London Energy/Air Emissions Reduction Strategy Task Force: Air Emissions and Energy Use in the City of London

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Table of Contents

EXECUTIVE SUMMARY **6**

1. INTRODUCTION **11**

1.1 GOAL 11
1.2 TERMS OF REFERENCE 11
1.3 WHY LONDON SHOULD ACT 11
1.3.1 *Global Climate Change is a Reality* *11*
1.3.2 *The Precautionary Principle and the Principle of Shared Responsibility* *11*
1.3.3 *Canada is a Signatory of the Kyoto Protocol* *12*
1.3.4 *London is a Member of the Partners for Climate Protection (PCP)* *13*
1.3.5 *Local Air Pollution (Smog) is Relatively High in the London Area* *13*
1.3.6 *Climate Change Mitigation is an Opportunity* *14*
1.3.7 *Previous City Documents Recommend Action* *14*
1.4 RELEVANT HISTORY 15
1.4.1 *Air Emissions Study* *15*
1.4.2 *Vision London* *16*
1.4.3 *Air Quality State of the Environment Report* *17*
1.5 ORGANIZATION OF THIS REPORT 17

2. CLIMATE CHANGE AND LOCAL AIR POLLUTION **18**

2.1 INTRODUCTION 18
2.2 GREENHOUSE GASES, THE GREENHOUSE EFFECT, AND GLOBAL WARMING 18
2.3 LOCAL IMPACTS OF GLOBAL WARMING: SOUTHERN ONTARIO. 19
2.4 AIR POLLUTANTS AND SMOG IN SOUTHERN ONTARIO 20
2.4.1 *Definitions* *20*
2.4.2 *London Region Air Quality* *23*
2.5 IMPACTS OF AIR POLLUTANTS AND SMOG 27
2.6 LOCAL AIR POLLUTION AND GLOBAL CLIMATE CHANGE 28

3. CO_2 EMISSIONS ANALYSIS: LONDON COMMUNITY **30**

3.1 QUANTIFICATION 30
3.1.1 *Greenhouse Gas Emissions Software* *31*
3.2 BASE YEAR 31
% of Total 32
3.3 CURRENT YEAR 34
3.4 CITY OF LONDON ENERGY USE BY ENERGY TYPE 34
3.4.1 *Electricity* *34*
3.4.2 *Natural Gas* *34*
3.4.3 *Transportation Fuels* *35*
3.4.4 *Heating Fuels* *35*
3.5 CITY OF LONDON ENERGY CONSUMPTION BY END USE SECTOR 36
3.5.1 *Residential Sector* *36*
3.5.2 *Commercial and Institutional Sector* *37*
3.5.3 *Industrial Sector* *37*
3.5.4 *Transportation Sector* *37*
3.6 ANALYSIS OF ENERGY USE, 1990-1998 39
3.7 FORECAST 41
3.7.1 *Forecast Generation* *41*

3.8 EMISSIONS REDUCTION TARGETS 43

4. AN ACTION PLAN FOR LONDON 46

4.1 INTRODUCTION 46
4.2 BARRIERS TO SUCCESS OF MUNICIPAL ACTION PLANS 46
4.2.1 *Financial Constraints 46*
4.2.2 *Information Gaps 48*
4.2.3 *Lack of Analytical Capacity 49*
4.2.4 *Constitutional and Legal Barriers: 49*
4.3 STEPS TO AN ACTION PLAN 50
4.4 ACTION PLAN STRATEGIES: KEY COMPONENTS 50
4.4.1 *Acquisition of dedicated energy-related staff resources. 52*
4.4.2 *Financial Resources 54*
4.4.3 *Integrate Energy Issues into City Planning 55*
4.4.4 *Implement the Recommendations of the 1995 Air Emissions Study. 56*
4.5 ACTION PLAN STRATEGIES: SPECIFIC MEASURES TO REDUCE ENERGY USE AND IMPROVE AIR QUALITY 57
4.5.1 *Transportation Demand Management 57*
4.5.2 *City's Own Operations 58*
4.5.3 *Carbon Sequestration 58*
4.5.4 *Industrial Commercial Sector 58*
4.6 ACTION PLAN STRATEGIES: MONITORING AND EVALUATING PROGRESS 59
4.7 ACTION PLAN STRATEGIES: DEMONSTRATION OF LEADERSHIP BY THE CITY OF LONDON 60
4.8 ACTION PLAN STRATEGIES: EDUCATION 60
4.9 ACTION PLAN STRATEGIES: AIR QUALITY PLAN 61
4.9.1 *Short term strategies 61*
4.9.2 *Long Term Strategies: 62*

APPENDICES 64

A. CALCULATIONS, ASSUMPTIONS AND NOTES 65

A.1 DATABASE 65
A.1.1 *Provincial Energy Use Statistics 65*
A.1.2 *Population Statistics 66*
A.1.3 *Energy Use Statistics by Sector 66*
A.2 ANALYSIS, 1990 AND 1998 68
A.3 FORECAST 70

B. PROPOSED MUNICIPAL ENERGY MANAGEMENT CO-ORDINATOR JOB DESCRIPTION 72

C. CONTACT TABLE 75

D. TERMS OF REFERENCE FOR THE ENERGY/AIR EMISSIONS REDUCTION STRATEGY TASK FORCE 76

List of Tables

Table 1.1. Partners for Climate Protection Milestones....13
Table 2.1. Terms and definitions associated with global climate change. 19
Table 2.2. Impacts of global warming likely to effect the London Area. 21
Table 2.3. Important Ontario pollutants, sources and impacts. 22
Table 2.4. Ambient Air Quality Criterion definitions and levels for ozone. 23
Table 2.5. Air quality index summary for 1996. Source: Air Quality in Ontario 1996. 25
Table 2.6. Air quality index summary for 1997. Source: Air Quality in Ontario 1997. 26
Table 3.1 City of London Energy Use By Type and Sector. Final Results 1990 (In GJ). 32
Table 3.2 City of London Secondary Energy Use by Type and Sector. Final Results 1998 (In GJ). 39
Table 4.1. Steps to a Local Action Plan as suggested by the PCP program, the current London situation of each step, and future actions required. 51
Table A.1 City of London CO_2 Emissions by Energy Type. 69
Table A.2 City of London Energy Use by Energy Type, 1990 and 1998. 69
Table A.3 City of London Energy Use and CO_2 Emissions per Capita. 70
Table A.4 Growth Multipliers for Energy Use Forecasting. 71

List of Figures

Figure 1.1 CO_2 emissions per capita of selected countries. 12
Figure 3.1 City of London Energy Use by End Use Sector, 1990. 33
Figure 3.2 City of London Equivalent CO_2 Emissions by Sector, 1990. 33
Figure 3.3 City of London Energy Use by Energy Type, 1998. 36
Figure 3.4 City of London Energy Use by Sector, 1998. 38
Figure 3.5 City of London Equivalent CO_2 Emissions by End Use Sector, 1998. 38
Figure 3.6 City of London Energy Use by Sector: 1990 and 1998 Comparison. 40
Figure 3.7 City of London Equivalent CO_2 Emissions by Sector, 1990 and 1998 Comparison (tonnes). 40
Figure 3.8 City of London Energy Use by Energy Type, 1990 and 1998 Comparison (GJ). 41
Figure 3.9 Equivalent CO_2 Production Forecast for the City of London: 1990-2016 (tonnes). 42

EXECUTIVE SUMMARY

Introduction

This Task Force report is in response to the recommendation by ETC that the City of London develop an energy/air emission reduction strategy with the overall goal of reducing CO_2 emissions and smog so as to improve the air quality in the City of London and reduce global warming. This report (in combination with the 1995 Air Emissions Study commissioned by the City) presents an Action Plan that includes measures to achieve energy and air emissions reductions and monitor future emissions.

The Need for Action

Emissions of carbon dioxide (CO_2), primarily through the burning of fossil fuels (including gasoline, diesel fuel, natural gas, propane, oil, coal and wood) are responsible for an enhanced greenhouse effect that has begun to change the global climate and poses a serious threat to individuals not only in London, but world-wide. Emissions of CO_2 made locally contribute to a global problem with major consequences. Regional impacts of global climate change may subject Londoners to a range of problems including: an increase in health problems related to heat stress, air pollution, and the spread of new infectious diseases; problems related to water resources including decreased water supply from ground and surface sources, impacts arising from lower Great Lakes water levels, and reduced wet land areas; increased energy demand for summer cooling, increased demand for summer water; and changes to agriculture through altered climate and moisture regimes.

Canada is a signatory of the Kyoto Protocol, which seeks to reduce emissions of CO_2 by signatory nations. Canada has agreed to a 6% reduction relative to 1990 by the period 2008-2012. In Canada, municipalities are estimated to exert direct and indirect control and influence over up to 50% of the greenhouse gas emissions.

Locally, London is situated in an area of southwestern Ontario known to be Canada's smog hot spot. The main components of smog are ground level ozone and particulates. Unlike emissions of CO_2 that have an equal impact per unit of emission anywhere in the world, emissions of pollutants that cause the formation of ground-level ozone have a local to regional impact. In the London area, air pollution from the United States contributes about 50% of the ground-level ozone, however, the remainder is generated from within southwestern Ontario, primarily through automobile emissions and coal-burning electric generating plants.

The primary impact in London from air pollution is on human health. Persons most at risk are those with respiratory problems, children and the elderly, but even healthy individuals who exercise outdoors in urban areas have been shown to be subject to health risks. Air pollution is cited as the cause of premature death for 1,800 premature deaths and 1,400 hospital admissions annually in Ontario[1]. According to Environment Canada, new research shows that there appears to be no safe level of human exposure to particulates or ground-level ozone.[2].

Smog, and in particular ground-level ozone, is also responsible for severe damage to vegetation, materials, and crops, leading to economic losses from air pollution episodes. Environment Canada estimates the benefits of reduced smog in major Canadian urban centres are $10 billion annually.

Key Findings for London

Energy Use in London

1. The transportation sector has the highest energy use, followed by nearly equal consumption by the commercial and residential sectors. Results are similar for 1990 and 1998.
2. The Transportation sector is the largest contributor to CO_2 emissions, accounting for approximately 40% of the emissions. The transportation sector is almost twice as large as the next largest sector. The transportation sector is also a significant contributor to poor air quality due to smog.
3. Energy use in the City of London has increased by 9% between 1990 and 1998.
4. The largest percentage change in energy use between 1990-1998 was recorded by the industrial sector. The transportation sector had the second highest recorded percentage change and the largest absolute gain.
5. In a Business-as-usual scenario, London's CO_2 emissions are forecasted to rise approximately 23% by the year 2011 from the base year (1990) emissions (13% from 1998 emissions).

Air Quality in London

6. Air quality in London ranks lower than that of many other Ontario cities; air pollution is a concern on 80-90 days of the year. The average number of days in southwestern Ontario with high Air Quality index readings has increased during the period 1993-97, primarily due to ozone levels.

[1] IP/RP Workgroup, 1996. Bulletin on inhalable and respirable particulates (IP &RP), IP/RP Progress Note #l, prepared for Ontario Smog Plan, by IP/RP Strategy Working Group, Chair: David Pengelly, November, 1996.
[2] Environment Canada: Air Issues Web Page: http://www.ec.gc.ca/envpriorities/cleanair_e.htm, July 28, 1999.

Targets and Progress to Date

7. To achieve Kyoto Protocol objectives will require an energy use reduction of just over 13% from 1998 energy use levels or 24% from forecasted 2011 levels assuming a Business-as-usual case.

8. London falls behind several other Canadian cities in addressing local emissions of CO_2 and air pollutants[3].

9. Significant opportunities exist to reduce emissions of CO_2 and air pollutants and generate economic savings, as addressed through the 1995 Air Emissions Study and this report.

Recommendations

Successful action plans require three key elements: human resources, financial resources and integration of energy issues into city operations and planning. The Task Force recommendations, with approximate costs in monetary or time (work weeks of the year) commitment required are:

Human Resources

1. The City hire a dedicated Energy Management Co-ordinator to achieve the objectives of this report and the 1995 Air Emissions Study. The Task Force sees the Energy Management Co-ordinator as the key figure responsible for initiating local action. To support this position, we also recommend that a community steering committee be established by the City to assist the Energy Management Co-ordinator with the implementation and monitoring of the Action Plan.
   Details: Section 4.4.1, page 52.
   Approximate Cost: $80K (on-going; salary and benefits); $50K (Start-up and on-going budget to support position, as per job description. Funds may initially come from a dedicated fund (recommendation 2), or through savings from, or payback to, projects stemming from the position and fund).

Financial Resources

2. The City set up a fund to provide for energy and air quality initiatives similar to other Canadian cities.
   Details: Section 4.4.2, page 54.
   Approximate Cost: $100K (minimum); (one-time or incremental contributions)

[3] There are currently 63 local government participants at various FCM (Federation of Canadian Municipalities) "Partners for Climate Protection" milestones.

Integration of Energy Issues into City Operations and Planning

3. The Energy Management Co-ordinator, assisted by the Planning Department, implement a research and action process into the connection between urban design and energy use.
   Details: Section 4.4.3, page 55.
   Approximate Time Commitment: 6 months; (one-time, in combination with recommendation 6).

4. The City, through the Energy Management Co-ordinator, take on the responsibility for annual monitoring of community energy use and CO_2 emissions.
   Details: Section 4.4.3, page 55.
   Approximate Time Commitment: 1 week (on-going; procedure in place from Task Force).

5. The City, through the Energy Management Co-ordinator, use the Greenhouse Gas Emissions software capabilities to conduct in-depth monitoring of municipal (City as a Corporation) energy use on an annual basis and report energy use and emissions in accordance with their endorsement of the Partners for Climate Protection (PCP) Campaign.
   Details: Section 4.6, page 59.
   Approximate Time Commitment: 1 week (on-going); in-depth analysis: 1-3 months (one-time)

6. The City, through the Energy Management Co-ordinator, develop an inventory and energy master plan specific to City Operations, in keeping with the recommendations of the PCP program, supported by the Federation of Canadian Municipalities (FCM).
   Details: Section 4.5.2, page 58**.**
   Approximate Cost/Time Commitment: To be determined.

7. The City, through the Energy Management Co-ordinator, where possible, mandate the provision of energy use statistics by energy suppliers as a condition of the license to operate in the City of London, in order to assure the highest quality of data for monitoring and predictive purposes. This recommendation is in response to the recognition of the difficulty in obtaining energy data critical to accurate monitoring and forecasting of energy use at the community level.
   Details: Section 4.6, page 59.
   Approximate Cost: none.

8. In keeping with the title "The Forest City", the City devote particular efforts to document, promote, and undertake programs that use the beneficial effects of vegetation to assist in reducing energy use, improving air quality, and as a potential sink for CO_2.
   Details: Section 4.5.3, page 58.
   Approximate Time Commitment: 1-3 weeks (on-going, by staff).
9. The City endorse the PCP targets of 20% for the City as a Corporation and 6% for the community as a whole, as an important step in promoting local action through local leadership.
   Details: Section 4.7, page 60; and Section 3.8, page 43.
   Approximate Cost: none.
10. The City file progress updates to the Canada Climate Change - Voluntary Challenge Registry program as a demonstration of community leadership.
    Details: Section 4.7, page 60.
    Approximate Time Commitment: 1 week, (on-going in combination with recommendations 3 and 5.)
11. The City, through the Energy Management Co-ordinator, develop a municipal education strategy to support promotion of the task force report and existing municipal projects.
    Details: Section 4.8, page 60.
    Approximate Cost: $5-15K (one-time; printing, distribution, public relations costs).
12. The City adopt an Air Quality Plan specifically targeted towards the goals of enhancing air quality, preserving human health and reducing direct and indirect costs due to air pollution.
    Details: Section 4.9, page 61.
    Approximate Cost/Time Commitment: as per current Task Force. (1-2 years)

1. INTRODUCTION

1.1 Goal

The overall goal of the Task Force is to reduce CO_2 emissions and smog so as to improve the air quality in the City of London and reduce global warming.

1.2 Terms of Reference

The Task Force terms of reference are to:

a) develop an overall CO_2 emissions and smog reduction strategy for the City of London
b) develop, recommend, and implement solutions.

Complete terms of reference are included in Appendix D

1.3 Why London Should Act

1.3.1 *Global Climate Change is a Reality*

The balance of scientific opinion and recent evidence indicate that global warming is now supported by observations of changing climate and weather. Because the primary greenhouse gas responsible for the *enhanced* greenhouse effect (CO_2) is well mixed in the atmosphere and has a relatively long lifespan in the atmosphere (50-200 years, depending upon the rates of uptake by different carbon stores in the Earth-atmosphere system), immediate action is required to reduce the rate of increase in the atmospheric concentration of CO_2 in order to mitigate the enhanced greenhouse effect. It is important to note that CO_2 has the same impact on the atmosphere, no matter where the emissions occur. Therefore it is important "to think globally and act locally".

