



## STAFF REPORT INFORMATION ONLY

### Summary of Toronto's 2011 Greenhouse Gas and Air Quality Pollutant Emissions Inventory

|                          |   |
|--------------------------|---|
| <b>Date:</b>             | March 27, 2013  |
| <b>To:</b>               | Parks and Environment Committee                       |
| <b>From:</b>             | Chief Corporate Officer                               |
| <b>Wards:</b>            | All   |
| <b>Reference Number:</b> | P:\2013\Internal Services\E&E\Pe13001E&E- (AFS 17004) |

#### **SUMMARY**

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The purpose of this report is to provide an update on the City's progress towards meeting the greenhouse gas and air quality pollutants reduction targets unanimously 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"). Data from 2011 and 2008 are compared to previously provided results from 2004 and the established baseline estimates of 1990 for both the City Government (emissions resulting from the operations of the City of Toronto) and the City Community (emissions occurring directly within or resulting from the activities within the borders of the City of Toronto).

Results show that greenhouse gas emissions in 2008 compared to 1990 levels were 26% lower for the City Government and 8% lower for the City Community, and that the emissions in 2011 were 37% lower for the City Government and 15% lower for the City Community. These results show that, barring the completely unexpected, Toronto will exceed its approved 2012 target of a 6% reduction from 1990 greenhouse gas levels.

Air quality pollutant emissions in 2008 were 1.1% higher than in 2004, and in 2011 were 1.5% higher than 2004 but the data used for this analysis are considered to be incomplete. The City's air quality pollutant target is a 20% reduction from 2004 levels by 2012. A more detailed inventory study will be completed in late 2013 which will incorporate more detailed data and which will provide a more accurate update on the City's progress for both greenhouse gas and air quality pollutant emissions.

## Financial Impact

This report has no financial impact.

## DECISION HISTORY

At its meeting of July 16 - 19, 2007 City Council unanimously 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>. The staff report contained recommendations concerning monitoring and reporting (see Recommendation 14) of smog causing emissions and greenhouse gas emissions.

Included within Recommendation 14 were the following clauses:

- a. direct the Director of the Toronto Environment Office to continue to coordinate the City's actions to measure, monitor and model greenhouse gases and smog causing emissions to ensure efforts are focused on those that have the greatest effect on human health and the natural environment;
- b. request energy utility companies in Toronto to provide data to the City, in a manner respectful of customer confidentiality requirements, to assist staff in monitoring the City's progress in meeting its targets;
- f. direct the Deputy City Manager, Cluster B, to report on air quality and greenhouse gas emissions, outcomes of policies, programs and activities in connection with the Climate Change and Clean Air Action Plan and recommend changes and new actions as part of regular annual reporting on the state of Toronto's natural environment and outcomes of policies, programs and activities.

## ISSUE BACKGROUND

In 2007 the Toronto Environment Office (TEO) produced "Greenhouse Gasses and Air Pollutants in the City of Toronto" (June 2007) in collaboration with Inner City Fund (ICF) International and the Toronto Atmospheric Fund. The document can be accessed at <http://www.toronto.ca/teo/pdf/ghg-aq-inventory-june2007.pdf>. The data assembled and analysed for the Inventory (June 2007) was also used to help prepare the City's Climate Change Action Plan (June 2007) as well as the Power To Live Green: Sustainable Energy Strategy (October, 2009).

The inventory published in 2007 was based on 2004 data. Obtaining updated and more detailed data from the City Community's major energy providers regarding City Community energy consumption and related emissions has proven very difficult and has delayed the satisfying of the instruction to report annually by five years. Obtaining more

detailed energy consumption data by both sector and geography was a conclusion reached in both undertaking the inventory analysis of 2007 and the subsequent energy plan analysis of 2009.

This 2011 inventory update report is based on data obtained in late 2012 that relates to energy consumption and related emissions in Toronto since 2004, including 2008 and up to 2011.

## **COMMENTS**

This report addresses and assesses annual energy consumption totals and their variation with time for the City Community and the City Government as well as their associated local air pollution and greenhouse gas emissions. Emissions are calculated at "end of pipe" rather than "lifecycle" emissions, since the latter is much more complex and has no standard measurement protocol. While this report does not address the analysis of data at finer temporal and spatial resolutions, it is intended that TEO's energy mapping and spatial analysis initiative, when completed in late 2013, will do exactly that, and will both better identify potential emission reductions and will also identify financial savings and other improvements with greater certainty across Toronto.

