and 2012. However, that 2.8% improvement is a long way shy of the 20% adopted target.

As such, the City Community has not meet its Council adopted locally generated smog causing pollutant emissions reduction target for 2012 in 2012. Having failed to achieve the target it is here assumed that the target will remain in effect until it has been met, and that further initiatives will be adopted to address the target. The obvious dominance of cars and trucks as the major local contributor of 80% of the air quality emissions clearly suggests the area in which new initiatives are required.

The true extent of emissions from trucks in Toronto is not fully known. Between 3% and 5% of all vehicles (or between 9% and 12% of vehicle-km travelled) in Toronto are trucks, yet the local impact of trucks on air quality and peoples' health is clearly disproportionate. For example, heavy trucks produce 45% of nitrogen oxides (NOx) coming from all road using vehicles, or 38% of all nitrogen oxides released within the City – albeit these are, at best, only crude estimates, as shown in Table 10.

Controlling vehicle emissions is a federal responsibility, which places limits on the City's ability to address emissions directly; however, the City can advocate for improvement and can also lead by example.

6.0 Using the Inventory for Detailed Program & Policy Design

The Consultants completed their work in early 2014 and concluded that the data currently available is inadequate to inform detailed policy and program work. In their report the Canadian Urban Institute (CUI) and Halsall Associates (the "consultants") state that:

"*…despite the higher spatial resolution and larger number of building-land use classifications used in the data provided to the study team by the City of Toronto, gaps in the data limited the analysis and the ability of the study team to target programs and identify opportunities*".

The information - electricity consumption data from Toronto Hydro and natural gas consumption data from Enbridge – is limited in terms of being able to develop targeted policies and programs according to sectors or neighbourhoods.

The quality and completeness of data that has been obtained to date from energy providers currently permits only for gross annual comparisons that enables the City to monitor its progress towards its targets as required by the annual inventory. But that same data does not allow for an adequate quality of conservation programming. The latter requires identification of where consumption abnormalities are to be found, either by geography or by user sector, such that remedial actions can be focused adequately and cost effectively.

To estimate transportation emissions we currently use data from 2008 (i.e., the latest available). The lack of currency in this data and that it currently does not include a breakdown by vehicle type - which is very significant given the variation in emissions between small cars and heavy-duty trucks. Therefore, our ability to identify appropriate emissions per vehicle is severely limited and this in turn limits our ability to design appropriate programming and our ability to establish the business case to be advocated for improvements in vehicle emission regulations to other levels of government.

The even more severe inadequacy of estimates of current energy consumption and emissions emanating from vehicles on city streets and highways also limits the city's ability to identify the nature and scale of vehicle pollution and limits the city's ability to advocate effectively.

The consultants' report identifies five ways to improve the quality of the data. They are:

1. Improve the accuracy of the City's Building File.

2. Standardize the classification of buildings and customers as well as the method of aggregating the data between the City, Toronto Hydro and Enbridge Gas (rather than continue to struggle with three incompatible classification systems).

3. Work with the gas and electrical utilities to address customer privacy issues.

   [A great deal of confidential data is required for the type of analysis required to match conservation programming with sectors and geographies as contemplated here. Not all data is readily available or shared openly among the parties. At present, some utilities feel constrained by legal interpretations and business practices from fully sharing available energy consumption data. Confidential City data also needs to be incorporated into the analysis together with confidential utility data. Both utilities and the City need to find ways of sharing and using their data to the benefit of all parties - for the purpose of creating effective energy conservation programming - whilst ensuring all data remains confidential at all times and to all parties.]

4. The quality of transportation data would benefit from a vehicle type breakdown specific to Toronto that reflects all vehicles travelling into, out of, within and through the city.

5. Incorporate electricity demand data into future energy analyses and mapping.

These five improvements will enable the City to more precisely target residential and non-residential conservation programs, transportation demand management and air quality actions and identify financial savings and opportunities and for district energy and integrated community energy systems.

7.0 Revised Emission Calculations

In April 2013 the Parks and Environment Committee received the 2011 greenhouse gas and air quality pollutant inventory report. This report, which reported that the City's greenhouse gas emissions had declined by 15% in 2011 against 1990 levels, was based on 2011 energy consumption data, as well as on the latest emissions intensity data as derived from the annual National Inventory Report (NIR) prepared by Environment Canada.