1.3.2 *The Precautionary Principle and the Principle of Shared Responsibility*[4]

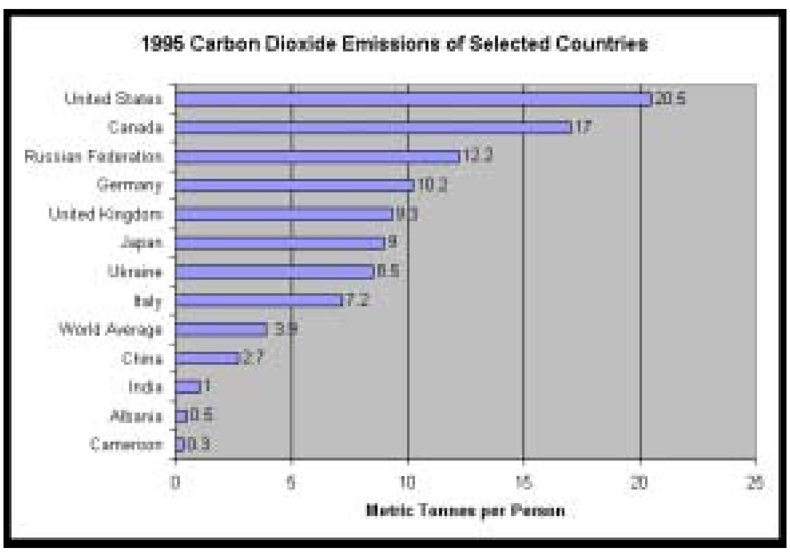
The precautionary principle advocates that actions be guided by the principle that where there are threats of serious or irreversible damage to health and livelihood, lack of scientific certainty should ***not*** be used as a reason for postponing mitigative actions that are cost-effective or justified for other reasons.

The principle of shared responsibility states that actions to address climate change will be required by all sectors of Canadian society, including governments, the private sector and the general public. Application of the principle of shared responsibility also has the goal of not disadvantaging any one region or sector through actions taken to reduce climate change.

1.3.3 *Canada is a Signatory of the Kyoto Protocol*

In order to respond to the challenge posed by global climate change, international representatives from 160 countries, including Canada, met in December 1997 in Kyoto Japan and agreed to the Kyoto Protocol. Under this protocol, Canada has agreed to a reduction target for greenhouse gas emissions 6% below 1990 levels by the period 2008-2012. Current forecasts predict that Canada's greenhouse gas emissions could be in the order of 13 per cent above 1990 levels by the year 2000 if no action is taken, thus falling short of its commitments (forecasts for London using the local database are presented in Chapter 3). Canada is also a large per capita contributor to the increase of atmospheric CO_2. An important point to note regarding greenhouse gas emissions in Canada is that *municipalities exert direct and indirect control and influence over up to 50% of the greenhouse gas emissions in Canada.*[5]

Figure 1.1 CO_2 emissions per capita of selected countries.



Source: Climate Change Calculator: Adapted from Energy Information Administration, 1998, Annual Energy Review 1997, Department of Energy, Washington, DC. Revised by Torrie Smith Associates, 1999.

[4]1995 National Action Program on Climate Change: http://www.ec.gc.ca/climate/resource/cnapcc/indexe.html
[5] Municipalities Issue Table Foundation Paper, National Climate Change Process, Nov. 23 1998

1.3.4 *London is a Member of the Partners for Climate Protection (PCP)*

The PCP program goal is to support Canadian municipal governments to prepare and implement local climate action plans, in combination with the Federation of Canadian Municipalities (FCM). Participants in the PCP program have been encouraged to follow the five milestone process for achieving tangible reductions of local greenhouse gases (see Table 1.1). The Task Force has attempted to follow these guidelines where possible.

1.3.5 *Local Air Pollution (Smog) is Relatively High in the London Area*

The 1995 Air Emissions Study characterized the air quality in London as "good" when compared with (1) provincial criteria and federal objectives; and (2) air quality in other Ontario cities. Finding (1) is true for most pollutants when compared over a number of years. Further analysis of data from the most recently available emissions data for 1996 and 1997 (Air Quality in Ontario) suggests, that for ozone, the primary pollutant of concern for Londoners, the air quality of London is somewhat poorer than for a number of other Ontario cities, has shown a trend of increased number of hours of moderate to poor air quality between 1993-97, and is in a region especially susceptible to influx of pollutants from the United States.

Table 1.1. Partners for Climate Protection Milestones

1. Profile energy use and emissions for the base year of 1990 for municipal operations, and then for emissions community-wide.
2. Forecast energy use and emissions for 10 or 20 years in the future for municipal operations, and then for emissions community-wide.
3. Establish a reduction target. Preferred targets are 20 per cent reductions in greenhouse gas emissions from municipal operations within 10 years of joining the program, and a minimum of six per cent reductions in community-wide emissions within 10 years of joining the program.
4. Develop and finalize a local action plan that aims to, first of all, reduce emissions and energy use in municipal operations, and then expand to reduce emissions in the community. The local action plan will also incorporate public awareness and education campaigns.
5. Begin implementation of the local action plan, and of measures that will reduce greenhouse gases.

1.3.6 *Climate Change Mitigation is an Opportunity*

Taking action on climate change at the municipal level can yield multiple benefits to the community, including[6]:

- improved air quality and public health
- improved competitiveness
- decreased automobile dependence and traffic congestion
- revised urban forestry and rural land use policies
- lower infrastructure investment costs
- reintegration of land uses
- enhanced economic development and job creation
- reduced fuel and electricity bills
- possible revenue from participation in emissions trading and landfill gas utilization projects

These benefits are derived from energy efficiency and renewable energy initiatives, landfill gas recovery and waste management projects, and community greening and land use change initiatives that constitute the major components of local action plans for greenhouse gas emission reductions.

In terms of direct costs of energy use, some aggregate statistics calculated for Canadian municipalities have been suggested. For a city of London's size, using a typical energy use mix, and assuming 2,000 MJ / capita energy use, the expected energy bill would be in the 6 – 8 million dollars per year range for City operations[7]. A 6% improvement, through achievement of PCP objectives would yield annual savings of $360,000 – 480,000 in direct energy costs alone to the City as a Corporation. A separate calculation by the National Research Council estimates Canadian municipalities could save in excess of $1 billion per year by adopting best practices and proven technologies for infrastructure construction, maintenance and rehabilitation. For a municipality of London's size, this estimate translates to potential savings of approximately $10 million year. In the United States, the City of Portland OR set a goal of increasing energy efficiency city-wide by 10% by 2000 from a program initiated in 1990. Total energy costs in all sectors are expected to reach $1 billion by 2000, so the energy-efficiency increase means that $100 million will be retained within the local economy.

1.3.7 *Previous City Documents Recommend Action*

This Task Force report has been preceded by three important and relevant documents

1. The 1995 City of London Air Emission Study (September 1995)
2. Vision London: London Environmental Plan (October 1996)
3. Air Quality State of the Environment Report: Middlesex-London Health Unit (October 1997)

[6] Municipalities Issue Table Foundation Paper: Final Report, National Climate Change Process, Nov. 23, 1998.
[7] National Climate Change Process: Municipalities Table Foundations Paper, p. 15.

These reports have recommended a number of actions. A brief review of the Task Force report in the context of previous reports is presented in Section 1.4

1.4 Relevant History

The Task Force and mandate are the result of two other important London reports. This section briefly summarizes the key recommendations of those reports, and how this report addresses those recommendations.

1.4.1 *Air Emissions Study*

The 1995 Air Emissions Study (AES95) forms an important starting point for this Report. It provides detailed observational and modelling analysis of air pollution and energy emissions within the City of London. The enhanced observational network and modelling analyses are unlikely to be replicated in the near future. Current observational capabilities for air pollutants are restricted to a single provincial station located at the Western Fairgrounds. Modelling analysis is not conducted on a local scale on a routine basis by any group. Thus, the analysis of local scale variability provided by that report is unique.

The Air Emissions Study presented a number of substantive recommendations. The highest priority recommendation from that study was to form a central advisory group to:

1. develop an overall energy/air emission reduction strategy for the City
2. ensure that measures are put in place to achieve it; and
3. periodically track success and re-evaluate priorities.

This Task Force and the present report are in response to recommendation (1). Our report (in combination with the Air Emissions Study) suggests an Action Plan that includes measures to achieve energy and air emissions reductions (Chapter 4). We also demonstrate and recommend procedures for monitoring emissions (Chapter 3 and Appendix **A**).

Other important recommendations of the Air Emissions Study included:

- The City of London should establish environmental and economic targets, which will allow for the monitoring and evaluation of reduction strategies to reduce energy and air emissions. In particular it should:

a) Reduce energy consumption for buildings, vehicles and equipment owned and operated by the City.
b) Reduce energy consumption for the operation of water supply and sewage treatment systems.
c) Promote multi-sector, community-wide energy use reductions.

- Base year and target year inventories of emissions be maintained and updated to justify technical measures for reducing energy use and air emissions.
- The City of London will have to improve the tracking of energy use, both within the corporation, and across the city.
- 36 other major suggestions are contained in the Study.

This report focuses primarily on the Community wide energy use. Detailed information is available on Corporate energy use, and the software acquired for emissions tracking and measures analysis by this Task Force is able to be used for both Corporate and Community sectors. Details are presented in Chapter 3 of this report. We recommend that the City use the Corporate module of the Greenhouse Gas Emissions software purchased by the Task Force to undertake a similar monitoring approach for Corporate operations.

The 1995 Air Emissions Report presents emissions data for a base year of 1990. This base year is convenient as it is also the base year for reductions agreed to under the Kyoto Protocol. This report updates the base year data to 1998, allowing temporal comparisons, and suggests methods for continuing annual updates of this database.

1.4.2 *Vision London*

The Plan's stated Principles for a healthy environment include: conservation of energy and resources, integration, monitoring, prevention, rehabilitation, sharing responsibility, and stewardship.
Goals and recommendations in the section "Air Quality and Energy Use" included:

- To improve air quality
- To reduce energy use
- To promote the use of renewable energy sources
- To reduce the emission of carbon dioxide, and other gases, which may contribute to global warming.

The Plan referred to the recommendations of the Air Emissions Study and added a number of other potential strategies. We expand on some of these in Chapter 4.

1.4.3 *Air Quality State of the Environment Report*

The October 1997 Air Quality State of the Environment Report[8] produced by the London-Middlesex Health Unit made a number of recommendations for further action to reduce exposure of the population to air pollutants of concern in the Middlesex-London region. Report No. 104-98 (Sept. 1998) provides an update on the status of these recommendations. The Task Force notes the recommendation to revisit the recommendations made in the 1995 City of London Air Emissions Study. A number of other recommendations are made in the areas of partnerships, education and promotion, local and provincial policy advocacy, and research. Many of these recommendations coincide with the objectives of the Task Force.

1.5 Organization of this Report

This report is organized into a number of sections. We begin with a brief review of the problems associated with CO_2 and air pollutant emissions, followed by a short discussion of other relevant London documents that contribute to Task Force objectives. The report then presents the database used to track energy use and CO_2 emissions for the City of London. A detailed explanation of the methods is available in Appendix **A**. Analysis of the database for the years 1990 and 1998 is presented, and some forecasts are generated to show where London is headed in terms of future CO_2 emissions. These are used to suggest some potential emission reduction targets that London could set. The report then outlines a number of emissions reduction strategies and suggests how these could be implemented.

[8] Middlesex-London Health Unit 1997. Air Quality. State of the Environment Report Series, October 1997. 46 pp.

2. CLIMATE CHANGE AND LOCAL AIR POLLUTION

2.1 Introduction

In this Chapter we introduce and discuss the atmospheric phenomena that underlie the need for this Task Force report. We discuss, separately, global climate change and local air pollution, but there are some linkages between these two important environmental problems which we point out. Global climate change through increased greenhouse gas emissions is a global scale problem in which emissions by any individual from any location have equal impact on the atmosphere, because CO_2 is a well-mixed gas in the atmosphere. Air pollution is a local problem directly influenced by emissions from individual homes, vehicles, businesses and factories. Air pollution is treated in greater detail in the 1995 Air Emissions Study, and for assessments on variability of air quality within the City of London we refer the reader to that report, as it contains observational and modelling analyses not replicated elsewhere, and which are not routinely conducted. We confine our analyses of air pollution in this report primarily to ozone, which is the most important air pollutant affecting London, and use available recent provincial government reports (Air Quality in Ontario 1996, 1997) to update the findings of the 1995 Air Emissions Study.

2.2 Greenhouse Gases, the Greenhouse Effect, and Global Warming

The Earth's atmosphere has a *natural greenhouse effect* that is imparted by a number of naturally-occurring gases (known as *greenhouse gases*). The most important of these naturally occurring gases are water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3). The atmosphere allows about half of the solar radiation from the Sun to penetrate to the Earth's surface where some is reflected, and the remainder absorbed. The absorbed energy is converted to heat which warms the surface and the air above. This heat energy is then radiated back towards space, but the natural greenhouse effect of the atmosphere acts to insulate the atmosphere by absorbing this heat. The atmosphere is cooler than the surface, and so therefore emits less radiation to space, effectively trapping some of the radiation and thereby warming the air near the Earth's surface. Without the natural greenhouse effect, the Earth would be about 33°C colder than it is now, and would be unable to sustain life.

When the concentrations of greenhouse gases change, then the ability of the atmosphere to trap heat also changes. Human activities have led to increasing concentrations of natural greenhouse gases in the atmosphere particularly CO_2 and methane from fossil fuel use. Current CO_2 concentrations are 30% above pre-industrial levels, and one-half of this growth has occurred in the last 30 years[9]. Removal of forests and alteration of wetlands also provide major sources of greenhouse gases to the atmosphere through removal of carbon stores, with the result that the carbon that they contained in combined form has been transformed to CO_2. Human activities have also introduced powerful, new greenhouse gases like chlorofluorocarbons (CFCs) that have radiative properties which make them much more efficient greenhouse gases than the natural greenhouse gases. The increase in overall greenhouse gas concentrations in the atmosphere leads to an *enhanced greenhouse effect* in which the Earth's surface becomes warmer. There is increasing evidence that global warming is now supported by the observational record.

Table 2.1. Terms and definitions associated with global climate change.

Term	Definition
Greenhouse effect	The process that causes the Earth's surface to be warmer than it otherwise would be in the absence of an atmosphere.
Greenhouse gases	Gases, either natural or anthropogenic in origin, which generate the greenhouse effect.
Enhanced greenhouse effect	Enhancement or intensification of the natural greenhouse effect due to increased concentrations of greenhouse gases above natural levels
eCO_2 (Equivalent CO_2)	Various greenhouse gases have different abilities to contribute to an enhanced greenhouse effect. These effects are normalized through reporting their effect in terms of equivalent CO_2 amounts.
Global warming	Overall warming of the atmosphere near the Earth's surface due to the enhanced greenhouse effect.

2.3 Local Impacts of Global Warming: Southern Ontario.

The federal government has undertaken an extensive study of regional impacts of anticipated climate change in Canada. The relevant report for London is the Ontario Region[10]. A summary of the main findings is presented in Table 2.2. The climate in Ontario could warm by 3-8°C (average annual value) by the latter part of the 21st century, even with stabilization of greenhouse gas emissions. Increases will probably be greater in the winter than in the summer leading to a reduced snow cover season, a longer growing season, less moisture in the soil, and an increase in the frequency and severity of droughts and heat waves. Results will vary on a local basis, as models are at present unable to fully resolve impacts in areas (such as London) in which climate is modified by local controls such as the Great Lakes. The

[9] Environment Canada: Climate Change. http://www.ec.gc.ca/envpriorities/climatechange_e.htm
[10] The Canada Country Study: Climate Impacts and Adaptation – Ontario Region Executive summary http://www.cciw.ca/green-lane/canada-country-study/intro.html

greatest confidence is attached to projections of changes in temperatures, however, impacts that may result from changes in precipitation patterns, soil moisture, and possibly in the frequency and intensity of severe weather events, could be more significant.

The greatest impacts in the Ontario region arising from global warming are likely to be on: water resources, human health, the built environment, energy, transportation, tourism and recreation, forestry, agriculture, construction and finance. The relevant highlights of this report are summarized in Table 2.2.

2.4 Air Pollutants and Smog in Southern Ontario

2.4.1 *Definitions*

An *air pollutant* is an airborne substance (solid, liquid or gaseous) that occurs in concentrations sufficient to present health impacts on humans, animals and vegetation, to damage structures, to toxify environments, and to otherwise interfere with the use and enjoyment of life or property[11, 12]. Air pollutants (Table 2.3) may be categorized as either primary (directly emitted into the atmosphere) or secondary (pollutants that result from chemical transformations).

Smog is a general term that refers to a mixture of air pollutants. The primary components of smog are ozone and particulates, but smog contains a number of other air pollutants as well. The ozone component of smog is sometimes referred to as ground-level ozone, to distinguish it from the ozone in the upper atmosphere, which is an important atmospheric constituent that absorbs ultraviolet radiation from the sun. There is no transport of ground-level ozone to the upper atmosphere; hence generation of ground-level ozone has no effect on the concentration of ozone in the upper atmosphere.

Ground-level ozone is a pollutant with no beneficial effects. It is a secondary pollutant formed from nitrogen oxides (NO_x) and volatile organic compounds (VOC) through chemical reactions occurring in the presence of strong sunlight (photochemistry) and enhanced by warm air temperatures.

[11] Ahrens, C.D. 1995 Meteorology Today, 5th Ed. West Publishing, Minneapolis-St.Paul.
[12]Oke, T.R. 1987. Boundary Layer Climates, Methuen, London.

Table 2.2. Impacts of global warming likely to effect the London Area.