## **Energy, Smog and Greenhouse Gases: Interwoven Issues**

Energy consumption, smog-causing emissions and greenhouse gas emissions go hand-in-hand when 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.

Energy consumption commonly occurs far from its source or generation point, as is the case for electricity use in Toronto. The consumption of electricity produces greenhouse gases in amounts that vary as a function of the source mix (i.e., coal, and natural gas resources when combusted release different amounts of greenhouse gas to produce the same unit of electricity, plus the inclusion of hydro-electric and nuclear generated electricity which releases none). Though such greenhouse gas emissions are included in the Toronto Inventory, any accompanying release of air pollution related smog-causing pollutants are not included unless they are specifically released within Toronto - as for example, by the Portland Energy Centre.

The consumption of natural gas, as for space heating and water heating, directly leads to the local release of air contaminants across the City. The tail-pipe emissions from vehicles contribute to both local air quality and global atmospheric pollution. The furnace and boiler flues of residences, commercial establishments and industrial enterprises as well as the tail pipes of cars, trucks, planes and trains all contribute to local air quality and global atmospheric issues. Local air quality issues also relate to immediate

and short term local health issues, and especially to cardio-vascular and respiratory issues and the associated burden of illness.

The issues of energy use and costs, of conservation and cost savings, of air quality and health, and of greenhouse gas emissions and climate change are all intrinsically linked; causes and solutions are inherently interwoven.

### City Adopted Air Quality and Greenhouse Gas Reduction Targets

This report tracks 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 smog reduction targets. City Council unanimously adopted the targets indicated in Table 1 at its meeting of July 16 - 19, 2007.

**Table 1. The City of Toronto's Adopted Emission Reduction Targets.**

|             | Air Quality Contaminants | Greenhouse Gases |
|-------------|--------------------------|------------------|
| <b>1990</b> |                          | Baseline Year    |
| <b>2004</b> | Baseline Year            | --               |
| <b>2012</b> | 20%                      | 6%               |
| <b>2020</b> | --                       | 30%              |
| <b>2050</b> | --                       | 80%              |

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 (hot summers that lead to more electricity consumption for air conditioning, and cold winters that lead to more natural gas consumption for space heating). The influence of these variables is to be explored in the subsequent and more detailed inventory report to be finalized in late 2013.

The targets of Table 1 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<sub>2</sub>O). The smog reduction targets relate mainly to ozone, particulate matter, nitrogen dioxide (NO<sub>2</sub>) and other gases.

Three sources of air quality related and climate change related emissions dominate all others: emissions from using natural gas, from using electricity, and from using automobiles and trucks. Lower emissions from these three can be achieved by using *less* (through conservation) and by using *better* (through greater efficiency).

The goal of the City's "Power to Live Green" policy document is to develop an energy strategy that builds on the City's sustainable energy foundation by significantly conserving, renewing and smartly distributing electricity and natural gas to bring the City closer to its greenhouse gas reduction targets. The document only addressed "stationary energy" (i.e., energy for use in buildings). Transportation and waste management aspects were expected to report separately.

## Greenhouse Gas Emissions from All Sources Combined

The emissions from the City Community include all the emissions from the City Government. However, the emissions from City Government are also included here to identify the degree to which the City is able to lead by example.

The main contributing sources of emissions are those of electricity consumption, natural gas consumption, vehicle fuel consumption and waste production. The greenhouse gas emissions for the City Community in 2011 decreased by 15% compared to 1990, as is indicated in Table 2.

### City Community

**Table 2. Sources of Greenhouse Gas Emissions (tonnes) for the City Community <sup>1</sup>.**

| Source  | 1990              | 2004              | 2008              | 2011                   |
|---|-------------------|-------------------|-------------------|------------------------|
| Electricity   | 5,847,765         | 6,185,036         | 5,217,000         | 4,331,786              |
| Natural Gas   | 8,741,625         | 8,614,130         | 8,385,928         | 7,947,639              |
| Transportation <sup>2</sup><br>(No Rail, Planes or Boats)         | 7,293,440         | 8,099,914         | 8,383,396         | 8,383,396 <sup>2</sup> |
| Waste Collected Privately<br>(2/3 of Total) <sup>3</sup>          | 3,631,502         | 2,396,683         | 2,084,536         | 1,717,123              |
| Private Waste Transported<br>post Private Collection <sup>4</sup> |                   | 71,014            | 36,123            | 13,004                 |
| Waste Collected by City<br>(1/3 of Total)                         | 1,815,751         | 1,198,341         | 1,042,268         | 858,561                |
| Public Waste Transported<br>post City Collection                  |                   | 35, 507           | 18,062            | 6,502                  |
| <b>Total</b>  | <b>27,330,082</b> | <b>26,600,626</b> | <b>25,167,314</b> | <b>23,258,012</b>      |
| <b>Change from 1990</b>   | --                | <b>-2.7%</b>      | <b>-7.9%</b>      | <b>-14.9%</b>          |

