TORONTO

Energy Efficiency and Beyond

Toronto's Sustainable Energy Plan

Staff Background Report

Energy Efficiency Office,
Business & Strategic Innovation,
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June 2007

ENERGY EFFICIENCY AND BEYOND

Staff Background Report on Toronto's Sustainable Energy Plan

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1. Executive Summary

In June 2006, Council directed staff to develop a plan that addressed energy in Toronto on a short (to 2010), medium (to 2015) and long (to 2030) time frame. Toronto's Sustainable Energy Plan was prepared by city staff and professional consultants with the input of stakeholders from the public, energy industry experts, and the staff of City divisions, agencies, boards and commissions. Based on this consultation, the following vision, goals, objectives and strategies have been developed for the Plan.

Vision:

Toronto will become a world leader in the sustainable use of energy from local, clean and renewable sources. It will strive to achieve energy self-sufficiency.

Goals:

To ensure that Toronto's energy supply becomes and remains environmentally sustainable, safe, secure and affordable.

Objectives:

- Maximize energy efficiency in Toronto's buildings and infrastructure
- Become a leader in renewable and clean energy sources
- Develop local sources of energy generation and distribution
- Turn Toronto's sustainable energy advantage into an economic advantage

Strategic Framework:

The City will achieve its objectives by:

- Developing and delivering effective programs throughout the City
- Securing the resources necessary to deliver its programs
- Demonstrating leadership through making City facilities models of energy use and generation
- Developing partnerships with building owners and managers, energy providers, businesses, unions, not-for-profit agencies, community members and others
- Identifying and addressing barriers to achieving its objectives, along with its partners
- Coordinating its work with its partners and others
- Setting targets
- Benchmarking, monitoring and reporting regularly on its progress in meeting those targets.

Toronto's Sustainable Energy Plan and Other City Goals

Achieving energy sustainability is an essential element in meeting the City's goals regarding climate change and improved air quality. Energy sustainability will also assist in ensuring a reliable supply of energy, in reducing long-term energy costs, and in reducing the outflow of energy dollars from the local economy. Programs that improve the energy efficiency of our existing building stock, such as Toronto's high-rise residential buildings, can also help to leverage additional benefits, including increased recycling and water efficiency. Ensuring that new buildings such as office towers are constructed to be as energy-efficient as possible can increase building value, improve indoor air quality, and increase employee productivity.

Currently Toronto's energy mix is dominated by natural gas, accounting for 63% of all the energy used (except for transportation) in Toronto while local renewable energy resources provide only 0.6%. In 2005 Toronto spent nearly $4.5 billion dollars on energy or nearly $1,800 per capita. Much of this was lost to the local economy.

Toronto's Sustainable Energy Plan envisions that by 2030 Toronto's energy consumption has been reduced by 21% (31% on a per capita basis). The plan anticipates that local renewable energy resources, while only accounting for 5% of the total energy supply, are on a solid footing by 2030 and will have the local capacity to contribute dramatically more to the energy supply in the period of 2030 to 2050.

The City has a long history of leadership in the area of energy sustainability. For example, the Better Buildings Partnership (BBP), recently mentioned in a speech by former US President Bill Clinton, has been achieving energy savings for over 15 years. Exhibition Place is home to a wide range of renewable energy technologies, including Canada's largest solar photovoltaic installation and North America's first urban wind turbine. Numerous other initiatives that support energy sustainability have been implemented in a wide range of City divisions, agencies, boards and commissions.

The City's energy sustainability efforts have been closely linked to its efforts to reduce greenhouse gas emissions and other pollutants. In keeping with these efforts, Toronto's Sustainable Energy Plan was developed in cooperation with the Climate Change and Clean Air Action Plan. The implementation of the Plan will require continued cooperation among a number of City divisions, agencies, boards and commissions on initiatives such as the Renewable Energy Action Plan, the ongoing development of the Green Development Standard, programs offered by Public Health, and the Green Economic Sector Development Strategy.