Impact on	Description
Water Resources	• Reduced Great Lakes water levels. Implications for shipping, recreation, hydro electric power. • Decreased water supply from both surface and groundwater sources in Southern Ontario. • Increased water demand during the summer months.
Health	• Summer effects through heat stress. • Possible increases in the number and/or severity of poor air quality episodes. • Hazards due to severe weather in all seasons. • Possible in-migration of disease-carrying organisms from other regions. • Changes in human health could affect the health and life insurance, and the pension industries.
Urban Infrastructure	• Reduced heating (winter energy) demand, increased cooling (summer energy) demand. • Impacts of precipitation changes upon the design of dams, sewers, and other water management infrastructure. • Reduced cost of infrastructure (buildings and transportation) due to decreased snow loads. • More frequent freeze-thaw cycles could increase weathering. • Warmer winters will lengthen the construction season and reduce costs associated with winter maintenance. • Property insurance and disaster-relief implications due to changes in the frequency or intensity of extreme events.
Agriculture	• Longer growing season may increase opportunities for crop selection. • Moisture-limited crop productivity. Should climate variability increase, it would increase variability in productivity. • Increased concentrations of carbon dioxide (CO_2) may improve yields and water utilization for some crop types.
Ecosystems	• Fish species composition and aquatic ecosystems affected by warming of the Great Lakes. • Changes in wetland areas. • Greater risk of extinction to threatened species in a changing climate. • Enhanced opportunities for successful establishment of exotic species.
Recreation	• Less reliable opportunities for outdoor winter recreation. • Increased use of beaches and parks in the longer warm temperature season. Possible impacts of water quality and ecosystem health on parks.
Forests	• Damage by pests and diseases. • Increased frequency and intensity of fires may occur. • Damage from severe weather, possibly enhanced by poorer conditions for tree growth in urban areas.

Source: Environment Canada. 1997. The Canada Country Study: Climate Impacts and Adaptation, Ontario Summary.

Air pollutants and smog are monitored and reported using an *Air Quality Index* (AQI), which converts hourly measured concentrations to a scaled value (termed a sub-index) using an *Ambient Air Quality Criterion* (AAQC) for each pollutant measured. The maximum sub-index for a given hour becomes the AQI. Six pollutants are monitored: sulphur dioxide (SO_2), ozone (O_3), nitrogen dioxide (NO_2), total reduced sulphur compounds (TRS), carbon monoxide (CO) and total suspended particles (TSP). The ambient air quality criteria are concentration levels set by federal and provincial governments. They are guidelines or objectives, and are set at various levels for different time periods. Definitions and the levels for ozone, the most relevant pollutant in London are shown in Table 2.4.

Table 2.3. Important Ontario pollutants, sources and impacts.

Pollutant	Source	Impact
Total Suspended Particulates (TSP) (0.1-100 microns)	Industrial processes, combustion, motor vehicle exhaust, road dust, forest fires, ocean spray and volcanoes	Respiratory problems; impacts increase as particle size decreases. Degraded visibility. Vegetation damage. Soil and surface water contamination.
Inhalable Particulates PM_{10} (< 10 microns) $PM_{2.5}$ (<2.5 microns)	PM_{10} Same as TSP. $PM_{2.5}$ is derived from chemical reactions in the atmosphere and combustion.	Same as TSP. Impacts increase as particle size decreases. $PM_{2.5}$ a new category thought to have no safe limits.
Carbon Monoxide (CO)	Fuel combustion (primarily transportation sources).	Toxic gas. Impairs visual perception, work capacity, learning ability and performance of complex tasks. Prolonged exposure may contribute to heart disease.
Sulphur Dioxide (SO_2)	Fuel combustion, especially from electric utilities, smelters, petroleum refineries.	Respiratory problems, aggravation of existing respiratory and cardiovascular disease. Plant injuries. Subsequent transformation to sulphuric acid (acid rain).
Nitrogen Oxides (NO_2, or NO_x)	Automobiles, thermal power plants.	Heart and lung problems. May encourage spread of cancer. Key component in ozone formation. Leads to acid deposition and vegetation damage.
VOCs (volatile organic compounds)	Transportation, solvent use, residential, industrial processes, vegetation.	Some VOCs can cause cancer. Component in ozone formation.
Ozone (O_3)	Secondary pollutant formed from combination of VOCs and NO_x in presence of sunlight and warm temperatures.	Respiratory and eye irritant . Crop and tree damage. Damages surfaces, and various materials including rubber and textiles.

Source: Ministry of the Environment. 1997 Air Quality in Ontario.

2.4.2 *London Region Air Quality*

London is located in Central Canada's smog hot spot, a narrow strip that runs along the north shores of Lake Erie, Lake Ontario and the St. Lawrence River to Québec City. The smoggiest place in Canada is, according to Environment Canada, in rural southwestern Ontario, along the north shore of Lake Erie. Here, ground-level ozone regularly exceeds the guidelines (maximum desirable level) more than 30 days per year, and exceeds 82 ppb, on average, for 18 days per year, based on data from 1986-1993. The reasons for this area of enhanced pollution include the high population density, and consequent large emissions of precursor pollutants, and a suitable climate (warm and sunny summer days). In cities, such as London, ozone levels may actually be lower than in the surrounding rural areas because ozone is removed by reaction with locally emitted nitric oxides (primarily from automobiles).

Table 2.4. Ambient Air Quality Criterion definitions and levels for ozone.

Ozone	Max. Desirable Level	Max. Acceptable Level	Max. Tolerable Level
1 hour	51 ppb	82 (80 in Ontario) ppb	153 ppb
24 hours	15 ppb	25 ppb	na
Definition	long term goal for air quality; basis for anti-degradation policy in unpolluted areas	intended to provide adequate protection against adverse effects on humans and the environment	action without delay is required to protect the health of the general public
AAQC relation to AQI [1]	AQI = 25 (good)	AQI = 50 (poor – 50 –99)	AQI = 100 (very poor)
[1] AQI = 0 corresponds to no measurable concentration			

Source: Environment Canada, Pollution Data Branch.

A large contribution to the smog problem of the London area is the influx of air pollution from the United States (the Ohio Valley, Cleveland and Detroit areas, in particular), which can contribute up to 50% of the total smog.

We note that similar to CO_2, the source of most air pollutants is from the burning of fossil fuels; similarly, the 1995 Air Emissions Study reports the largest contributor to air emissions is energy use.

Using data reported in Table 2.5 and Table 2.6 (from the 1996 and 1997 Air Quality in Ontario Report) we also present the following summary, which updates some information contained in the 1995 Air Emissions Study:

- London ranks 2nd and 3rd worst (1997 and 1996 respectively) of provincial monitoring stations for number of hours in the AQI "poor" and "moderate" categories. The 1997 total is 557 hours for London compared to the provincial average of 394, and the provincial median of 390 hours.
- London ranks 4th (1997) and 5th (1997) worst in the number of days (approximately 25% of the year) with at least one hour with AQI > 31 (moderate, poor or very poor).
- The Southwest region (where London is located) has the highest percentage time of moderate and poor air quality in the province.
- Ozone is responsible for almost all (>90%) of the AQI occurrences of moderate or poor air quality in the Southwest region.
- London ranks 15th (1997) and 13th (1996) of 29 stations in terms of the number of hours with AQI classification "very good". The London value of 60% is only slightly worse than the average of all stations (57.3%).
- The 24 hour PM_{10} data show some exceedances for London (4% of the time in the summer); values are generally good compared to other Ontario stations. Some exceedances are noted from the more recently "real time" $PM_{10}/PM_{2.5}$ monitoring system. The current AQI does not incorporate the real time $PM_{10}/PM_{2.5}$ data.
- In the period 1993-1997, the southwest region has shown an increase (the largest in the province) in the average number of days with AQI > 49.

Some caution must be expressed in these results due to interannual variability, as some years may show fewer or greater numbers of air pollution episodes depending upon (primarily) summer weather patterns.

Table 2.5. Air quality index summary for 1996. Source: Air Quality in Ontario 1996.

City	Region	Very Good 0	Good 16-31	Mod. 32-49	Poor 50-99	Very Poor 100+	Total hours	SP	O_3	TRS	# of days with at least 1 hr > 31
		Number of Hours AQI in Range						# of hrs Pollutant Responsible for AQI > 31			
Fort Frances	N	3080	4775	707	216	0	8778	28	178	717	175
Windsor	SW	5297	2660	664	115	0	8736	17	711	51	122
Burlington	GTA	4620	3580	533	51	0	8784	22	562	x	96
Sarnia	SW	4407	3781	547	49	0	8784	4	588	4	92
London	**SW**	**5298**	**2837**	**571**	**71**	**0**	**8777**	**0**	**642**	**x**	**90**
Oakville	GTA	5092	2979	508	38	0	8617	4	542	0	88
Windsor U	SW	5694	2495	524	71	0	8784	3	592	x	87
York	GTA	5384	2815	367	48	0	8614	33	382	x	82
Hamilton Dt	WC	4865	3495	418	5	0	8783	44	322	48	81
Hamilton Mt	WC	5032	3193	545	14	0	8784	5	530	24	80
Niagara Falls **	WC	2564	2929	495	23	0	6011	0	518	x	80
Mississauga	GTA	5426	2667	358	16	0	8467	13	361	x	79
Cornwall	E	5420	3054	291	8	0	8773	2	261	36	78
Kitchener	WC	4653	3621	486	15	0	8775	0	501	x	76
Etobicoke	GTA	6114	2293	367	9	0	8783	30	346	x	72
St Catharines	WC	5364	2903	411	19	0	8697	2	428	x	72
Hamilton W	WC	5286	3115	374	9	0	8784	6	345	32	72
Sudbury	N	3368	4970	423	6	0	8767	2	425	0	69
Scarborough	GTA	5673	2707	317	21	0	8718	3	335	x	62
Kingston	E	4864	3375	377	8	0	8624	3	382	x	62
Sault Ste. Marie	N	4484	4065	220	15	0	8784	15	189	31	58
Etobicoke	GTA	5787	2711	256	1	0	8755	10	247	x	57
Oshawa	GTA	4878	3640	249	9	0	8776	0	258	x	56
Hamilton E **	WC	3209	2470	247	7	0	5933	9	244	1	50
North Bay	N	3947	4438	276	19	0	8680	0	295	x	48
North York	GTA	5636	2958	182	6	0	8782	16	172	x	47
Ottawa	E	5322	2989	120	3	0	8434	4	119	x	29
Toronto Dt	GTA	6729	2000	53	0	0	8782	20	33	x	24
Thunder Bay	N	4791	3943	50	0	0	8784	3	42	5	16

Regions: SW – Southwest, WC – West Central, GTA – Greater Toronto Area, E – Eastern, N – Northern

** site terminated in Sep. 96
x pollutant not measured

Table 2.6. Air quality index summary for 1997. Source: Air Quality in Ontario 1997.

City	Valid hours	Very Good 0-15	Good 16-31	Mod. 32-49	Poor 50-99	Very Poor 100+	# Hours >31	SP	O_3	TRS	SO_2	# of days with at least 1 hr >31
	Number of Hours AQI in Range							# of hrs Pollutant Responsible for AQI > 31				
Windsor U.	8760	5585	2623	496	56	0	552	6	546	X	0	92
Windsor C.	8752	5433	2662	590	67	0	657	12	431	205	8	146
London	**8753**	**5126**	**3070**	**509**	**48**	**0**	557	**0**	**557**	**X**	**0**	**81**
Sarnia	8749	4302	3957	474	16	0	490	0	486	4	0	78
Kitchener	8736	4691	3585	440	20	0	460	2	458	X	0	69
St Catharines	8465	5196	2822	431	16	0	447	1	446	X	0	65
Hamilton Dt.	8760	5525	2845	373	17	0	390	29	336	25	0	71
Hamilton Mtn.	8756	4900	3338	488	30	0	518	4	499	15	0	76
Hamilton W.	8760	5569	2834	339	18	0	357	1	346	10	0	56
Toronto Dt.	8728	7225	1421	79	3	0	82	1	81	X	0	22
Scarborough	8573	5933	2328	281	31	0	312	0	312	X	0	55
North York	8736	5023	3339	348	26	0	374	1	373	X	0	63
Etobicoke W.	8723	5594	2776	324	29	0	353	8	345	X	0	61
Etobicoke S.	8744	6085	2314	304	41	0	345	19	326	X	0	64
York	8678	5616	2723	306	33	0	339	16	323	X	0	77
Burlington	8689	4963	3266	446	14	0	460	2	458	X	0	79
Oakville	8760	5206	3089	438	27	0	465	5	460	0	0	75
Oshawa	8752	4634	3783	296	39	0	335	3	332	X	0	62
Mississauga	8496	5173	2915	380	28	0	408	10	398	X	0	70
Ottawa	8760	5148	3385	222	5	0	227	0	227	X	0	38
Kingston	8753	5327	3074	323	29	0	352	7	345	X	X	58
Cornwall	8760	4638	3713	387	22	0	409	0	373	36	0	75
Fort Frances	8759	2932	5453	330	44	0	374	0	232	142	X	90
Thunder Bay	8671	4041	4426	204	0	0	204	0	203	1	0	30
Sault Ste Marie	8760	3966	4479	311	4	0	315	2	276	37	0	58
North Bay	8741	3494	4797	420	30	0	450	0	450	X	X	70
Sudbury	8749	3199	5133	384	33	0	417	0	416	0	1	60

X pollutant not measured

2.5 Impacts of Air Pollutants and Smog

Ground-level ozone, inhalable particulates and acid aerosols are now known to have serious cardiorespiratory health effects including aggravation of lung infections and asthma. Specific results from some Ontario studies show:

- A two to four per cent excess of respiratory deaths could be attributed to pollutant levels of ozone, particulates and nitrogen dioxide in a Toronto study.[16]
- Air pollution (in the form of inhalable particles) has been estimated to cause 1,800 premature deaths and 1,400 hospital admissions annually in Ontario.[13]
- In the summer months (May-August) 5% of daily hospital admissions for respiratory problems were associated with ozone, and a further 1% were associated with sulphates. These effects were noted for all age groups, with infants being the most sensitive. The research also did not note a threshold effect, which suggests even very low levels of pollutants may increase hospital admissions for respiratory problems.[14]
- Research by Environment Canada[15] shows that there appears to be no safe level of human exposure to ground-level ozone or particulates. The research also suggests that nitrogen oxides, sulphur dioxide and carbon monoxide may not have safe lower levels either.
- Every Ontarian is affected by air pollutants: children and the elderly are particularly sensitive, but even healthy outdoor workers show effects of exposure to low-levels of ozone.[16]
- Long-term exposure to air pollutants is associated with decreased lung function and increased city-specific mortality rates[17].

These health effects pose a burden on the health care system through increased emergency room visits and increased hospital admissions. They also have a negative economic impact through increased health care expenditures and loss of income through lost days of work.

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[13] IP/RP Workgroup 1996. Bulletin on inhalable and respirable particulates (IP &RP), IP/RP Progress Note #l, prepared for Ontario Smog Plan, prepared by IP/RP Strategy Working Group, Chair: David Pengelly, November, 1996.

[14] Burnett, RT et al. 1994. Effects of low ambient levels of ozone and sulphates on the frequency of respiratory admissions to Ontario hospitals. *Environmental Research*, **65**: 172-194.

[15] Environment Canada: Air Issues Web Page: http://www.ec.gc.ca/envpriorities/cleanair_e.htm, July 28, 1999.

[16] MacPhail, J. 1999. OMA Ground Level Ozone Position Paper, Ontario Medical Association Health Policy Dept.

[17] Burnett RT, Cakmak S, Brook JR. 1998. The effect of the urban ambient air pollution mix on daily mortality rates in 11 Canadian cities. *Canadian Journal of Public Health*, **89**: 152-156.

Users of the AQI are reminded that values are based upon reference to the AAQC, and these values may be adjusted downwards in light of the recent research – in other words, re-analysis of the air quality data may show greater numbers of hours and days when pollutant levels exceed objectives.

Environment Canada estimates the benefits of reduced smog in major Canadian urban centres are $10 billion annually.

In addition to health effects, smog (and in particular ozone) can result in significant damage to agricultural crops and to forests and vegetation in and around London. Two other major impacts of air pollutants are the acidification of lakes from acid rain (derived from SO_2 emissions), which results in ecosystem damage and reduced recreational opportunities, and damage to the ozone layer (CFC emissions). In turn, damage to the ozone layer results in greater levels of UV radiation near the surface of the Earth, presenting further hazards to human health and the environment.

2.6 Local Air Pollution and Global Climate Change

Local air quality is influenced by ground level pollution, which is directly affected by our local emissions. Where local emissions are high we can reasonably expect greater air quality concerns. Local pollutant concentrations depend on: weather patterns, local and regional emission rates, and weather-dependent air chemistry. Local emissions can be compounded by long range transport of ground-level ozone and ozone precursor pollutants, and to some extent by transport of fine particulates.

Global warming and climate change are the result of emissions by everyone; in this case, effects of greenhouse gas emissions are not restricted to near the source of emission, but rather are distributed globally, because greenhouse gases (primarily CO_2) become well mixed throughout the atmosphere and have a long lifetime.

Reductions of greenhouse gas and air pollutant emissions in urban areas therefore have the double benefit of improving local air quality (through reduction of air pollutants such as smog and particulates) and contribute in a significant manner (because large fractions of greenhouse gases come from urban areas) to reducing global warming.

Local air quality and global climate change are linked in a further way: changes in weather patterns associated with global climate change may affect the frequency and intensity of air pollution episodes (those times when air pollution is at its worst). Warmer summer-time temperatures may also act to enhance the formation of ground-level ozone, because ozone formation is enhanced at higher air temperatures. However, changes in cloud cover and precipitation frequency may offset this potential increase. Interannual climate variability affects the frequency of such weather-related extremes, and so also play a role in the frequency and intensity of future air pollution episodes.