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

Note 2: Transportation data from 2011 is not yet available. The next update is expected in 2014. Data from 2008 is used here to permit inclusion within 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 two-thirds to one-third standard for all years in future Inventories.

Note 4 This data is guesstimated. 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 and 2011 are at least as high as, or even much higher than, the City Government waste haulers emissions, as they haul waste further afield.

### City Government

The greenhouse gas emissions for the City Government in 2011 decreased by 37% compared to 1990, as indicated in Table 3.

**Table 3. Sources of Greenhouse Gas Emissions (tonnes) for the City Government.**

| Source                          | 1990             | 2004             | 2008             | 2011             |
|---------------------------------|------------------|------------------|------------------|------------------|
| Buildings                       | 178,425          | 497,611          | 464,320          | 398,596          |
| Streetlights                    | 37,786           | 28,203           | 21,947           | 19,406           |
| Water                           | 202,900          | 157,952          | 123,044          | 111,760          |
| Vehicles (fleet)                | 46,236           | 32,564           | 38,270           | 43,364           |
| Waste management (1/3 of Total) | 1,815,751        | 1,198,341        | 1,042,268        | 858,561          |
| <b>Total</b>                    | <b>2,281,099</b> | <b>1,914,672</b> | <b>1,689,849</b> | <b>1,431,687</b> |
| <b>Change from 1990</b>         | --               | <b>-16.06%</b>   | <b>-25.92%</b>   | <b>-37.24%</b>   |

The amount of greenhouse gases released is calculated from fuel consumption data respecting electric and natural gas use, from data of traffic volume and from data of the tonnages of waste (by material subtype) delivered to landfill sites. This inventory also includes the previously overlooked additional 200% of privately hauled waste material (as in Table 2). It is apparent (based on population to waste collected analysis) that very few, if any, other cities report the private collection of waste in their cities. Care will be taken to ensure appropriate apples-to-apples comparisons with other cities in the future.

It is expected that both the City Community and the City Government will have exceeded the target of a 6% reduction in greenhouse gas emissions in 2012. It will not be possible to confirm this until such time as all data from all source contributors is received.

## Contributions of Individual Source Types in the City Community

### Electricity

From 1990 to 2008, there was a 10.2% increase in electricity use, which is slightly less than the population increase in Toronto of 11.0% for 1991 to 2006. As indicated in Table 4, the increase in electricity consumption in 2004 compared to 1990 was 1.0%, but the increase in electricity consumption in 2008 compared to 1990 was considerably greater at 10.2%, and the increase in electricity consumption in 2011 compared to 1990 was 4.0%. The short term data trends appear to be irregular and it is apparent that other factors are significant. A fuller evaluation of the variability and influence of weather, economic state, life-style and population characteristics is being undertaken and will be explored in the subsequent and more detailed inventory report to be provided in late 2013, and will be discussed in the context of the need for both a more detailed and an improved frequency of data acquisition, rather than relying on irregular and discrete data collection years.

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

|             | Electricity Consumption (kWh) | Change from 1990 | Electricity Emissions Factors (gCO <sub>2</sub> e / kWh) | Electricity Emissions (tCO <sub>2</sub> e) | Change from 1990 |
|-------------|-------------------------------|------------------|--|--|------------------|
| <b>1990</b> | 25,314,997,857                | --               | 231  | 5,847,765                                  |                  |
| <b>2004</b> | 25,558,000,709                | 0.96%            | 242  | 6,185,036                                  | 5.77%            |
| <b>2008</b> | 27,898,394,277                | 10.21%           | 187  | 5,217,000                                  | -10.79%          |
| <b>2011</b> | 26,253,247,548                | 3.71%            | 165  | 4,331,786                                  | -25.92%          |

Clearly, Toronto's consumption of electricity in the period 1990 to 2011 has increased variably among the years for which data is shown here. Conversely, Toronto's electricity related greenhouse gas emissions have decreased by 26% during that same period. This is because the corresponding electricity emission-factors have declined over the same period to reflect the changing source fuel mix of the electricity supply. Essentially, coal has been gradually phased-out and greenhouse gas emissions per unit of electricity produced are progressively reduced because of it.