This report has identified that the City's greenhouse gas emissions for 2012 are 25% less then those reported in 1990, which would appear to be an improvement of 10% in one year. This identified one-year large change in estimated greenhouse gas emission levels is a function of revisions by Environment Canada in the emissions intensity data. The factors used to report emission levels in 2011 were a preliminary estimate and Environment Canada has revised the consumption intensity factor for electricity from 150 to 100 g CO_2 eq / kWh. This in effect reduced the estimated level of emissions in 2011 associated with electricity use by 33%.

The following discussion further explains the technical adjustment that has resulted in the revised estimate of greenhouse gas emissions.

The NIR is produced and published annually by Environment Canada's Greenhouse Gas Division. It is the best standard for annual data assessment available in Canada regarding greenhouse gas releases from energy sources in each province. These annual reports report on previous years and do not report on current years. Typically NIR reports are released in April or May and describe the situation, as it was understood 18 months earlier.

Canada's NIR greenhouse gas inventory contains specifics concerning Canada's and each individual province's electricity generation (GWh), greenhouse gas emissions (kt CO_2 equivalent) and the greenhouse gas intensity (g GHG / kWh) of electricity generated. Their consumption intensity factor (g CO_2 eq / kWh) also includes transmission line loss estimates.

The previous inventory summary report for Toronto based on 2011 consumption data relied on preliminary consumption intensity (g CO_2 eq / kWh) data from NIR 2010 (this is referred to below as "early reporting"). Typically, this preliminary information can be back-changed over as many as three or four years in the NIR (following consultation with provincial utilities and ministries) but changes to the previously preliminary year of data are typically the most significant.

The last two NIR summary reports (as released in 2013 and 2014) show:

- Consumption intensity varying (as in Table 11), in the years 1990 (the base year), 2005 and 2011;
- The consumption intensity is not consistently provided and back-changes are not always noted - as occurs for 2007; and
- Shows the severity of possible year-to-year changes in consumption intensity as between a "factor" of 150 in 2010 dropping to 100 in 2011. Changes in the intensity consumption factor from 150 (in 2010) to 100 in the following year (in 2011), effectively creates a very significant 33% drop in GHG emissions.

Table 11: Variation of Consumption

National Inventory Report - Year	1990	2000	2005	2007	2008	2009	2010	2011	2012
2013	230	320	240	240	170	120	150	110[1]	-
2014	220	320	250	n/a	170	120	150	100	110[1]

Note: 1 Intensity (i.e., the amount of CO_2 released per kWh of electricity consumed in Ontario - g CO_2 eq / kWh) between 1990 and 2011/2012 as reported in Canada's National Inventory Reports of 2013 and 2014 by Environment Canada.

Note: 2 The consumption intensity values for 2011 (in the 2013 report) and 2012 (in the 2014 report) are identified in the NIR as "preliminary data".

8.0 DISCUSSION

Toronto has exceeded its 2012 target of a 6% reduction from 1990 in greenhouse gas emissions with a 25% reduction, and is well on its way to achieve the 2020 target. The City Government has achieved a 49% reduction in its greenhouse gas emissions in 2012 compared to 1990 levels.