3. CO_2 EMISSIONS ANALYSIS: LONDON COMMUNITY

3.1 Quantification

The first step in undertaking an emissions analysis is to complete an energy use profile or inventory. The energy use inventory can be conducted by individual corporations or for the municipality as a whole. In this report we undertake an analysis for the municipality. **We recommend that the City undertake a similar analysis for corporate operations, following a similar protocol, and to report these results to the PCP program, and possibly also to the VCR** (Voluntary Challenge Registry). We note that several London companies have already lodged corporate action plans with the VCR (e.g., 3M).

The emissions analysis assumes that energy use is the primary source of CO_2 emissions. Identifying sources and quantities of emissions is important to effectively determine emission reduction targets and to establish measures to reach those targets. The inventory needs to be detailed enough to allow the identification of "problem" areas and to support an analysis of where efforts should be placed in order to maximise CO_2 reduction efforts. For example, separating the City into "sectors" allows for an analysis of how each sector contributes to the City's overall energy use. It should be noted that CO_2 is part of a *carbon balance* that includes stores (or *sinks*) of carbon in the atmosphere, oceans and terrestrial systems. Some CO_2 emissions are "lost" to the atmosphere through storage in some of these systems. An important practical carbon sink on short-term time scales is the uptake of CO_2 by vegetation. The current database does not include this uptake in the emissions analysis. Actions to increase the store of carbon in vegetation can reduce the rate at which CO_2 concentrations will increase, at least on short time scales; possible local strategies are suggested in the Action Plan.

Completing an energy use inventory for a base year will establish a starting point to compare with future inventories and forecasts. In addition, the base year is necessary in setting a target, as the target is compared relative to the base year. It is also beneficial to complete an inventory of a current year. The current year inventory can be used as a comparison with the base year inventory to determine how the energy use pattern in the City is evolving, and to test the accuracy of forecasts. The Task Force has performed an energy use inventory for the most recently available data, 1998, and uses this as its "current year".

On-going monitoring and the updating of the energy use inventory is an important and necessary process. In doing this, the City can track their progress in achieving emission reduction targets, and evaluate the success of proposed measures.

3.1.1 *Greenhouse Gas Emissions Software*

The emissions analysis conducted in this report uses a specialized software package "Greenhouse Gas Emissions Software"(GHGES) developed by Torrie Smith Associates of Ottawa, ON. This package is now used as part of the PCP program, and is used by a number of Canadian, American and Australian municipalities. The software offers advantages in simplicity of use, functionality, and compatibility compared to a custom or in-house development of similar capabilities using a programming and/or spreadsheet approach. The software allows:

- analysis of both community and corporate greenhouse gas emissions from energy use and waste, quantifies financial savings, air pollutant reductions and other co-benefits of greenhouse gas emission reduction strategies;
- automates energy conversions, and includes embedded (and upgradeable) emission coefficients;
- provides monitoring and analytical functions for local action plans.

The current version incorporates the latest emissions coefficients appropriate for Ontario, and future upgrades are envisioned (Torrie Smith, pers. comm.) that will expand the capability of the software to estimate emissions of other air pollutants. Specific instructions on the use of the software are presented in Appendix A.

Although intended for "non-energy professionals", the software nevertheless takes some time to become familiar with. To maximize the use of this software tool, the **TF recommends the City designate one or more individuals responsible for the use and update of this software, and ensure they have sufficient and up-to-date training on the use and methods associated with the software**, as provided, for example through programs administered by the vendor or third parties (e.g., PCP).

3.2 Base Year

1990 was chosen as the base year for the energy use inventory. An Air Emissions Study was completed for the City of London in 1995 (SENES Consultants Limited), which produced an inventory of energy use in London and corresponding carbon dioxide (CO_2) emissions for 1990. The City of London experienced a boundary change in 1993 with the annexation of lands surrounding the City. In order to be able to make comparisons with inventories of later years, it was necessary to calculate energy use in 1990 including the annexed lands.

It is important to be able to effectively monitor and update the database. In doing so, the effectiveness of programs/policies can be measured against the change in energy use and CO_2 emissions over the years studied. Therefore, it is important that the information provided in the energy use inventory be easily replicated and updated, to ensure the continuity of data as much as possible and that relative comparisons can be made between different years.

The Air Emissions Study (AES95) was used as a template for collecting information for 1998. However, it was found that some of the information reported in AES95 could not be easily replicated. Much of the data that is required to complete the energy use inventory is not available specific to the City of London. In these instances, provincial values prorated to the City of London, as well as other assumptions, must be made. However, it is essential that the method and sources used to calculate these values be easily replicated when updating the inventory in later years. The TF encountered difficulties in replicating the analysis presented in AES95. Therefore, in this report we modify some values from AES95 (for the base year 1990) to reflect the use of a method and source that is felt to be reliable and replicable (See Appendix A).

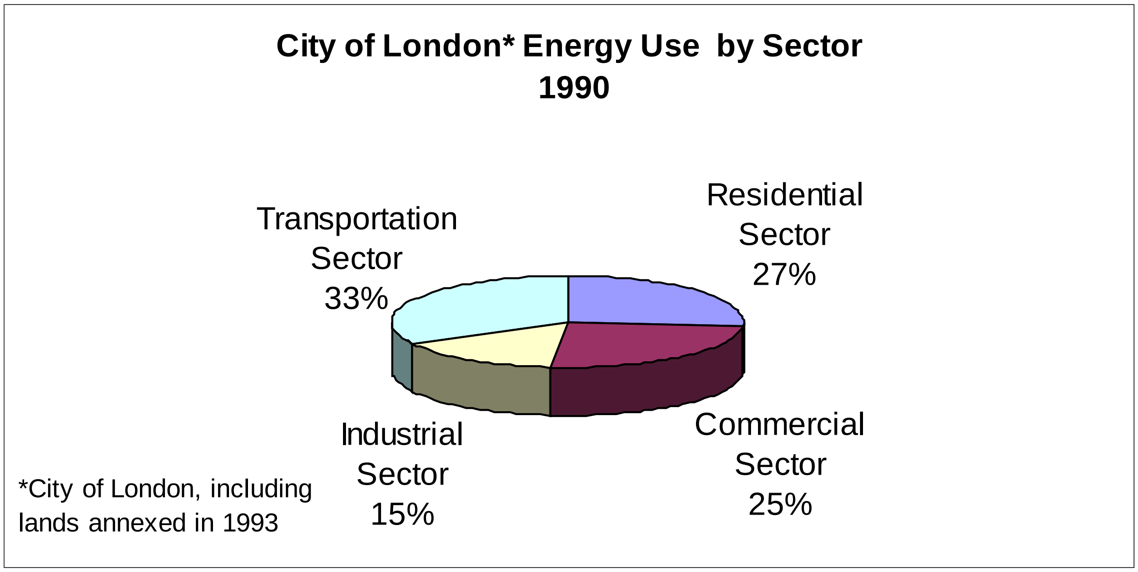
Results of the base year inventory for London are presented in Table 3.1. See Appendix A for a full breakdown of fuel use by sector. Figure 3.1 provides a percentage breakdown of energy use by sector in 1990.

Table 3.1 City of London Energy Use By Type and Sector. Final Results 1990 (In GJ).

	Electricity	**Natural Gas**	**Petroleum Fuels[1]**	**Other[2]**	**All Fuels**	**% of Total**
Residential	3,599,000	8,010,000	1,430,648	488,000	13,527,648	26.80%
Commercial	4,264,000	7,883,000	465,200	0	12,612,200	24.99%
Industrial	2,700,000	4,608,000	325,800	122,715	7,756,515	15.37%
Transportation	0	37,000	15,886,292	656,169	16,579,461	32.85%
Total	10,563,000	20,538,000	18,107,940	1,266,884	50,475,824	
% of Total	20.93%	40.69%	35.87%	2.51%		

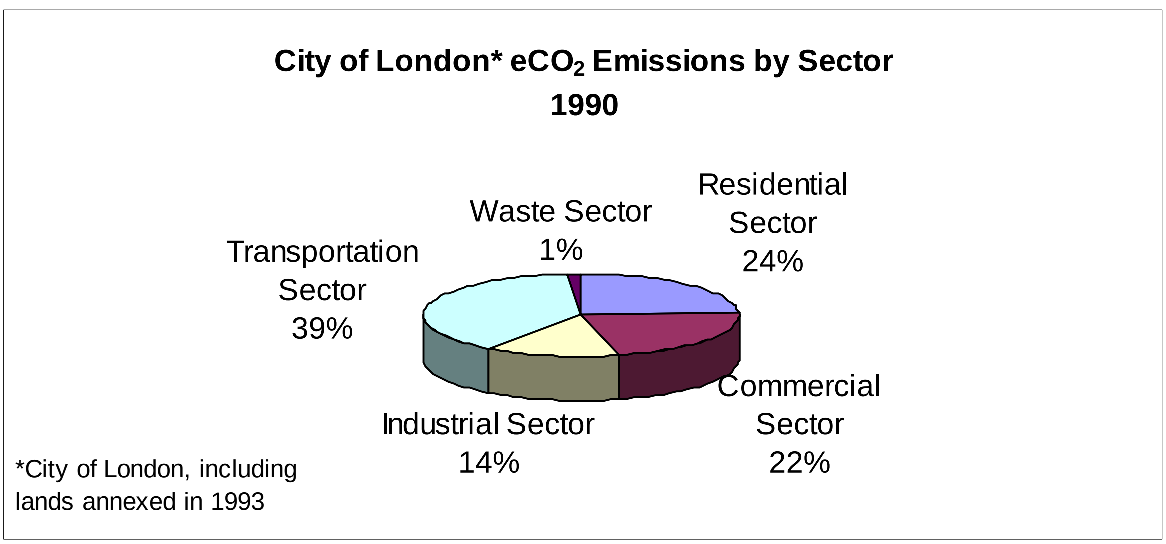
1. Petroleum Fuels includes gasoline, diesel, fuel oil and heavy fuel oil
2. Other includes propane, wood, and kerosene

Figure 3.1 City of London Energy Use by End Use Sector, 1990.



When analyzing greenhouse gas emissions for the City of London, an additional sector becomes important. The waste sector does not consume energy *per se*, however, through the breakdown of waste in the landfill, it does release greenhouse gases, and therefore should be included in the emissions inventory. Figure 3.2 is a breakdown of percentage equivalent CO_2 emissions (eCO_2) by sector.

Figure 3.2 City of London Equivalent CO_2 Emissions by Sector, 1990.



3.3 Current Year

An inventory of a current year was undertaken in order to determine "where London is" in terms of energy use and CO_2 emissions. 1998 was chosen as the current year. As a result of the current year inventory, it is possible to determine how the City of London is evolving in terms of energy use and CO_2 emissions. It is then possible to relate how London is doing compared to forecasts that were based on 1990 data.

The Air Emissions Study was used as a template whenever possible to aid in the collection of energy use values for 1998. The detail provided in that report determined what was included in the energy use profile and the source of the input data. The compilation of required data was achieved through the collection of values that relate directly to London (e.g., total electricity sales in the City of London), as well as through the use of provincial energy statistics and a number of assumptions. The form of this Report also uses AES95 as a template to allow for easy comparisons between the two documents.

3.4 City of London Energy Use by Energy Type

3.4.1 *Electricity*

Electricity consumption in the City of London in 1998 includes total electricity sales, as provided by London Hydro, as well as electricity produced by the Energy from Waste plant at the London Health Sciences Centre (Victoria Campus). London Hydro reports total electricity sales in the City of London in 1998 as 2,911,752,000 kWh. Of this total, 67% or 1,950,619,000 kWh were to the residential sector while the rest were to the commercial sector (businesses, institutions, and industries). The electricity consumption that was recorded for the commercial sector was divided to separate the portion that is used by the industrial sector (See Appendix A). The Energy from Waste plant produced 5,385,833 kWh of electricity in 1998[18], bringing the total electricity use in the City of London in 1998 to 2,917,137,833 kWh.

3.4.2 *Natural Gas*

Total natural gas use in the City of London in 1998, as reported by Union Gas, was $629{,}406 \times 10^3$ m^3. Broken down by sector, natural gas use is as follows: residential sector, $240{,}895 \times 10^3$ m^3 (38%),

[18] This is the last full year of operation for the Energy from Waste Plant; the plant was shutdown in Oct. 1999.

commercial/institutional sector, $217,093 \times 10^3$ m^3 (35%), industrial sector, $169,706 \times 10^3$ m^3 (27%), and transportation, $1,712 \times 10^3$ m^3 (<1%).

3.4.3 *Transportation Fuels*

There are two main types of transportation fuel sales. Retail pump sales include sales of transportation fuels at retail locations. Non-retail pump sales are those used for refuelling fleets, taxis etc.

Data for retail-pump sales of gasoline and diesel for 1998 were commercially available (Kent Marketing, 1999). Total sales in the City of London in 1998 were reported as: 352,047,330 litres (13,617,191 GJ) of gasoline and 9,521,366 litres (368,286 GJ) of diesel.

Natural gas use in the Transportation sector in 1998 (retail pump sales and non-retail pump sales), as reported by Union Gas, was $1,712\times10^3$ m^3 (65,158.72 GJ).

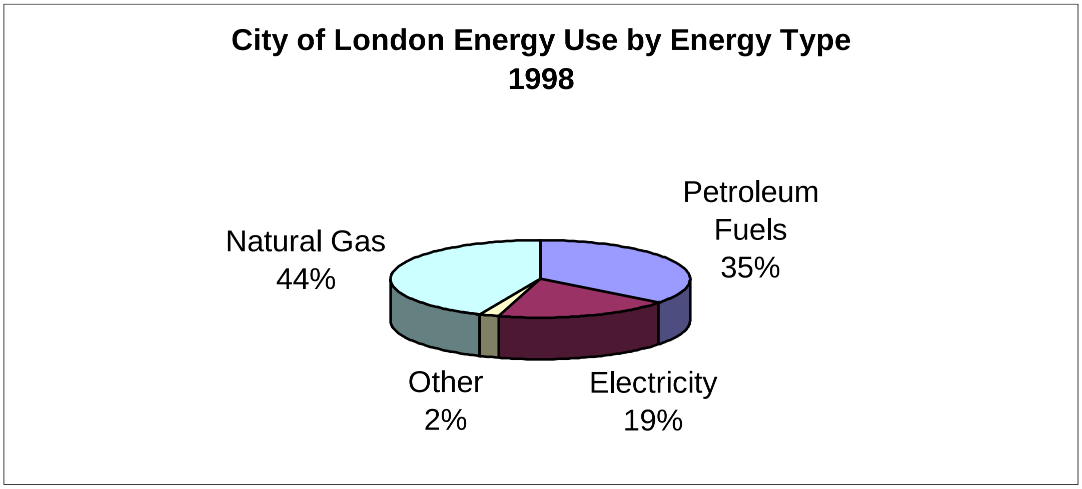
Data for non-retail pump sales of gasoline, diesel, and propane were not available specific to the City of London. In order to calculate these, provincial values were prorated to the City of London on the basis of population (See Appendix A). Because 1998 statistics were not available at the time of printing of this document, non-retail pump sales are actually 1997 values. Non-retail pump sales totalled 839,448 GJ of gasoline, 3,131,899 GJ of diesel, and 585,135 GJ of propane. Retail pump sales of propane were reported as zero.

3.4.4 *Heating Fuels*

With the exception of wood, the data for heating fuels came entirely from 1997 provincial statistics (See Appendix A). Included in heating fuels are fuel oil, heavy fuel oil, wood, kerosene, and propane consumption in the residential sector. Provincial statistics, prorated to the City of London on the basis of population, provide an estimated consumption of 1,513,308 GJ of fuel oil, 172,579 GJ of heavy fuel oil, 97,915 GJ of kerosene, and 194,888 GJ of propane. The value for wood is the same as the value reported in 1990. It is estimated that this value would not have increased by much, and may have actually decreased as a result of conversions to natural gas. Overall, wood represents only a small percentage of total fuel use (0.7%).

The final profile of energy use by fuel for the City of London in 1998 is shown in Figure 3.3. Energy use totalled approximately 55,413,829 GJ, with 43.2% attributed to natural gas, 35.4% to petroleum fuels (gasoline, diesel, fuel oil and heavy fuel oil), 19% to electricity, and 2.3% to others (propane, wood and kerosene).

Figure 3.3 City of London Energy Use by Energy Type, 1998.



3.5 City of London Energy Consumption by End Use Sector

It is important to separate energy by end use sector so that it is easier to see where opportunities for energy saving and emission reduction measures may exist. Energy use in the City of London has been allocated to four sectors: residential, commercial/institutional, industrial, and transportation.

3.5.1 *Residential Sector*

According to Union Gas and London Hydro, the residential sector consumed 9,168,464 GJ of natural gas and 3,459,601 GJ of electricity in 1998. The residential sector was recorded to have used 403,000 GJ of wood fuel in 1990. This value was carried over to 1998 (see section 3.4.4). Residential sector consumption of fuel oil and propane was derived from provincial statistics and prorated to London's population. Based on this method, consumption of fuel oil was 1,065,996 GJ in 1998 and consumption of propane was 194,888 GJ in 1998. (See Appendix A). Total residential consumption accounts for 26% of total energy use in London.

3.5.2 *Commercial and Institutional Sector*

The commercial and institutional sector account for 23% of total energy use in London. Natural gas consumption by the commercial and institutional sector was recorded by Union Gas as 8,262,560 GJ in 1998. Electricity sales were not as helpful, as the commercial consumer usage that was provided also included industrial usage.