Summary of Recommendations

Toronto's Sustainable Energy Plan contains eighteen detailed recommendations related to City policies, coordination of energy programs with other orders of government, and the development of pilot programs and these are summarized in Appendix C. Key elements of the plan are detailed below.

Investing in Energy Sustainability in the Community

Toronto's Sustainable Energy Plan recommends $84 million in new capital spending for programs to improve energy efficiency and support the generation of renewable energy. Half of this amount ($42 million) will be set aside for the Toronto Energy Conservation Fund (TECF), a revolving loan fund for facilities in the Municipal, University/College, School, and Hospital (MUSH) sector, and the not-for-profit sector. Another $20 million is recommended for a Toronto Green Energy Fund, a revolving loan fund to promote the generation of renewable energy in the community. A program for energy retrofits for the low-rise residential sector and other sectors (e.g. small businesses) will be the subject of further reports from City staff.

To date, financial assistance from the City for energy savings projects has largely focused on the City's own facilities and on buildings in the MUSH and not-for-profit sectors. This has been due in part to concerns about longstanding provincial restrictions against providing financial incentives to private, for-profit businesses. This Plan recommends that staff report on whether or not the City could extend financial assistance to the private sector under the provisions of the *City of Toronto Act, 2006.*

The second revolving fund recommended in this report, the Toronto Green Energy Fund, deals with renewable energy. Shifting away from the use of fossil fuels requires that the City provide support to the generation of sustainable energy. There is a wide range of potential renewable energy technologies that the City could assist. A common barrier to these technologies is their high up-front cost. Financing support for early adopters of renewable energy would help move these technologies closer to greater market acceptance, and would also help to position Toronto as a world leader in renewable energy. Financing programs of this type are common in cities in both Europe and the US.

The Toronto Sustainable Energy Plan complements the City's efforts to reduce electricity demand by 90 megawatts by 2010 through its Memorandum of Understanding with the Ontario Power Authority (OPA). The Energy Efficiency Office, which is managing the 90 MW program, will develop partnerships with the high rise residential sector (existing rental and condominium buildings), the MUSH sector, and developers of new buildings, to help reach this target. This program will offer building owners in these sectors an incentive payment from the OPA for electricity savings. The OPA is also offering incentives to businesses and homeowners through other partnership agreements with the Building Owners' and Managers' Association and Toronto Hydro.

A comprehensive list of all of the support programs available for energy initiatives in Toronto can be found in the consultants' report - *Background Report on the Energy Plan for Toronto*.

Investing in Energy Sustainability in City Facilities - City Hall and Nathan Phillips Square

The remaining $22 million of the $84 million in new spending is recommended for the first phase of a plan to make City Hall a sustainability showcase, including the sustainability elements of a revitalized Nathan Philips Square (total - $13 million), and for connecting City Hall, Police Headquarters and Union Station to Enwave's Deep Lake Water Cooling system (total - $9 million).

In response to the Roundtable on the Environment's direction to make Toronto City Hall a showcase for energy efficiency and sustainability, Toronto Hydro Energy Services Inc. was hired in the fall of 2006 to conduct a study of all potential energy efficiency opportunities in the building including the use of renewable energy technologies. The executive summary appears as an attachment to the Climate Change, Clean Air and Sustainable Energy Action Plan.

Investing in Energy Sustainability in City Facilities – Deep Lake Water Cooling

As a clean and renewable energy resource, Deep Lake Water Cooling (DLWC) would enable the City to substantially reduce its demand for electricity in buildings. The reduction in electricity use translates into a 75 percent reduction in greenhouse gas emissions as compared to conventional chillers.

Metro Hall was recently converted to DLWC and it is now recommended that City Hall, Police Headquarters and Union Station be converted from conventional cooling systems to the DLWC system.

Operating costs for a DLWC system are lower than a conventional system and on a net present value basis the capital costs involved in moving to a DLWC system are also lower than staying with a conventional system.