The community's greenhouse gas reduction target of 6% by 2012 appears certain to be well surpassed in respect to the emissions associated with electricity consumption in Toronto, having already attained a 26% reduction in 2011.

Toronto Hydro has provided the City with data of annual total electricity consumption for every year since 1990, and coupled with their provision of more detailed electricity consumption data, as by simple sector and neighbourhood, beginning in 2003, and as by more complex land use classes and approximate location for 2008 and 2011, that will permit a fuller analysis of annual and monthly variations of consumption and the causalities, to be provided in a fuller report of late 2013.

## Natural Gas

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

|             | <b>Natural Gas Consumption (m<sup>3</sup>)</b> | <b>Change from 1990</b> | <b>Natural Gas (grams CO<sub>2</sub> eq. / m<sup>3</sup>)</b> | <b>Natural Gas Emissions (tonnes CO<sub>2</sub>e)</b> | <b>Change from 1990</b> |
|-------------|--|-------------------------|---|---|-------------------------|
| <b>1990</b> | 4,355,568,000                                  | --                      | 2007  | 8,741,625   | --                      |
| <b>2004</b> | 4,323,001,973                                  | -0.75%                  | 1993  | 8,614,130   | -1.46%                  |
| <b>2008</b> | 4,435,527,684                                  | 1.84%                   | 1891  | 8,385,928   | -4.07%                  |
| <b>2011</b> | 4,203,705,477                                  | -3.49%                  | 1891  | 7,947,639   | -9.08%                  |

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 3.5% between 1990 and 2011. 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 community's greenhouse gas reduction target of 6% by 2012 would appear to be well on its way to being surpassed in respect to the emissions associated with natural gas consumption in Toronto, having already attained a 9% reduction in 2011.

## Car and Trucks

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

|             | <b>Car and Truck Emissions (tonnes CO<sub>2</sub> equivalent)</b> | <b>Change from 1990</b> | <b>Change from 2004</b> |
|-------------|---|-------------------------|-------------------------|
| <b>1990</b> | 7,293,440   | --                      | --                      |
| <b>2004</b> | 8,099,914   | 11.06%                  | --                      |
| <b>2008</b> | 8,383,396   | 14.94%                  | 3.50%                   |
| <b>2011</b> | 8,383,396 <sup>1</sup>  | 14.94% <sup>1</sup>     | 3.50% <sup>1</sup>      |

*Note 1: Transportation data from 2011 is not yet available. The next update is expected in 2014. Data from 2008 is used here to permit inclusion in the combined overall totals of this report.*



Table 6 shows the estimated emissions from road vehicles in Toronto between 1990 and 2011. 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 received from Transportation Services for 2008. However, these estimates are likely to be less reliably accurate for 2008. Furthermore, 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. Indeed, trucks were not included in any way in the 1990 estimates. In effect, the very simply estimated base data case data of 1990, is, and will remain, inadequate and all ensuing comparisons suspect.

In the 21 year period from 1990 to 2011, greenhouse gas emissions associated with the combustion of gasoline and diesel in road vehicles is estimated to have increased by 15%. In the 4 year period from 2004 and 2008, the increase in these emissions was 3.5%. On an average annual basis, the rates of increase for the two periods are similarly less than 1% (0.71% and 0.87%).

### **Contributions of Individual Source Categories in the City Government**

Consistent and detailed data by category for City Government emissions in 1990 is not available. The data since 2004 is compared here to the total estimate for 1990 previously arrived at as part of the 2007 inventory.