An estimated 4,304,160 GJ of electricity was used by the commercial and institutional sector in 1998 (See Appendix A for explanation). Commercial and institutional sector consumption of fuel oil was derived from provincial statistics and prorated to London's population to generate an estimated consumption of 427,152 GJ of fuel oil for 1998 (See Appendix A).

3.5.3 *Industrial Sector*

Natural gas consumption in the industrial sector was available through Union Gas and revealed a consumption of 6,459,010 GJ in 1999. An electricity consumption of 2,771,229 GJ was estimated based on the statistics provided by London Hydro, which grouped the industrial sector with the commercial and institutional sector (See Appendix A).

Fuel oil, heavy fuel oil, and kerosene consumption were also included in the industrial sector. These values were estimated based on provincial statistics that were prorated to the City of London on the basis of population (See Appendix A). 1998 consumption of these fuels includes 20,160 GJ of fuel oil, 172,579 GJ of heavy fuel oil, and 97,915 GJ of kerosene. Total consumption for the sector translates to 17% of total energy use.

3.5.4 *Transportation Sector*

The transportation sector is the most difficult sector for which to create an energy use inventory. It is also the largest sector for energy use (34%). Due to the mobile nature of vehicles, it is difficult to ascertain what percentage of fuel sold within the City of London is actually burned within the City's boundaries. However, London is fortunate in that it experiences a high degree of "self-containment" due to its geographical characteristics. Therefore, for the purposes of this inventory, fuel sales within London's boundaries are assumed to have been burned within the City.

An additional problem in creating an inventory of transportation fuels is the lack of access to statistics that relate directly to the City of London. Only retail pump sales for gasoline and diesel, and total use of natural gas for transportation are available for the City of London. Non-retail pump sales for gasoline, diesel and propane all had to be derived from provincial statistics that were prorated to the City of London on the basis of population (See Appendix A).

Based on retail and non-retail pump sales, transportation fuel use is estimated as 14,456,643 GJ of gasoline, 3,500,197 GJ of diesel, 585,117 GJ of propane and 65,157 GJ of compressed natural gas. Figure 3.4 highlights the City of London's 1998 energy consumption by end use sector.

Figure 3.4 City of London Energy Use by Sector, 1998.

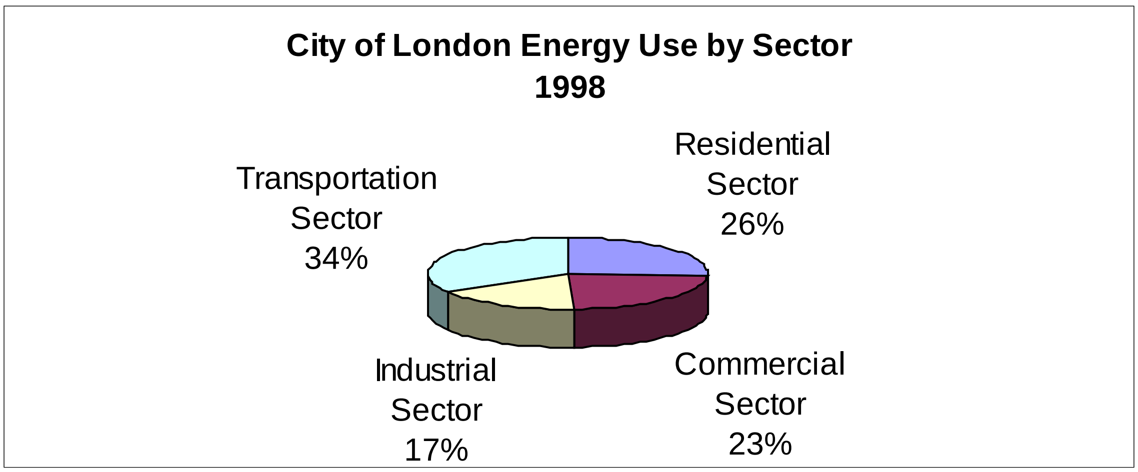


Figure 3.5 presents the City of London's eCO_2 emissions by end use sector for 1998. Once again, the waste sector appears in the discussion of greenhouse gas emissions.

Figure 3.5 City of London Equivalent CO_2 Emissions by End Use Sector, 1998.

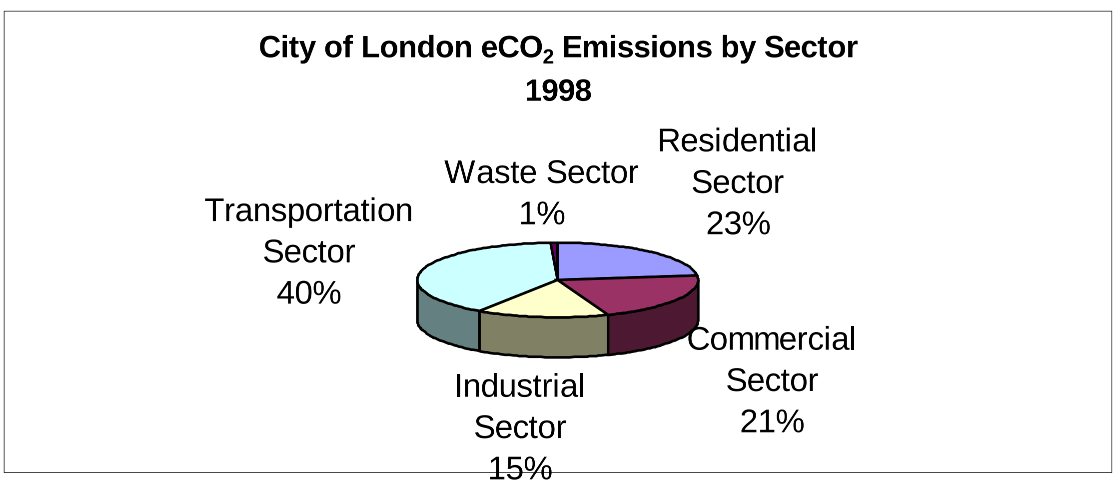


Table 3.2 outlines the City of London's current year inventory. See Appendix A for a full breakdown of fuel use by sector.

Table 3.2 City of London Secondary Energy Use by Type and Sector. Final Results 1998 (In GJ).

	Electricity	Natural Gas	Petroleum Fuels[1]	Other[2]	All Fuels	% of Total
Residential	3,459,601	9,168,464	1,065,996	597,888	14,291,949	25.79%
Commercial	4,304,160	8,262,560	427,152	0	12,993,872	23.45%
Industrial	2,771,229	6,459,010	192,739	97,915	9,520,893	17.18%
Transportation	0	65,157	17,956,840	585,117	18,607,114	33.58%
Total	10,534,990	23,955,191	19,642,727	1,280,920	55,413,828	
% of Total	19.01%	43.23%	35.45%	2.31%		

1. Petroleum Fuels includes gasoline, diesel, fuel oil and heavy fuel oil.
2. Other includes propane, wood, and kerosene.

3.6 Analysis of Energy Use, 1990-1998

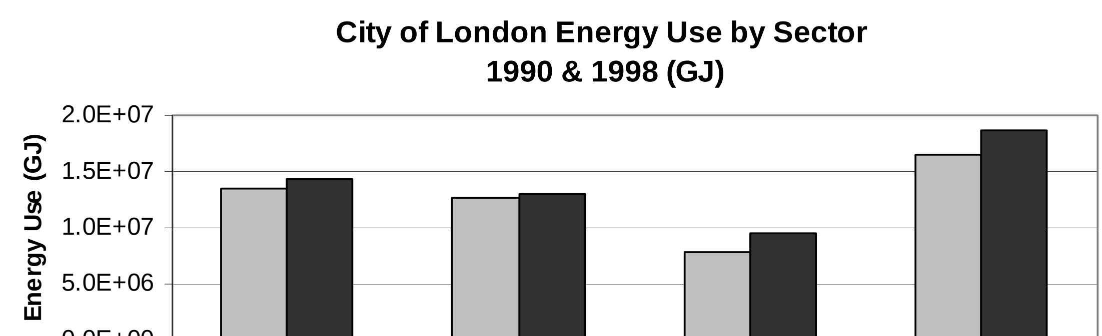
The benefit of completing a base year and a current year energy use inventory is in the resulting ability to make comparisons between two observed situations. It is possible to see how the City is evolving in a 'business as usual' situation, and to make consequent recommendations based on the actual situation, rather than relying on forecasts. In addition, because forecasts are derived from the base year, a current year inventory helps in providing a test of the accuracy of the forecasts.

Figure 3.7 compares greenhouse gas emissions between the base year and the current year. With the exception of the waste sector, greenhouse gas emissions have increased in all sectors between 1990 and 1998. It is expected that the greenhouse gas emissions would have decreased in the waste sector as a result of the diversion of waste from landfill due to recycling programs. The greatest percentage increase in greenhouse gas emissions was observed in the industrial sector (20.5%), followed by the transportation sector (12%), the residential sector (5%), and the commercial sector (2.8%).

Figure 3.6 compares energy use by sector, for the years 1990 and 1998. Energy use has increased in all sectors in the period 1990-1998, with the greatest percentage increase (22%) found in the industrial sector, followed by the transportation sector (12%), the residential sector (6.5%), and the commercial sector (3%).

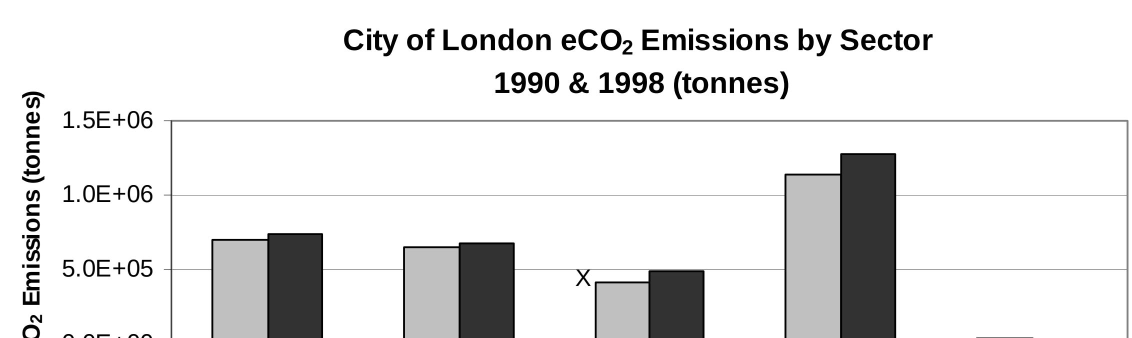
Figure 3.7 compares greenhouse gas emissions between the base year and the current year. With the exception of the waste sector, greenhouse gas emissions have increased in all sectors between 1990 and 1998. It is expected that greenhouse gas emissions would have decreased in the waste sector as a result of the diversion of waste from landfill due to recycling programs. The greatest percentage increase in greenhouse gas emissions was observed in the industrial sector (20.5%), followed by the transportation sector (12%), the residential sector (5%), and the commercial sector (2.8%).

Figure 3.6 City of London Energy Use by Sector: 1990 and 1998 Comparison.



	Residential Sector	Commercial Sector	Industrial Sector	Transportation
1990	13,527,648	12,612,200	7,756,515	16,579,462
1998	14,291,949	12,993,872	9,520,893	18,607,117

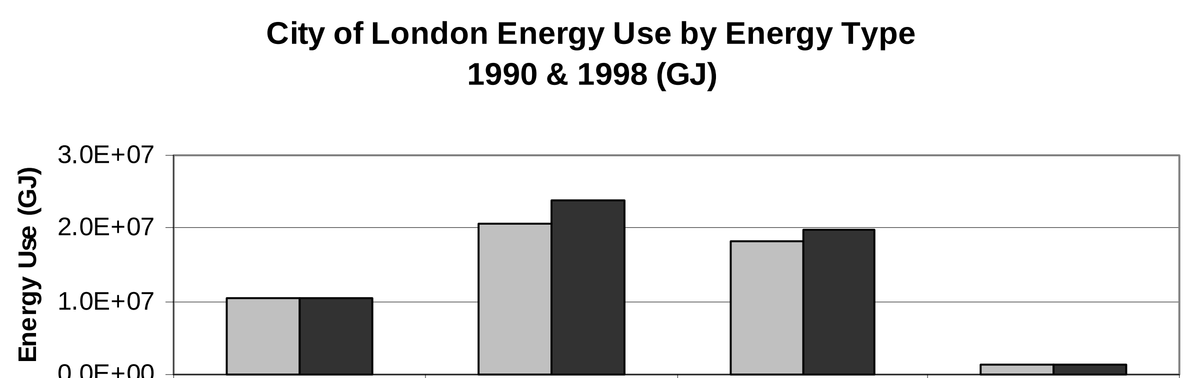
Figure 3.7 City of London Equivalent CO_2 Emissions by Sector, 1990 and 1998 Comparison (tonnes).



	Residential Sector	Commercial Sector	Industrial Sector	Transportation Sector	Waste Sector
1990	699,836	655,521	407,010	1,131,792	42,983
1998	734,745	673,672	490,774	1,270,522	25,250

Figure 3.8 compares energy use by fuel type in the City of London between 1990 and 1998. All fuel types experienced an increase in consumption between 1990 and 1998, with the exception of electricity. Natural gas experienced the greatest increase in consumption (16%), followed by petroleum fuels (8.6%), and other (3.5%). Electricity experienced a decrease in consumption of 0.3% between 1990 and 1998. It is important to note that petroleum fuels include gasoline, diesel, fuel oil and heavy fuel oil, and other includes propane, kerosene and wood. See Appendix A for a full breakdown of energy use by fuel type.

Figure 3.8 City of London Energy Use by Energy Type, 1990 and 1998 Comparison (GJ).



	Electricity	Natural Gas	Petroleum	Other
1990	10,563,000	20,501,000	18,144,939	1,266,884
1998	10,534,990	23,890,034	19,707,868	1,311,938

3.7 Forecast

Forecasts are helpful in enabling a city to quantify, based on its base year inventory, where it is headed in the future if no action is taken to reduce their energy use and consequent CO_2 emissions. Forecasts are required to assess what mitigation measures are required to achieve target emissions, such as those suggested by the PCP program, on the basis of base-year (1990) emissions.

3.7.1 *Forecast Generation*

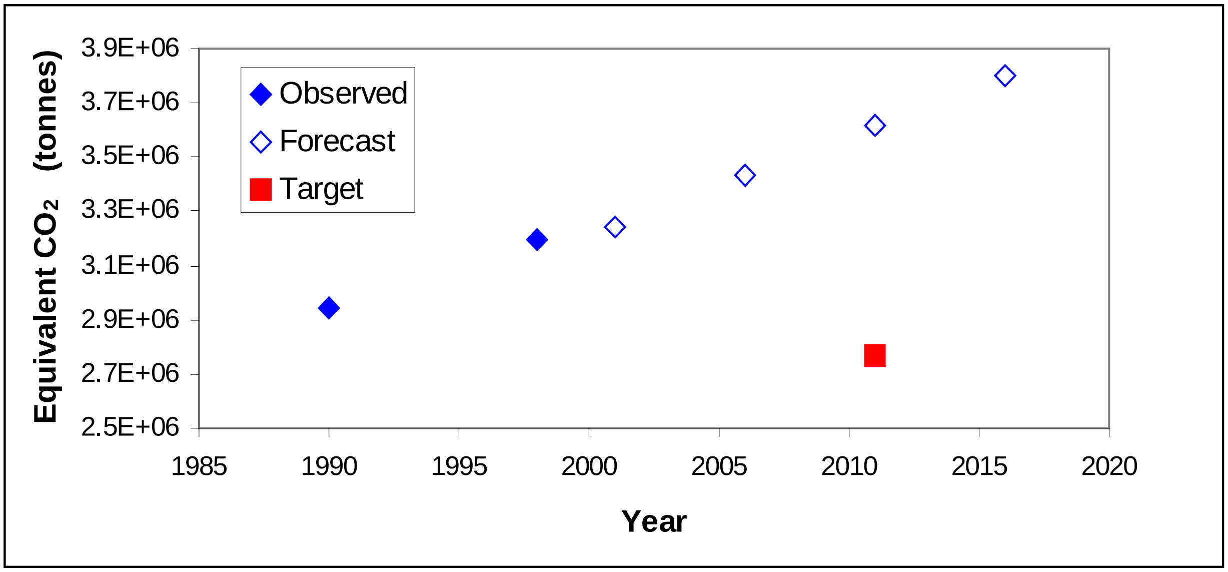
The first step in generating an energy use and emission forecast is to decide on the forecast years. For this project, it was decided to generate forecasts for the years 2001, 2006, 2011, and 2016 based on the necessity of using documents from the City of London Planning Department, which uses these years in its own forecasts.

The forecast is relative to the base year inventory. In order to generate the forecast, various growth multipliers are applied to the base year data. (See Appendix A for a list of the growth multipliers).

When representing the forecast graphically, it is helpful to include the target as a visual reminder of the goal of the project; to reduce community-wide greenhouse gas emissions by 6% of 1990 levels by the years 2008-2012.

Figure 3.9 is an equivalent CO_2 forecast that was generated for the City of London. Values for 1990 and 1998 are observed, while values for 2001-2016 are projected. The forecast represents a 'business as usual' forecast, which assumes that no additional emission-reduction efforts are being implemented, and that efficiencies of technologies remain constant. These assumptions are conservative, in that technologies have typically shown increased efficiencies with time, and it is likely that active or passive emissions reduction efforts will be implemented by various sectors. The task of integrating more realistic assumptions in the forecast is beyond the scope of the current project. **The TF recognizes the value in more detailed and accurate energy use forecasting, and advocates the City invest in the ability to provide energy analysis and forecasting capabilities by staff.** The current forecasts meet with the general standards presented by the PCP protocol and VCR program.