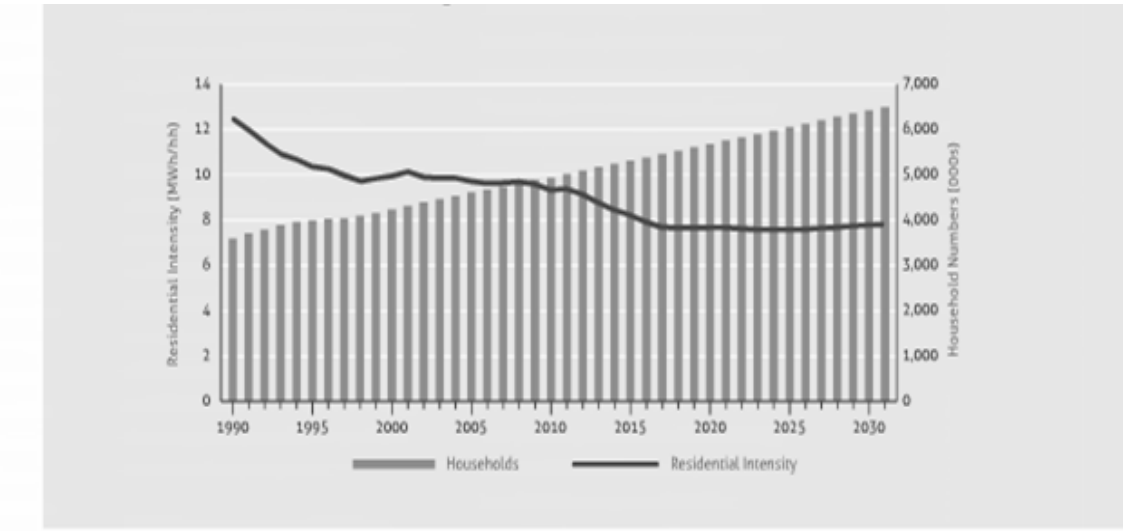
Toronto has not met its 2012 target of a 20% reduction from 2004 levels in locally generated smog causing emissions. The major source of air quality related emissions within Toronto comes from road vehicles and especially from trucks on provincial highways within the City's boundaries. The City needs to partner with others and advocate for improved vehicle emission standards for all urban Canadians and ensure that

such improvements, though coming at a cost, will also reduce the economic costs of morbidity and mortality to all Canadians.

The achievement of Toronto and its residents and businesses in partnership with the Province in reducing greenhouse gas emissions by an estimated 25% highlights how a focused and coordinated effort can bring about the desired environmental benefit. Underlying the reduction in emissions are two major collective efforts:

a) Eliminating the use of coal in the generation of electricity, which was facilitated by substantive per capita reductions in energy consumption (see Figure 1); and
b) Significantly reducing the amount of waste going to landfill and, therefore, the amount of methane gases generated.

Figure 1: Residential Electrical Intensity (Households are Becoming More Efficient) [1]



Note 1: Extracted from "Achieving Balance: Ontario's Long Term Energy Plan" (Ministry of Energy, December 2013, p.12)

Toronto's next greenhouse gas emission reduction target of 30% by the year 2020 appears to be achievable. Continued focused efforts to improve the energy efficiency in buildings will most likely ensure that the City's reaches and probably exceeds its 2020 target.

Achieving the long term target of an 80% reduction in greenhouse gas emissions by 2050, however, will require the development of new policies and programs, in particular efforts that improve the efficiency of the use of natural gas in buildings and efforts that reduce the emissions associated with transportation. City Council when it adopted the "*Power to Live Green: Toronto's Sustainable Energy Strategy*" in 2009 and set

aggressive natural gas targets for energy conservation in the operation of buildings has already indicated its commitment to reducing emissions tied to the use of natural gas.

With respect to air quality, this report suggests that Toronto has made limited progress in reducing locally generated air pollutants. Transportation has been identified as the major local source of air pollutants and if Toronto is going to achieve a reduction in locally generated air pollutants it will have to be done by finding ways to reduce transportation related emissions.

The Federal Government has established new standards for light duty vehicles (i.e. cars, vans and pick-up trucks) for the 2017 to 2025 model years. These new standards will improve the fuel efficiency of light duty vehicles and reduce emissions but as identified in this report, emissions from heavy-duty trucks make up a disproportionate amount of the transportation related emissions. City Council when it considered a staff report on the results of the local air quality study conducted in Etobicoke-Lakeshore (Wards 5 and 6) a directed staff to seek out opportunities to work with and encourage the Federal Government to improve the emission standards for heavy duty vehicles (see item #HL30.8 at http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.HL30.8).

Vehicle emissions are a concern and it is an issue that is not unique to Toronto. All urban areas in Canada probably have similar levels of air pollution emissions associated with motor vehicles. Therefore it is recommended that City Council consider looking to partner with other municipalities to identify ways of working with the Provincial and Federal Governments in implementing emission improvements that will result in improved in local air quality to benefit of all urban residents.

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