#### **Electricity Consumption**

**Table 7. City Government Electricity Consumption per year (kWh).**

| <b>Category</b>                | <b>1990</b>        | <b>2004</b>          | <b>2008</b>          | <b>2011</b>          |
|--------------------------------|--------------------|----------------------|----------------------|----------------------|
| Facilities & Real Estate       |                    | 108,435,156          | 101,721,005          | 92,289,671           |
| Parks & Recreation             |                    | 114,358,240          | 107,830,116          | 110,808,887          |
| Toronto Community Housing Corp |                    | 405,494,001          | 394,802,838          | 400,306,247          |
| Toronto Transit Commission     |                    | 110,162,230          | 110,821,061          | 77,472,322           |
| Toronto Water                  |                    | 560,474,741          | 541,113,575          | 515,839,515          |
| Transportation Services        |                    | 125,707,175          | 125,123,565          | 124,117,755          |
| All other ACDs                 |                    | 236,853,336          | 230,015,131          | 221,807,850          |
| <b>Total</b>                   | <b>353,492,356</b> | <b>1,661,484,878</b> | <b>1,611,427,290</b> | <b>1,542,642,247</b> |
| <b>Change from 1990</b>        | --                 | <b>370.02%</b>       | <b>355.86%</b>       | <b>336.40%</b>       |
| <b>Change from 2004</b>        | --                 | --                   | <b>-3.01%</b>        | <b>-7.15%</b>        |

Between 2004 and 2011 there has been a 7% improvement in the overall reduction of electricity use by City Government. But between 1990 and 2004 there was an apparent and significant increase, with emphasis here on "apparent", of 368% 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.

Toronto Community Housing Corporation emitted approximately 25% of City Government greenhouse gas emissions in the period 2004 to 2011. Toronto Water emitted approximately 33% of the total in the same period. The Toronto Community Housing Corporation's electricity consumption has declined over the period 2002 to 2008, but was lowest in 2004. Toronto Water's electricity use declined steadily in the same period.

Examination of the more reliable data of 2004 through to 2011, show that for all categories in Table 7, a reduction of electricity consumption occurred. The Toronto Transit Corporation has a remarkable 30% reduction in their consumption over this period.

### Natural Gas Consumption

**Table 8. City Government Natural Gas Consumption (m3).**

| <b>Category</b>                       | <b>1990</b>       | <b>2004</b>        | <b>2008</b>        | <b>2011</b>        |
|---------------------------------------|-------------------|--------------------|--------------------|--------------------|
| <b>Parks &amp; Recreation</b>         |                   | 13,866,210         | 13,254,460         | 11,444,380         |
| <b>Toronto Community Housing Corp</b> |                   | 75,479,758         | 98,908,749         | 87,085,897         |
| <b>Toronto Water</b>                  |                   | 11,199,966         | 11,559,937         | 14,093,809         |
| <b>All others ACDs</b>                |                   | 27,537,778         | 27,563,513         | 22,685,212         |
| <b>Total</b>                          | <b>48,215,491</b> | <b>128,083,712</b> | <b>151,286,659</b> | <b>135,309,298</b> |
| <b>Change from 1990</b>               | --                | <b>165.65%</b>     | <b>213.77%</b>     | <b>180.63%</b>     |
| <b>Change from 2004</b>               | --                | --                 | <b>18.12%</b>      | <b>5.64%</b>       |

The increased consumption of natural gas by the City Government between 1990 and 2004 follows the same pattern as shown for electricity consumption. The building energy data for 1990 again in part reflects an incomplete data record, and in part reflects the inclusion of buildings and facilities that were not part of the building stock in 1990.

However, since 2004, the patterns of change between electricity consumption and natural gas consumption have not been as similar. Whereas electricity consumption decreases compared to 2004, the consumption of natural gas is higher in 2008 and 2011 than it was in 2004.

A fuller evaluation of the variability and influence of other factors such as weather, economic state, lifestyles and population characteristics is being undertaken and will be explored in the subsequent and more detailed inventory report to be finalized in late 2013.

### **Electricity and Natural Gas Emissions**

**Table 9. Summary of Emissions resulting from City Government Electricity and Natural Gas Consumption (tonnes CO<sub>2</sub> equivalent).**

|                         | <b>1990</b> | <b>2004</b>    | <b>2008</b>    | <b>2011</b>    |
|-------------------------|-------------|----------------|----------------|----------------|
| <b>ELECTRICITY</b>      | 81,657      | 402,079        | 301,337        | 254,536        |
| <b>Change from 1990</b> | --          | <b>392.40%</b> | <b>269.03%</b> | <b>211.71%</b> |
| <b>Change from 2004</b> | --          | --             | <b>-25.06%</b> | <b>-36.70%</b> |
| <b>NATURAL GAS</b>      | 96,768      | 255,223        | 286,027        | 255,819        |
| <b>Change from 1990</b> | --          | <b>163.75%</b> | <b>195.58%</b> | <b>164.36%</b> |
| <b>Change from 2004</b> | --          | --             | <b>12.07%</b>  | <b>0.23%</b>   |