Figure 3.9 Equivalent CO_2 Production Forecast for the City of London: 1990-2016 (tonnes).



If energy use, and subsequent eCO_2 emissions are allowed to evolve following a 'business as usual' scenario, eCO_2 emissions will reach 3,802,910 tonnes by the year 2016, an increase of 29% from 1990.

Some interesting observations can be made regarding the equivalent CO_2 forecast generated for the City of London. It appears that the forecasted emissions, based on 1990 observations, are lower than might actually occur. Figure 3.9 shows that the observed emissions in 1998 fall above the forecast line, suggesting that emissions, in a business as usual scenario, may actually evolve to be higher than forecasted. This result may be due to the lack of detailed information regarding fuel use forecasts on which to generate the growth multipliers that create the forecast. (See Appendix A).

3.8 Emissions Reduction Targets

A target is set to reflect a goal for reducing greenhouse gas emissions. The local target may be based on national targets set through international agreements (e.g. Kyoto Protocol). These targets are typically set as a percentage reduction of emissions relative to a selected base year; for example the PCP recommended community emission reduction target is a 6% reduction in community wide emissions within ten years of joining the program. A variation on this type of target is a more aggressive, sectorially limited target, such as the PCP suggested target of a 20% reduction in emissions from municipal operations within ten years of joining the program. This target is based on results-to-date of the international climate change protection program. Alternatively, a less-aggressive target can be set, such as the stabilization (i.e. not net increase) of greenhouse gas emissions within a certain time period.

A different class of target is one based on improvements to energy efficiency. For example, Portland OR set a goal of increasing energy efficiency city-wide by 10% by 2000 from a program initiated in 1990. The manufacturing sector of Canadian industry is familiar with this type of target through its continuing commitment to improve energy efficiency (energy consumption per unit of product output), using available technology.

This report focuses its attention on the community as a whole, rather than on operations of the City as a Corporation. Using, as an example, the PCP greenhouse gas emission target for communities (6% reduction in greenhouse gas emissions, relative to 1990, by the year 2011), by the year 2011, greenhouse gas emissions should be 2,765,697 tonnes, 6% lower than was calculated for 1990. However, through normal population growth, greenhouse gas emissions are expected to continue to increase. In a 'business as usual' scenario, greenhouse gas emissions are forecasted to reach 3,619,173 tonnes by the year 2011

(Figure 3.9). In order to realise the target, an emission reduction of 23.6% from the forecasted 2011 level will have to occur which translates to a reduction of 13.4% from the current year (1998) emissions.

The adoption of national targets at local levels or within certain sectors is subject to criticism. For example, industry in general does not, support the Kyoto target of a 6% absolute reduction in 1990 levels of greenhouse gas emissions by 2008-2012. They believe that the target was proposed using political criteria, without regard for what might be attainable. In the case of Canada's industrial sector, it would mean a real reduction of 20% to 30%, considering increases in production capacities since 1990. The Alliance of Manufacturers and Exporters of Canada, which represents 3,500 companies, suggests that Canada will face serious economic losses in meeting the currently suggested targets unless there is a major leap forward in the capabilities and adoption of new emission reduction technologies by both industry and individual Canadians.

Our current level of analysis is unable to provide substantive information on the "reasonableness" of achieving various target options in the local context. This would require further work, and would, in any case, still be limited by the assumptions regarding future growth and technology improvements. Within the City of London, equivalent CO_2 emissions are highest for the transportation sector (40% of the total), while the industrial sector ranks 4^{th} (15% of the total) after the residential and commercial sectors (23%, 21% of the total respectively) suggesting that, within the City of London, efforts at reducing emissions are best placed in the transportation, residential and commercial sectors.

The Task Force believes implementing local action through the recommendations of this report will improve energy use efficiencies and air quality in London, which in turn, will contribute towards the achievement of national and international goals of reducing CO_2 emissions and help to mitigate the costs of global climate change and its local effects upon London. Early action will assist in achieving these goals.

The experience of other cities participating in the PCP program suggests the PCP targets may be feasible. It has been recently reported[19] that the City of Ottawa has reduced overall corporate energy use by 8% since 1990, reduced CO2 emissions by 29% over the same time period, and that Ottawa residents have stabilized their energy use since 1990, and have reduced CO2 emissions by 10% over the same time

[19] City of Ottawa Environmental Management Branch, Dept. of Engineering and Works. 1997. Corporate Plan for Greenhouse Gas Reduction, Second Annual Progress Report.
Task Force on the Atmosphere, Action Plan Advisory Committee (City of Ottawa) 1997. Greenhouse Gas Reduction Action Plan Second Annual Progress Report, Oct. 29, 1997.

period. Regina has broadened their goal to 20% of CO_2 emissions community wide[20]. Toronto and Hamilton-Wentworth have have similarly endorsed the corporate 20% target, which in some cases has been broadened to include the community as a whole. Based on these reports:

The Task Force recommends the City endorse the PCP targets of 20% for the City as a Corporation and 6% for the community as a whole, as an important step in promoting local action through local leadership.

[20] City of Regina 1998. Cool Down the City. Progress Report submitted to the Voluntary Challenge Registry.

4. AN ACTION PLAN FOR LONDON

4.1 Introduction

The TF terms of reference include developing an overall strategy for reducing smog and CO_2 emissions, including specific recommendations and solutions. These steps are commonly referred to as an ACTION PLAN. We present here our ideas, which should constitute the core of an Action Plan for the City of London. Full details of many of the items will require further work to establish.

Approaches to initiating change include: regulations, economic instruments, leadership, voluntary agreements, awareness and education.

The Action Plan here is directed more towards the community as a whole; we also recommend that the City develop an Action Plan specific to City Operations, in keeping with the recommendations of the PCP program, supported by FCM.

4.2 Barriers to Success of Municipal Action Plans

The Municipalities Issue Table Foundation Paper of the National Climate Change Process identifies several barriers to success for Municipal Action Plans. We list those barriers here, along with our recommendations to overcome or reduce these barriers.

4.2.1 *Financial Constraints*

A critical issue in implementing Action Plans is lack of financing. The Municipalities Foundation Paper suggests part of the problem is often related to the absence of a strategic approach to incorporating energy management, waste management and community greening projects. Further, payback periods required to implement successful reductions of emissions are often longer than 5 years. Several options are available for financing. These may be categorized as:

Revolving fund: Financing is provided with internal (or possibly external) capital, for profitable investment in a municipality's own buildings, vehicles and infrastructure. The energy savings are used to refinance the fund. The Toronto Atmospheric Fund (TAF) and the Regina Special Initiative Investment Program (SIIP) are Canadian examples of revolving funds. The TAF was initially funded through the sale of a property, and now finances projects that will assist Toronto in reducing GHG emissions and air pollution. The SIIP was initially allocated $250,000 and was used by city departments to provide money for energy efficiency measures. Initiatives were required to repay the fund from energy savings, at rates equivalent to those which the money could have earned if invested in the market.

Direct borrowing: Borrowing can be done for specific projects or through issuance of bonds or debentures. Energy savings are used to cover the interest and capital over the time period of the loan or bond.

Performance Contracts: Third party financing usually offered by energy service companies. An energy service company installs energy management or efficiency technologies in a building with no up-front costs to the owner. The company is paid back from the energy savings achieved, reducing or eliminating the cost and risk to the owner, and reducing staff time and resources necessary to undertake in-house energy management programs.

Emissions Trading: A possible new avenue of financing is the trading of emissions reduction credits. Verified reductions in emissions will generate a market value. In the U.S., a trading system for sulphur dioxide emissions (responsible for acid rain) is now worth an estimated $500-million (U.S.) in trades a year, with a current trading price of just under $250 (U.S.) a ton. Current trades for CO_2 emissions are estimated to be between 0.50 to $5 (U.S.) a ton, but could become as high as $16 a ton.[21]

For example, a manufacturer using large amounts of fossil fuels that generate significant GHG emissions could opt to pay a municipality to capture methane produced by the municipality's landfills that otherwise would be vented to the atmosphere. Successful, documented reductions of GHG emissions by the City of Toronto currently have put them in a position to market their emission reductions in the international carbon trading market (partnered with Torrie Smith and Associates).

There is a Pilot Emission Reduction Trading (PERT) program under way in Ontario with a primary focus on smog precursor pollutants, but which also has been expanded to include CO_2. Another pilot project under way directed solely to GHG is GERT (Greenhouse Gas Emission Reduction Trading Pilot). The purpose of the Pilot project is to review documentation on traded projects (from either sellers or buyers). If requirements are met, the projects are registered and will be eligible for recognition against future compliance obligations.

TF Response: The City of London has at least two existing revolving fund programs identified through the Downtown Millennium Plan which could be expanded, or serve as the basis for a similar fund that addresses energy use. The funds identified are the: Façade Improvement Loan Programme, and the Building Code/Fire Code Loan Programme. Details are provided in the Downtown Millennium Plan. The source of funds for these programmes is identified as the Civic Investment Reserve Fund. This fund could also be used as the source for the initial funds for a programme directed at improved energy efficiencies/technologies/management, and air quality. Specific terms and conditions of such a fund would have to be determined, but could follow the examples of existing funds in Toronto or Regina.

The City should consider, where appropriate, the benefits of Performance Contracts for enhancing energy efficiency in Municipal Operations, and to promote successful programs to the community at large.

The City should investigate in more detail the potential for emissions trading either through energy efficiencies obtained (or which could be obtained from municipal operations) or from landfill waste gas recovery.

4.2.2 *Information Gaps*

Energy information collection at the municipal level is often difficult. Energy management is information-intensive and up-front costs associated with developing the energy use database for developing and monitoring GHG reduction strategies may be prohibitive.

TF Response: The 1995 Air Emissions Study undertook the first energy use assessment in London. The TF has subsequently updated and documented this procedure for 1998. The TF has purchased, on behalf of the City, and implemented a dedicated software package that can be used to monitor emissions, test possible GHG reduction strategies, and assess progress towards achieving targets.

The TF has found that acquisition of energy data at the municipal level is difficult, and may be increasingly so in an era of greater energy supply company deregulation. The TF suggests, where possible, mandating the provision of energy use statistics by energy suppliers as a condition of the license to operate in the City of London.

[21] Globe and Mail (Chase, S. Firms warm to greenhouse credits), Oct. 30, 1999 p. B 1.

The TF has attempted to fully document the procedures for compiling the necessary information. Consistency in procedures is required for the success of continued monitoring programs. The identification of staff resources to handle this process on an on-going basis and to work with energy supply companies will reduce the difficulties in this process.

4.2.3 *Lack of Analytical Capacity*

A lack of expertise and analytical capacity typically exists within municipal governments; the TF believes this to be true for the City of London. Absence of this resource means that there is a reduced ability to assess, plan and carry out energy projects on the part of the Municipality, which leads to a reduced ability to meet targets and derive benefits from energy programs.

TF Response: The TF has initiated a rudimentary analytical capacity through the purchase and set-up of the GHG emissions software. The software provides initial capabilities of tracking energy use and emissions, as well as a rudimentary planning tool both within the municipality, and by the City as a Corporation. The TF will provide initial training to identified City Staff members in the operation of this software. The TF members directly engaged in this program will likely be lost as a resource following the completion of the TF duties. Our experience with this report indicates a significant learning curve is involved in the procurement of necessary data and use of the software. The TF recommends that dedicated staff be identified and directed to maintain and update this resource, in order to maximize efficiency of personnel resources, and utilization of the software.

4.2.4 *Constitutional and Legal Barriers:*

Strong collaboration between municipalities and provincial authorities is required to overcome regulatory restrictions that inhibit action. This is particularly true for London, in which the smog problem is generated in part by transboundary pollution.

TF Response: Collaboration is required on both the part of local politicians and City Staff with provincial/federal counterparts. For the purposes of achieving emissions reduction targets, the identification of dedicated staff resources to engage in the collaboration with relevant provincial and federal authorities, and relevant groups (such as FCM) would be useful. The FCM may also provide a useful resource for identifying common concerns among Canadian Municipalities and lobbying federal and provincial authorities.

The TF has undertaken initial collaboration with local representatives of the MOE regarding air pollution information for the City of London, and with representatives of the PCP regarding implementation of the software package. Although not directly tied to overcoming regulatory barriers, these collaborations are an example of the actions required to access required information and to implement realistic reduction strategies.

4.3 Steps to an Action Plan

The TF follows the milestones for the PCP program (Table 1.1). Here we review the main steps to developing a Local Action Plan, the current situation regarding each step in London, and future actions required to complete the step, if required.

4.4 Action Plan Strategies: Key Components

In this section we outline potential strategies that can be used to achieve emissions reductions in the City of London to achieve the TF goals of improved air quality and reduced CO_2 emissions.
Before specific strategies or measures are discussed, we present recommendations regarding some fundamental issues that are key to the implementation and success of the Action Plan.
The issues considered key in the experience of cities that have developed successful plans are:

1) **Human resources,**
2) **Financial resources,**
3) **Integration of energy issues into city planning.**

Table 4.1. Steps to a Local Action Plan as suggested by the PCP program, the current London situation of each step, and future actions required.

PCP Program Step	Current Situation	Future Actions Required
1. Profile energy use and emissions for the base year of 1990 for municipal operations, and then for emissions community-wide.	The community database has been completed. Data is available for municipal operations.	• Enter and analyze data for municipal operations. (City) • Use a questionnaire to collect information from other community sectors on specific projects that may affect the level of energy use and emissions over the next 10-20 years. (Agency):TBA
2. Forecast energy use and emissions for 10 or 20 years in the future for municipal operations, and then for emissions community-wide.	Community emissions forecasts have been generated at the standard planning department intervals.	• Generate forecasts for City operations (City). • Monitor energy use/emissions on an ongoing (annual) basis to document measures success and target achievement. (City)
3. Establish a reduction target. PCP targets are 20% reductions in GHG emissions from municipal operations and a minimum of 6% reductions in community-wide emissions within 10 years of joining the PCP program.	The PCP targets have been adopted in this report and various priority actions have been listed.	• Targets should receive official endorsement by the municipality. • Ideally, the database and analysis tools available should be used to quantify how implementation strategies will contribute to target achievement.
4. Develop a local action plan. Initial PCP aims are to reduce emissions and energy use in municipal operations, and then expand to reduce emissions in the community. The local action plan should also incorporate public awareness and education campaigns.	This action plan is directed towards the Community. Various action plan strategies are suggested and prioritized in this report.	• The Action Plan requires further development in terms of implementation strategies, full analyses of costs and benefits and endorsement by politicians and City Staff. • An inventory of municipal actions and their greenhouse effect will be tabulated. • An energy management co-ordinator position should be set up to oversee the implementation.
5. Implement the local action plan.	Implementation strategies are suggested.	• Implementation of the local action plan will begin in the year 2000 and tie in with various existing and proposed projects in order to measure GHG emission reductions and monitor and evaluate target goals • Members of the task force will be asked to continue as an initial (1 year) steering committee to develop and oversee implementation strategies.

4.4.1 *Acquisition of dedicated energy-related staff resources.*

The TF recommends that the City hire a dedicated energy management co-ordinator.

Overview and Rationale

One of the greatest barriers to action is a lack of adequate staff resources. Without the acknowledgement of energy use issues and related greenhouse gas emissions concerns as a priority, it is difficult to implement many of the necessary measures that are needed to address these concerns. The City must take ownership of the commitment that is needed to address the federal initiative to reduce greenhouse gas emissions. In the experience of other cities, these positions easily pay for themselves in the savings that they generate through identification of energy saving measures, knowledge of other available energy efficiency programs, and facilitating integration of energy measures into City planning. Further, these positions can also bring in funds from Government grants or other sources by acting as energy consultants on projects. For example, the Portland Energy Office, developed from a US Dept. of Energy program on Sustainable Cities in 1989-90, brings in three dollars' worth of grants and contracts for every dollar it draws from the city's general fund.

In Canada, there are currently 63 local government participants at various FCM "Partners for Climate Protection" milestones. Given these communities have made a commitment to demonstrate progress, dedicated staff are able to exercise a leadership role within the community by communicating economic and GHG emissions savings through implementation of action plans. Various job titles include: Edmonton – Environmental Engineer, Regina – Energy Management Co-ordinator, Toronto – Environmental Evaluation Analyst, Vancouver – Special Office of the Environment, Hamilton – Energy Management Project Manager.

Objective

To provide the City with a dedicated energy resource person capable of achieving significant cost savings from implementation of various energy efficiency programs for both the City as a Corporation, and the community as a whole.

Description

The energy management co-ordinator will have a variety of tasks as outlined in Appendix B in order to develop strategies and monitor municipal emissions. Priorities will include liaison with other municipal departments and communities in setting up programs, establishing GHG targets and determining financial opportunities, expanding the energy use inventory profile for the municipality and other sectors and, and identifying opportunities to introduce appropriate GHG policy and partnerships on all government levels.

Implementation

The Task Force recognizes that a permanent position implies an ongoing financial commitment and that many energy use projects may yield paybacks on time frames greater than 5 years. Options to address this were discussed generally in section 4.2.1; in short, they include:

Internal capital: Initial funds for the position come from the City, through budget allocation, or from funds generated from, for example, the sale of land.

Borrowing: use a loan to hire initially, savings are used to cover the cost of the loan.

Performance Contracts: use third energy service companies to fund the cost. These companies are paid back from the energy savings.

We expect initially, that the Energy Management Co-ordinator would:

a) identify the areas of greatest potential for energy savings and reductions in emissions caused by energy use in the community;
b) prioritize energy conservation activities in relation to their potential impact on the community;
c) gain support for energy management plans and programs and
d) broaden public understanding of energy issues in the community.

To achieve these goals, and those outlined in the section "Duties and Responsibilities" (Appendix B), the Energy Management Co-ordinator would be supported by a community steering committee established to oversee the implementation and monitoring of the Action Plan (see recommendation in Section 4.6). We also anticipate that the Energy Management Co-ordinator may require further resources. These could include (but not be limited to):

- additional human resources to accomplish goals. Here, the Task Force notes the current availability of the "OnSite" program that provides persons trained by PCP specifically to assist cities with energy management. The Energy Management Co-ordinator would supervise this position.
- a facilitator through FCM's new community support planning program to assist in implementing this Action Plan and further developing the business case;
- a supporting budget to accomplish goals

The Task Force views the Energy Management Co-ordinator as the key figure for initiating, sustaining, and co-ordinating local action.

4.4.2 *Financial Resources*

The TF recommends that the City consider ways of setting up a fund to provide for energy and air quality initiatives.

Overview and Rationale

Municipalities that have developed self-sustaining funds can provide loans and grants to address energy efficiency, renewable energy, urban planning, transportation and greening of the city. The success of programs in Toronto and Regina, Canadian leaders in the field of municipal energy efficiency and reductions in GHG emissions, is due in part to financial resources made available specifically for energy efficiency and air quality issues. A limiting factor in the ability of many Cities or corporations to institute further change is on restricted payback periods for current financial situations. The establishment of a pool of funds, which allows initiation of energy efficiency projects and payback from savings, can help to overcome this limitation.

For example, 1) the Toronto Atmospheric Fund, was established in 1992 with an endowment of $23 million from the sale of property (in 1997, more than $1 million was available for grants alone) 2) in 1998, Sudbury approved $4 million from internal funds for projects identifying $990,000 in annual savings with a payback of 4.27 years and 24% reduction in carbon dioxide emissions and 3) Edmonton's Energy Management Revolving Fund has initiated over 30 projects to date, valued at over $1 million, with an average combined payback of 2.9 years.

Objective

Maintain an ongoing budget for GHG strategies

Description

Alternatives include revolving funds, direct borrowing or performance contracts. For example, by determining cost savings from the completion of current municipal retrofits to all its buildings, a restricted refinancing fund could be created for new initiatives from these savings, for use either by the Corporation or by the Community at large. Other opportunities can also be explored to support this refinancing fund including incentive programs from various government programs and performance contract strategies for various sectors that will generate additional monies. This would require staff resources, as would be provided for by an energy management co-ordinator.

Possible examples include:

- Natural Resources Canada – Office of Energy Efficiency – Commercial Building Incentive Program that encourages building owners to incorporate energy-efficient technologies and practices in designs for new commercial and institutional buildings.
- The Federation of Canadian Municipalities is currently lobbying our Federal Government for a national partnership of municipal, provincial and federal governments using innovative financing mechanisms that focus on investments in core municipal infrastructure to improve quality of life by enhancing environmental health, ensuring economic vitality and improving social equity as sustainable communities. The program would recommend resource allocation for a ten-year period to invest in municipal water, waste, energy and transportation projects to reduce GHG emissions and smog-producing pollution. A securitization fund would close the loop, ensuring communities would have access to resources needed to launch projects.

We note that the newly emerging field of emissions trading may provide for other financial opportunities for the City. We recommend that the City investigate opportunities that may arise from emissions trading, e.g., from capture of landfill gas emissions, or other possibilities.

Implementation

The municipality will need to direct the energy management staff person to compile a report of self-sustaining strategies from other communities both in Canada and the United States.

4.4.3 *Integrate Energy Issues into City Planning*

The TF recommends that the Energy Management Co-ordinator, assisted by the Planning Department, implement a research and action process into the connection between urban design and energy use.

Overview and Rationale

The third key to success is to raise the level of awareness and the integration of energy issues into main-stream City Planning. In some cities this is accomplished by an Energy Office (e.g., Portland OR), in others, Energy Action Plans have been initiated, similar to GHG / Air Quality Action Plans (e.g., Kamloops BC).

Land-use planning and urban design have significant impacts on energy use in a city. Urban form, transportation networks, and the diversity of development all contribute to the energy use pattern. Discouraging urban sprawl, designing residential areas that are supportive of an efficient transit system and encouraging a well-planned mix of development will lead to a more energy-efficient community. The key energy use sectors in London identified in this study are the transportation and residential sectors. Planning decisions directly influence the use of energy by these sectors.

Objective

To incorporate energy planning into the Official Plan and to modify the Plan and zoning regulations to reflect the vision of a community that takes energy-efficiency, and its related economic and environmental benefits, into consideration, and particularly to integrate energy issues into new developments.

Implementation

Action by Planning Department and Energy Management Co-ordinator.

4.4.4 *Implement the Recommendations of the 1995 Air Emissions Study.*

From the beginning of the TF mandate, it was clear that a substantial number of specific measures relevant to a GHG/Air Quality Action Plan had been identified in the 1995 Air Emissions Study. We incorporate these, as appropriate, into this document.

4.5 Action Plan Strategies: Specific Measures to Reduce Energy Use and Improve Air Quality

The Task Force has identified a number of Action Items and measures that will achieve reductions of energy use and improve air quality. We prioritize these on the basis of potential contribution to reduced GHG emissions / improved air quality, and possible cost of the program.

4.5.1 *Transportation Demand Management*

Recommendation: Promote Transportation Demand Management as a pilot municipal GHG emissions outreach strategy.

Overview and Rationale

Based on recommendations in the Transportation Plan Review of 1994 and on the Official Plan Amendment of July 1996, the City of London is committed to a 15% reduction in automobile use by the year 2011. The 1994 Transportation Plan pointed out clearly that a combination of selected road investments coupled with a 15% reduction in automobile use were the most effective means for the City to meet future transportation requirements. The principal benefit to the City of London in achieving these objectives will be a signification reduction in the need to expand roadways, resulting in projected savings of $30-$33 million over a 20 year period.

Objective

To pilot employer-based TDM programs in the City of London that increase mobility and reduce emissions.

Description

The position will address a successful TDM plan as well as reduction in harmful emissions and reduced road congestion through more cost-efficient use of existing resources: roads, parking and transit. This will be an opportunity for the City of London to promote GHG emissions measures and monitor their effectiveness.

Implementation

The municipality is addressing a two-year pilot starting in the year 2000

4.5.2 *City's Own Operations*

The Task Force recommends that the City, through the Energy Management Co-ordinator, undertake the project of completing the energy use inventory of its own operations in recognition of its endorsement of the PCP Campaign.

A record of existing and future energy-saving measures and their associated economic and environmental benefits should be completed, and these measures should be implemented as a part of a Corporate Action Plan. The process could be overseen by the (proposed) Energy Management Co-ordinator.

4.5.3 *Carbon Sequestration*

As "The Forest City" London is home to an extensive urban forest resource that acts as a large sink or store of carbon. Uptake of CO_2 by vegetation helps to offset some of the increase due to energy use and deforestation. Direct uptake of CO_2 by trees is approximately 136 kg $year^{-1}$; when indirect savings due to the cooling and heating benefits provided by the shading and sheltering effects of vegetation are included, a tree may have an effect of 200-800 kg CO_2 per year[22].

The potential for vegetation to act as a carbon sink is important. The TF recommends:

- **new developments should ensure that as many existing trees are preserved as possible;**
- **tree re-planting programs be supported to assist in local sequestration of CO_2;**
- **tree planting programs consider the potential of tree species to act as sources of smog precursors;**
- **promote the use of trees and other vegetation in urban design within existing developments and in new developments to provide microclimatic benefits that lead to reduced energy use in both summer and winter seasons.**

4.5.4 *Industrial Commercial Sector*

A number of opportunities exist for improving emissions from the industrial commercial sector in London. These include:

- Planning for additional cogeneration sites, including site identification, integration into future community planning projects etc.

[22] Municipalities Issue Table Foundation Paper, National Climate Change Process, Nov. 23 1998

- Renewable energy initiatives
- "Greening" of vehicle fleets
- Promote participation in the VCR program that encourages businesses to develop their own Action Plans, and give preferential promotion to those London Companies participating
- Offer a workshop to the EMRCB membership (in partnership with Local Air Quality Initiative) facilitated by Rose Technology to provide companies with detailed project energy strategies in terms of financial and energy savings and environmental impact – i.e., the reduction of greenhouse gas emissions and of atmospheric pollutants.
- Developing and implementing Air Quality Advisory action plans
- Promote Natural Resources Canada Office of Energy Efficiency programs, possibly on a cost recovery basis, using energy savings.

4.6 Action Plan Strategies: Monitoring and Evaluating Progress

An important aspect of any municipal Action Plan is the evaluation and monitoring process. Through updating the energy use database, the City can monitor the progress of projects and policies implemented on the recommendation of the Action Plan. However, the database, and therefore the accuracy of the observations, is only as good as the information that is available. It should be an effort of the City to ensure that the necessary information to complete an energy use inventory is available whenever possible. Information is often difficult to obtain, and some forms of information may become more difficult to access, in this, an era of greater energy supply company deregulation. The TF recommends:

- **the City, through the Energy Management Co-ordinator, assume responsibility for the ongoing maintenance of the established energy use / CO_2 emissions database using the GHGES;**
- **where possible, mandating the provision of energy use statistics by energy suppliers as a condition of the license to operate in the City of London, in order to assure the highest quality of data for monitoring and predictive purposes;**
- **the City, through the Energy Management Co-ordinator, should consider filing progress updates to the VCR program as a show of community leadership;**
- **a steering committee be established to oversee the implementation and monitoring of the Action Plan.** Members of the Task Force continue as a one-year steering committee to develop implementation strategies for a long-range period of 10-20 years

4.7 Action Plan Strategies: Demonstration of Leadership by the City of London

Official endorsement of, and participation in, the Action Plan implementation process is a fundamental aspect of its success. Participation by council and mayor, and the allocation of appropriate staff resources will have many positive impacts on the development and implementation of the Action Plan. An additional perspective would be brought to the process, which would help to streamline the recommendations to those that are feasible within the political realm.

Recommendations:

- **Endorsement of the Action Plan**
- **Endorsement of PCP targets**
- **Submission of the London Action Plan to the Voluntary Challenge Registry**
- **Endorsement of Air Quality Policy**
- **Endorsement of 1995 Air Emissions Study Recommendations**
- **Staff and council participation in future committees/task forces overseeing energy and air quality plan implementation.**

4.8 Action Plan Strategies: Education

Important components of an Action Plan are programs directed towards education, training and awareness. Action Items regarding education may be directed towards a) the citizens of London, b) City Staff.

Using the VCR guidebook as an example, the education strategy should provide answers to the following questions:

Are climate change / air quality issues and impacts explained to employees/citizens?
Does the City have a documented position on climate change issues?
Does the City assist individuals to reduce personal energy use and GHG emissions?
Where does a Londoner find resources regarding energy use / air quality?

The TF recommends:

That a municipal education strategy be developed to support promotion of the task force report and existing municipal projects.

The municipal education strategy could include some of the following:

- Develop a tailor-made message to disseminate the Task Force's mandate to the public.
- Promotion (through City's communication office) – web site, city publications – Spectrum etc., talk shows, media PSA's, bill inserts, magazine/LFP and community newspaper articles.
- Utilize the web sites and communication vehicles of Task Force member organizations as well as other aligned utility services and agencies.
- Promote participation by London businesses and institutions in the VCR. The City has instituted an Action Plan – challenge others to follow.
- Promote use of Environment Canada's national CO_2 calculator software by London residents/homeowners. The calculator will allow participants to estimate their personal CO_2 emissions, bringing the monitoring and local action to their most basic level. Users of the calculator could be challenged to set up and monitor their own individual action plan, much in the way the VCR program works for businesses and institutions.
- Add an energy and smog caucus discussion chat forum to the city's internet programming.
- Explore communication opportunities with the Chamber of Commerce's Environment Committee and EMRCB's membership.

4.9 Action Plan Strategies: Air Quality Plan

The Task Force recognizes the value of an Air Quality Plan for enhancing air quality, preserving human health and reducing direct and indirect costs due to air pollution. The TF recommends adoption of an Air Quality Plan specifically targeted towards these goals.

The following strategies are taken from the Waterloo region plan.

4.9.1 *Short term strategies*

- Adopt or enhance a "Green Fleet" policy to ensure that all fleet vehicles and motorized equipment are maintained at peak efficiency, are replaced with more efficient vehicles, use less polluting alternative fuels and that motor vehicle technology is optimized.
- Carry out emissions testing on all fleet vehicles on a regular basis or as prescribed (i.e., DriveClean)

- Reduce emission of volatile organic compounds during sunlight hours by establishing a schedule to refuel fleet vehicles after sundown/before sunrise. Summer months (min. before 9 a.m. or after 3 p.m.)
- Continue to improve energy conservation and efficiencies in all facilities. Set improvement goals.
- Develop and implement incentives to encourage municipal staff to use public transportation and car pooling on a year round basis.
- Maintain and promote the anti-idling bylaw enacted in August, 1999.
- Increase naturalized areas for all public lands in order to reduce municipal maintenance by motorized vehicles and reduce the use of pesticides. Develop incentives for residents to replace trees that have to be removed and encourage/enforce tree planting for all private and public developments.
- Increase and improve walking and cycling routes in order to reduce vehicle use.
- Establish a program to increase awareness of the air quality benefits of public transit aimed at increasing ridership. Examples include media advertising (radio, newspaper, television, billboards, bus boards, benches, bus shelters, etc.) and reduced/eliminated fares on days when the Air Quality Index is predicted to be 50 or more.
- Develop a municipal response plan on Smog Alert Days that reduces and/or prohibits, where possible, the following activities:
  - Use of oil-based paints, solvents and other volatile-organic-compound-emitting products
  - Street sweeping
  - Refuelling vehicles during daylight hours
  - Road re-surfacing activities
  - Operation of crematoriums
  - Pesticide spraying
  - Use of gasoline powered equipment – gas mowers, weed cutters, leaf blowers, etc.

  N.B. In case of emergency operations, some of these prohibitions may not apply.

4.9.2 *Long Term Strategies:*

- Support a transportation plan that strives to provide a balance between continuing to provide efficient road transportation systems while also shifting away from auto reliance and towards greater use of transit, pedestrian and bicycling facilities.
- Support initiatives to provide public transportation for rural residents.

- Develop and conduct, with the assistance of health and environmental groups, a broad public education campaign about smog, including what residents can do to reduce their own emissions. The campaign should build on initiatives, which have already been undertaken and not duplicate efforts.
- Develop a plan for promoting municipal clean air initiatives and sharing resources and technologies that reduce air pollutants with industry, businesses and educational and health care institutions.
- Develop a plan for telecommuting options, carpooling, variable work hours, and flexible dress code, walking and cycling initiatives to reduce car use.
- Develop an audit plan that corporations can use to track activities and as a guide for achieving optimum performance for clean air initiatives.
- Incorporate a Clean Air Plan into other municipal strategic plans.

APPENDICES

A. CALCULATIONS, ASSUMPTIONS AND NOTES

Throughout this report, many calculations and assumptions have been made. In an attempt to make this report clear, concise, and easy to replicate, these calculations and assumptions are included in this Appendix.

A.1 Database

The completion of the database required the collection of data from many different source, including data that was specific to the City of London, as well as provincial statistics. In order to ensure that the information recorded in the database can be easily replicated, it is important to include details about the data sources. The details here are presented by fuel type, and includes the years 1990 and 1998, unless otherwise specified.

In instances where the base year data could not be easily replicated (from the 1995 Air Emissions Study), or where current information was not available specific to the City of London, provincial values were prorated to the City of London on the basis of population. In order to ensure ease in monitoring and replication, the same source was used to provide provincial values for the base year and the current year. While it is acknowledged that using provincial values may not be as accurate as optimally desired, it is felt that the benefit of having continuity of data sources outweighs the disadvantages of using provincial statistics. Therefore, some of the information reported in AES95 has been changed.

A.1.1 *Provincial Energy Use Statistics*

The provincial values were taken from:
1990:
Statistics Canada. Quarterly report on energy supply-demand in Canada. Ottawa: Minister of Industry, Science and Technology, 1990. Table 8D and Table 14. Catalogue no. 57-003-XPB.

1998:
Statistics Canada. Quarterly report on energy supply-demand in Canada. Ottawa: Minister of Industry, Science and Technology, 1997. Table 8D and Table 16. Catalogue no. 57-003-XPB.

For the 1998 entries, 1997 values were actually used because, at the time of printing, the 1998 document had not been released.

A.1.2 *Population Statistics*

The populations used to prorate provincial values are:

1990:
Ontario: 10,313,100. Source: Statistics Canada. Quarterly Demographic Statistics. Ottawa: Minister of Industry, Science and Technology. 1995. Catalogue no. 91-002 Vol. 8 no. 3.

London: 306,955. Source: John Flemming, City of London Planning Department.

1998:
Ontario: 11,242,006. Source: Statistics Canada. Quarterly Demographic Statistics. Ottawa: Minister of Industry, Science and Technology. 1999. Catalogue no. 91-002 Vol. 12 no.4.