The issue of the inadequacy of baseline data for City Government 1990 is again apparent here. Anecdotal evidence suggests that a) the need for 1990 baseline data following Toronto's adoption of the Toronto protocol of 1988 (stemming from the World Conferences on the Changing Atmosphere in Toronto, June 1988) for a 20% reduction target of carbon dioxide emissions from 1990 levels by 2005 was not rigorously implemented for several years, and that b) the process of amalgamation and staff movements led to the loss of many paper records. As such, the combination of incomplete and missing data as well as the poor quality of back-casted estimates associated with 1990 is neither surprising nor reversible. Furthermore, the subsequent improvement in record keeping, and the inclusion of buildings and other facilities that were not part of the City Government's building stock in 1990, results in an understandably increase in electricity and natural gas related emissions since 1990 and as appears in the data for 2004, 2008 and 2011 in Table 9.

Though, for consistency of comparisons with other cities and in keeping with City adopted policy, continuing to relate improvements to the 1990 baseline is very important, examining what improvements have been made since 2004 offers a more reliable sense of more current endeavour and progress.

Since 2004, the emissions relating to electricity consumption by City Government has decreased by 25% to 2008 and by 37% to 2011. The reduction includes the success of

introducing conservation measures but also owes much to the Province's closing down of coal powered electricity generating plants.

### 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 chemistry specific substance but rather a physically specific sized particle. Commonly particulates having an aerodynamic diameter smaller than 2.5 microns (PM<sub>2.5</sub>) may cause a smog alert to be called. The size of such particles may be understood by recognizing that more than 640,000 of them could fit side-by-side on the head of a pin of 2 mm diameter. 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. Smogs are 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.

**Table 10. City Community NOx Emissions <sup>1</sup>, 2004, 2008 and 2011.**

| Source  | 2004<br>(tonnes) | 2004<br>%<br>of Total | 2008<br>(tonnes) | 2008<br>%<br>of Total | 2011<br>(tonnes) | 2011<br>%<br>of Total |
|---|------------------|-----------------------|------------------|-----------------------|------------------|-----------------------|
| Natural Gas - Data From Enbridge <sup>2</sup> | 5,046            | 16.49%                | 5,885            | 19.02%                | 5,466            | 17.94%                |
| Portlands Energy Centre                       | --               |                       | --               |                       | 289              | 0.95%                 |
| NPRI - All other sources <sup>3</sup>         | 2,139            | 6.99%                 | 1,360            | 4.40%                 | 1,009            | 3.31%                 |
| Cars & Light Trucks <sup>4</sup>              | 10,720           | 35.03%                | 11,446           | 36.99%                | 11,446           | 37.58%                |
| Heavy Diesel Trucks <sup>4</sup>              | 12,697           | 41.49%                | 12,251           | 39.59%                | 12,251           | 40.22%                |
| <b>Total</b>                                  | <b>30,602</b>    |                       | <b>30,942</b>    |                       | <b>30,461</b>    |                       |
| <b>Change from 2004</b>                       | <b>--</b>        | <b>--</b>             | <b>1.11%</b>     | <b>--</b>             | <b>-1.55%</b>    | <b>--</b>             |

- Notes: 1. NO<sub>x</sub> is used here as a surrogate indicator of general year round air quality, as based on emissions rather than concentrations.*
- 2. Includes Portlands Energy Centre for 2008 and 2011.*
- 3. Includes all sources reporting to the National Pollution Release Inventory.*
- 4. Next Updated Community Transportation Data Set is not available until 2014. Data from 2008 is used here represent 2011 emissions to permit inclusion in the combined overall totals of this report.*

Nitrogen oxides (NO<sub>x</sub>) are the emissions selected in preference to using fine particulate matter as the distribution of resultant NO<sub>x</sub> 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. NO<sub>x</sub> (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 they have gone up slightly since then, but better data for transportation emissions may result in more accurate and favourable results.

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 1.6% was seen between 2004 and 2011. Equally clear, is that the major local contributor to the presence of nitrogen oxides in Toronto's air are Toronto's trucks and cars which contribute a combined 78% in 2011 to Toronto's general year round air quality. 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.