London: 330,856. Source: Canada. Statistics Canada. Profile of Census Divisions and Subdivisions in Ontario. Ottawa: Minister of Industry, Science and Technology. 1996.

This document provided London's population in 1996; applied a growth rate of 1.6% per year as suggested by John Flemming, City of London Planning Department.

A.1.3 *Energy Use Statistics by Sector*

Electricity: There are two sources that were considered when collecting information on electricity use. The first is London Hydro, who provided data on commercial and residential customer usage. The second source was the electricity generated at the London Health Sciences Centre Energy From Waste (EFW) plant. The source for the EFW data was the Operations Manager, Canadian Waste Services Inc. London Hydro provided electricity data broken down by residential and commercial sectors. However, it is assumed that a portion of the commercial customer usage is used by the industrial sector. In order to separate these, the percentage breakdown of commercial and industrial electricity recorded in AES95 was applied to the commercial data provided for 1998. Therefore, a breakdown of 39% industrial and 61% commercial was applied to the total provided for commercial customer usage. The method is not ideal, and the TF recommends that, where possible, electricity usage be provided in the sectors required.

Natural Gas: Union Gas was the sole source used to compile natural gas data.

Fuel Oil, Heavy Fuel Oil, Kerosene, and Propane used in the Residential Sector: These fuel types were not available specific to the City of London. Provincial values were prorated to the City of London on the basis of population. Because the values reported for these fuel types in the AES95 report could not be easily replicated, the values for the base year were also changed to reflect the estimations made based on the provincial values.

Kerosene has only been entered into the industrial sector because this is the only sector in the GHG software that has kerosene as an option. However, this actually represents kerosene usage in all of the sectors.

Propane usage has been included in the residential sector. However, it has not been included in the commercial or industrial sectors because it is felt that at least a portion of the propane usage in these sectors is attributed to use by fleets. Therefore, propane use in the commercial and industrial sectors is actually represented in the transportation sector.

Wood: The value for wood that was reported in AES95, for the base year inventory, was used for 1998. It is estimated that this value would not have increased, and may actually have decreased as conversions to natural gas take place. Regardless, wood only represents a small portion of total energy use (0.7%).

Transportation Fuels: The transportation fuels that were recorded for the City of London include gasoline, diesel, propane, and compressed natural gas (CNG).

Transportation fuel sales are of two main types, retail pump sales and non-retail pump sales. Retail pump sales for gasoline and diesel are available commercially from Kent Marketing. However, non-retail pump sales are not available commercially, and therefore provincial values had to be prorated to the City of London on the basis of population. Because the transportation fuel data that was reported in the AES95 report is hard to replicate, the base year inventory has been changed to reflect the use of provincial values, which are felt to be replicable. Data for CNG was provided by Union Gas.

The Statistics Canada documents that were used to provide provincial values do not list non-retail pump sales. Therefore, a combination of categories (from the Statistics Canada Quarterly report on energy supply-demand in Canada) was used in each instance to arrive at the figures reported. These are:

- Non-retail pump sales for gasoline was a combination of the 'Road Transport and Urban Transit', 'Public Administration', and 'Commercial and Other Institutional' categories.
- Non-retail pump sales for diesel was a combination of the 'Road Transport and Urban Transit', 'Public Administration', 'Commercial and Other Institutional', 'Cement', 'Chemicals', and 'Other Manufacturing' categories.
- Non-retail pump sales for propane was a combination of the 'Road Transport and Urban Transit', 'Public Administration', 'Commercial and Other Institutional', and 'Other Manufacturing' categories.

The GHGES software prompts data to be entered as Vehicle Kilometres Travelled (VKT), however, the data comes in the form of total fuel use. Therefore, another method had to be used to enter the data. First, the default fuel economy values that are given in the help screens of the GHGES were used to determine fuel economy. The fuel economies of different vehicle types using the same fuel type were averaged to give the fuel economy for that fuel type. For example, personal vehicles and commercial vehicles that use gasoline were averaged to provide the Average L/100 km for gasoline, etc. The next step uses trial and error, putting in values for VKT until the value in the Energy in GJ box at the bottom of the screen matched the energy use values for each fuel type.

Waste Sector: The waste sector does not use any energy *per se*, however, it does release greenhouse gases through the breakdown of waste in the landfill. Therefore, it is important to include this sector in the emissions analysis. The software requires as input total waste to the landfill, and the percentage breakdown of that waste into paper products, food waste, plant debris, wood, textiles, and other.

The data for the waste sector came from two sources, both received from Tony Van Rossum, City Engineering Department. These sources were the "Landfill Waste Quantities-W12A" table, and the "Residential Waste Generation Estimates, Multi-Family Households, City of London, 1994" table.
The first source provided the total waste to landfill, broken down into several categories, and the second source provided a means of breaking the data into the percentage format demanded by the software. First, the categories that are assumed to be able to realistically be broken down into paper, food etc. were separated from the rest of the categories in the Landfill Waste Quantities table. These categories are: London collection, SE3 transfer station, township depot, and township collection. The rest of the categories were considered to fall into the "other" category in the software. The percentage breakdown offered by the "Residential Waste Generation Estimates" table was then applied to the four categories, and these values were entered into the software.

A.2 Analysis, 1990 and 1998

The following tables are taken directly from the database, and provide details of the energy use inventory by fuel type.

Table A.1 City of London CO_2 Emissions by Energy Type.

City of London Equivalent CO_2 Emissions by Energy Type, 1990 & 1998 (tonnes)

Energy Type	1990	1998	Change	% Change
Electricity	574,933	573,409	-1,524	-0.3
Natural Gas	1,012,695	1,180,104	167,409	16.5
Fuel Oil	138,842	110,722	-28,120	-20.3
Heavy Fuel Oil	23,992	12,779	-11,213	-46.7
Gasoline	857,968	985,141	127,173	14.8
Diesel	232,671	247,094	14,423	6.2
Propane	44,419	46,747	2,328	5.2
CNG	1,828	3,219	1,391	76.1
Kerosene	8,305	6,626	-1,679	-20.2
Wood	3,595	3,871	276	7.7
Waste	42,983	25,250	-17,733	-41.3
Total	**2,899,248**	**3,169,712**	**270,464**	**9.3**

Table A.2 City of London Energy Use by Energy Type, 1990 and 1998.

City of London Energy Use by Energy Type, 1990 & 1998 (GJ)

Fuel Type	1990	1998	Change	% Change
Electricity	10563000	10534990	-28,010	-0.3
Natural Gas	20,501,000	23890,034	3,389,034	16.5
Fuel Oil	1,897,647	1,513,308	-384,339	-20.3
Heavy Fuel Oil	324,000	172,579	-151,421	-46.7
Gasoline	12,590,420	14,456,643	1,866,223	14.7
Diesel	3,295,872	3,500,197	204,335	6.2
Propane	741,169	780,005	38,836	5.2
CNG	37,000	65,157	28,157	76.1
Kerosene	122,715	97,915	-24,800	-20.2
Wood	403,000	403,000	0	0
Total	**50,475,823**	**55,413,828**	**4,938,004**	**9.8**

Table A.3 City of London Energy Use and CO_2 Emissions per Capita.

Energy Use and CO_2 Emissions Per Capita 1990 &1998

	1990	1998
Energy Use*	164.9	164.4
CO_2 Emissions**	9.45	9.43

* in GJ/person/year
** in tonnes/person/year

A.3 Forecast

A forecast is required to estimate future energy use and consequent CO2 emissions by the City. Forecasts generated in this report are based on the growth multipliers applied to the base year inventory. Therefore, the outcome of the forecast depends greatly on the growth multipliers that are used. The GHGES suggests providing as much detail as possible when choosing growth multipliers. For example, individual growth estimates for each fuel type in each sector would yield the most accurate forecast. However, information in this amount of detail is not available for the City of London. In this case, the GHGES suggests applying the same growth multiplier to all fuels within a given sector. These multipliers are:

- a growth multiplier of the housing increase to the residential sector,
- a growth multiplier of the commercial floor area to the commercial sector,
- a growth multiplier of the industrial floor area to the industrial sector,
- and a growth multiplier of the population to the transportation and waste sectors.

It is acknowledged that quantities of waste have been decreasing since 1992, and that applying a population growth multiplier will cause the waste to increase in the forecast years. However, we assume for the purpose of this report that the current efficiency of recycling programs is maintained in the future, and therefore, waste taken to the landfill may begin to increase relative to the population increase. The software can be used to test the relative benefits of increases in the recycling efficiency on GHG emissions from the waste sector.

The following tables indicate how the growth multipliers for each sector were determined.

Table A.4 Growth Multipliers for Energy Use Forecasting.

Residential Sector	1990	2001	2006	2011	2016
# of Households[1]	122,114	131,152	140,674	150,867	161,455
Increase[2]		9,038	18,560	28,753	39,341
Growth Multiplier[3]		7%	15%	23.5%	32%

Commercial Sector	1990	2001	2006	2011	2016
Floor Area[4](m^2)	8,525,020	9,240,748	9,590,883	9,936,082	10,282,405
Increase		715,728	1,065,863	1,411,062	1,757,385
Growth Multiplier		8%	12.5%	16.5%	20.6%

Industrial Sector	1990	2001	2006	2011	2016
Floor Area[5](m^2)	3,061,345	3,404,616	3,602,035	3,799,454	3,996,872
Increase		343,271	540,690	738,109	935,527
Growth Multiplier		11%	17%	24%	30.5%

Transportation and Waste Sectors	1990	2001	2006	2011	2016
Population[6]	306,955	347,995	368,425	387,240	406,275
Increase		41,040	61,470	80,285	99,320
Growth Multiplier		13%	20%	26%	32%

[1] Households data is from: London. Planning Division. City of London Population and Housing Forecast 1996-2016. London: Department of Planning and Development. 1999.
[2] Applicable to all sectors, increase is relative to 1990.
[3] Applicable to all sectors, the growth multiplier is percentage increase, 1990 to respective forecast year.
[4] Commercial floor area data was received from John Flemming, City of London Planning Department. The City does not keep records of floor area, so this should be considered a 'best estimate'. Commercial floor area includes institutional floor area.
[5] Industrial floor area data was received from John Flemming, City of London Planning Department. The City does not keep records of floor area, so this should be considered a 'best estimate'.
[6] Population data is from: London. Planning Division. City of London Population and Housing Forecast 1996-2016. London: Department of Planning and Development. 1999.

B. PROPOSED MUNICIPAL ENERGY MANAGEMENT CO-ORDINATOR JOB DESCRIPTION

PURPOSE

Under the general supervision of the Manager of Environmental Services, this employee is responsible for the management and operation of the Energy Management Program for the Corporation. The program will encompass buildings, transportation fleets, sewer and water systems, outdoor lighting and a variety of equipment. As a member of the Department's management team, the incumbent will be involved in the setting of long and short-range plans, budgets, policies, procedures and manpower control. Independence of judgment and action is necessary, due to the overall impact of the position on the division and the department.

DUTIES AND RESPONSIBILITIES

- Provide administrative direction, operational and management policy, establishes priorities, standards and procedures and financial control for the Energy Management Program
- Participates as a member of the Department's management team and contributes to policy development, mission statements, action plans and broad management strategies
- Develops strategic and tactical policies, procedures, programs and ensures implementation modes are appropriate, effective and efficient in delivering the functions of the Energy Management Program
- Provides leadership, direction and initiative to develop and encourage the efficient and economical operation of all Corporate operations
- Undertakes the development and implementation of a comprehensive staff development and training program for the Energy Management Program
- Participates in and prepares reports for Committees of Council, relative to energy management services
- Provides a wide range of technical advise to client groups both public and private, on energy management matters and current policy and procedures
- Negotiates on behalf of the Energy Management Program with other departments, governments, agencies, community groups, etc., where their roles and responsibilities complement or supplement that of the Energy Management Program
- Implements the City effort regarding carbon dioxide emission reduction and other initiatives
- Addresses public and elected official inquiries and exercises a substantial degree of freedom in method of response
- Provides advice in the preparation of tender documentation and requests-for-proposals relating to Corporate activities
- Confers with consultants, professionals, government officials, media and the public

- Maintains awareness of provincial, federal and global policy and initiatives that related to energy use and management

- Performs related work as required

QUALIFICATIONS:

Education:
University degree in a suitable field of engineering.

Experience:
Minimum five (5) years' experience in delivering energy management programs and a minimum of three (3) years' experience in a supervisory and administrative capacity. Education/experience should include a broad understanding of air pollution and atmospheric chemistry.

Added Requirements:
Must possess a valid driver’s license and have available use of a vehicle

Knowledge, Abilities and Skills:

- Extensive knowledge of the practices, principles and technique of energy management in the areas of buildings, transportation and industrial plants, particularly as applicable to the implementation of a corporate energy management program

- Consider knowledge of the interrelationships between energy use and the environment

- Considerable knowledge of computerized energy accounting and monitoring systems

- Knowledge of mathematics and economics as applied to the evaluation of projects and programs

- Knowledge of labour practices and agreements and ability to interpret them to subordinates

- Ability to plan, organize and manage the activities of technical staff

- Ability to establish and maintain effective working relationships with employees, superiors, elected officials, representatives of other civic departments, outside agencies and the general public

- Ability to prepare and present complex proposals effectively

- Ability to delegate responsibility and to ensure that functions and tasks are carried out

- Ability to follow all safety regulations as set out by corporate policy

- Substantial skills in public interfacing situations which demand sensitivity, knowledge, coolness, organization, service orientation and mustering of adequate resources for responses

STAFF ALLOCATIONS

Salary and Benefits	$80,000
Promotion	$50,000

	% Allocation	Year 2000
Inventory	14%	
Opportunities	11%	
Implementation	53%	
Project Evaluation	20%	
Contingency	2%	

C. CONTACT TABLE

DATA	SOURCE	CONTACT	COST	NOTES
Transportation Fuel Use	Kent Marketing	Marlene Burt ph: 519-672-7000 fax: 519-672-3228	$100 for one year's data	Data included total retail gasoline and diesel sales for the specified year.
Natural Gas	Union Gas	J.E. (Jim) Sanders Manager, Business Development ph: 519-667-4182 fax: 519-667-4299 jsanders@uniongas.com		
Electricity	London Hydro			
Software	Torrie Smith Associates	Ralph Torrie rtorrie@torriesmith.com ph: 613-824-3045 fax: 613-824-3297 or Judy Smith judysmith@torriesmith.com www.torriesmith.com		
Ambient Air Quality	MOEE	Dr. Gerald Diamond Air Analyst ph: 873-5044 diamonge@ene.gov.on.ca		
City Liaison	City of London	Ron Standish Director of Engineering Planning tel: 661 4978 Rstandis@city.london.on.ca		
	City of London	Tony Van Rossum Environmental Services Engineer ph: 661-5701 Tvanross@city.london.on.ca		
Electricity: Victoria Hospital EFW Plant	Canadian Waste Services Inc.	Michael Campbell, Operations Manager ph: 685-8179 fax: 685-8276		
Population/ Households data & estimates	City of London Planning Department	John Flemming ph: 661-5343		

D. TERMS OF REFERENCE FOR THE ENERGY/AIR EMISSIONS REDUCTION STRATEGY TASK FORCE

GOAL

The overall goal is to reduce CO_2 emissions and smog so as to improve the air quality in the City of London and reduce global warming.

PURPOSE

The Task Force reports to the Municipal Council, through the Environment and Transportation Committee.

The Task Force shall by June 1999:

(a) develop an overall CO_2 emissions and smog reduction strategy for the City; and

(b) develop, recommend and implement solutions.

MEMBERSHIP

The Task Force shall consist of the following members.

Leon Baltas, P. Eng., Environmental Engineer Dillon Consulting Limited	George Brown Chief Operating Engineer GM Diesel	Deane Burns Environmental Health Officer Middlesex London Health Unit
Bill Crawford Chief Technical Officer CMHC	Ron Elliot Deputy Executive Director Project Green	Gerry Macartney General Manager, or designated representative Chamber of Commerce
Ian Service Environmental Specialist 3M Canada Inc.	Diane Szoller ACE	James Voogt Urban Climatologist University of Western Ontario
Ken Walsh, P. Eng., Senior Manager, Engineered Solutions London Hydro	a representative to be designated from Union Gas	representative(s) to be designated from the City of London

and other individuals as resource people, on an as needed basis as required by the Task Force to properly represent the needs of the community.
A majority of the membership shall constitute a quorum.

QUALIFICATIONS
The representatives of these organisations or agencies have the special qualifications, interests and other abilities, including the ability and willingness to devote the necessary time to the work of this task force.

TERMS OF APPOINTMENT
Until the mandate is complete.

APPOINTMENT PROCESS
By approval of the covering report and this Terms of Reference by ETC.

ELECTION OF CHAIR AND VICE-CHAIR
The Task Force shall determine the Chair and Vice-Chair.

MEETINGS
At the call of the Chair

REMUNERATION
Task Force members shall serve without remuneration.

Task Force members shall also be provided with either free parking on the Civic Square parking garage or with two free L.T.C. bus tickets while attending Task Force meetings or when conducting Task Force-related business at City Hall.

STAFF AND SUPPORT SERVICES
Meetings shall be attended by appointed staff representatives in an advisory non-voting capacity.

The day-to-day co-ordination of support services, including the preparation of agendas, reports and meeting schedules will be provided by the City Clerk's Department.

Task Force meeting reports will be provided to the Environment and Transportation Committee and the Advisory Committee on the Environment.

The allocation of financial resources to the individual Task Force shall be considered by the Municipal Council during its annual current budget process and shall be based on request of the Task Force.