As such, it appears very probable that the City will not meet its Council adopted 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.

### **Reaching Future Greenhouse Gas and Air Quality Targets**

The City's greenhouse gas reduction target of 80% for transportation by 2050 can be met if the vehicles that operate in Toronto were to achieve, on average, a Canadian Environmental Protection Act CEPA standard of 4.7 litres per 100km (50 miles per US gallon). The 50 mpg standard was a pre-election commitment of President Obama, which if enacted, and based on recent history, would also become the Canadian Standard. If the standard is introduced before 2037, which would allow for a 13 year (or greater) fleet replacement or change-over in the fleet, of all vehicles in the City, then the vehicle fleet in Toronto would meet its 80% target by 2050.

This would also lead to an equivalent 80% reduction in the air quality pollutants associated with tailpipe emissions. However, the true extent of emissions from trucks 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 47% of nitrogen oxides (NOx) coming from all road using vehicles, or 37% of all nitrogen oxides released within the City – albeit these are, at best, only crude estimates, as shown in Table 11.

**Table 11. City Community Greenhouse Gas and Air Quality Emissions in 2011.**

| <b>Emissions Source</b>              | <b>Greenhouse Gases (Tonnes)</b> | <b>Greenhouse Gases %</b> | <b>Air Quality (as NOx) (Tonnes)</b> | <b>Air Quality (as NOx) %</b> |
|--------------------------------------|----------------------------------|---------------------------|--------------------------------------|-------------------------------|
| Natural Gas                          | 7,947,639                        | 31%                       | 6,764                                | 20.47%                        |
| Electricity                          | 4,331,786                        | 17%                       | 289 <sup>1</sup>                     | -- <sup>1</sup>               |
| Waste                                | 1,717,123                        | 7%                        | -- <sup>1</sup>                      | -- <sup>1</sup>               |
| Cars & Light Trucks                  | 9,524,638                        | 37%                       | 11,446                               | 34.63%                        |
| Heavy Gas Trucks plus Other Vehicles | 510,536                          | 2%                        | 2,299                                | 6.96%                         |
| <b>Heavy Diesel Trucks</b>           | <b>1,591,311</b>                 | <b>6%</b>                 | <b>12,251</b>                        | <b>37.07%</b>                 |
| Totals                               | 25,623,032                       | 100%                      | 33,049                               | 100.00%                       |

*Note 1: Emissions related to the generation of electricity at Portland Energy Centre in Toronto are included based on preliminary (un-reviewed) NPRI reporting for 2011. However, electricity generated beyond Toronto's boundaries is not included as their emissions cannot be contributed directly to local air quality in Toronto in a quantifiable manner without detailed air quality modelling. It is hoped that this will be available in future inventories.*

The lack of data in regard to specific volumes of the different truck types using City roads is a significant omission – one, that if rectified could provide much better estimates of the significance of emissions from trucks on the public health of Toronto's inhabitants.

The reduction in emissions from using electricity in Toronto has clearly occurred on the back of the Province's closing down their coal fired electricity generating plants. (Preliminary data for 2010, the most recent year for which reliable data is available, of the amount of electricity generated from coal actually increased as did electricity from natural gas in 2010.) This has been accompanied by an increased reliance on the use of gas fired electricity generating plants (making them the new coal) and renewables. Future reductions will be required beyond 2012 to meet the City's future targets for 2020 and 2050. The recent pattern of natural gas consumption has not shown significant reductions.

A more detailed inventory study will be completed in late 2013, and will incorporate more detailed sectoral data of 2011 which will permit a more accurate and useful update on the City's progress for both greenhouse gas and air quality pollutant emissions. In conjunction with which, the results of an energy mapping and conservation opportunity study currently underway will be provided. This work will identify future conservation opportunities and their relative appropriateness for residents and businesses in the City.

## **CONCLUSION**

The City Community is expected to exceed its approved 2012 target of a 6% reduction from 1990 in greenhouse gas emissions and could well exceed a 37% reduction. The City Community is not expected to meet its approved 2012 target of a 20% reduction from 2004 levels in smog causing emissions or local air quality.

A more detailed assessment and recommendations as to a) what will be required to meet the City's adopted future targets respecting greenhouse gas and air quality emissions; and b) what energy conservation initiatives are most likely to save money for Toronto residents and businesses will be provided later in 2013.

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## **SIGNATURE**

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