Community Energy Planning

The City uses a neighbourhood-based approach to land use planning. We need to begin planning our energy systems on the same basis. When we look at energy issues on a building-by-building level, we can miss significant opportunities to make our energy use more sustainable. At the same time, a macro-level energy system (large, centralized energy generation along with an extensive transmission and distribution network), which is how energy has historically been dealt with in Ontario, does not lend itself to local energy planning.

This report recommends that the City begin a long-term process of moving towards an energy system that encourages local, clean and renewable energy generation; pursues community-based solutions to energy efficiency challenges, and is integrated with other City planning processes.

Renewable Energy in Toronto

Toronto has huge renewable energy resources that have generally been left untapped. Local renewable energy sources currently supplies less than 0.6% of Toronto's energy needs with the major sources being Deep Lake Water Cooling and energy produced from capturing methane released in the waste streams. This plan recommends a number of early actions, and longer-term suggestions, that can quickly make Toronto Canada's renewable energy leader.

Monitoring and Reporting

Toronto's Sustainable Energy Plan also recognizes that, if we are to succeed in meeting our energy targets, we must monitor and report on our progress. This will be done in part through the provisions of the *Energy Conservation Leadership Act*, which will require municipalities and other public institutions to prepare and submit an energy plan each year. Monitoring and reporting practices are another area in which the City's divisions, agencies, boards and commissions should continue to work together.

2. Introduction

The world's population is becoming increasingly urbanized. Over 80% of Canadians now live in cities. With over 50% of Canada's energy consumed in cities, energy is increasingly becoming an urban issue.

Toronto is Canada's largest city and sixth largest government, and home to a diverse population of more than 2.6 million people. Toronto's electricity consumption is greater than New Brunswick, Saskatchewan, Nova Scotia or PEI. It consumes almost 20% of Ontario's electrical power.

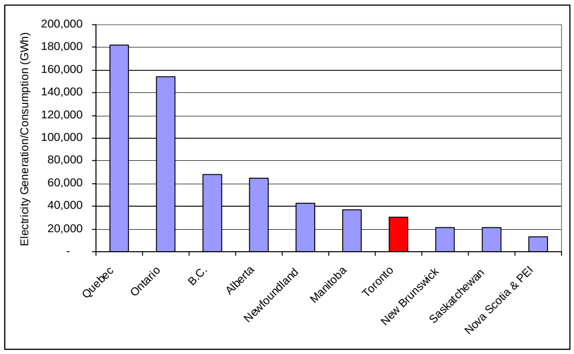
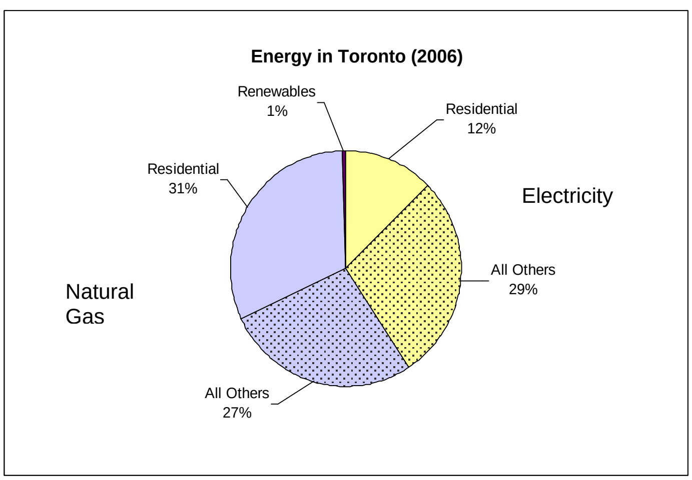


Figure 1: Electricity Generation/Consumption in Canada

Toronto uses over of 72,000,000,000 equivalent kilowatt-hours (ekWh)[a] of energy annually from all sources including electricity and natural gas each year. This energy is consumed in buildings, industrial processes, and the city infrastructure (such as street lighting). We also consume energy in our transportation systems and in the manufacturing of the goods and products we consume.[b]



	Building Type	Energy	
		(GWh/yr)	(%)
Electricity	Residential	9,035	12%
	All Other	20,843	29%
Natural Gas	Residential	22,780	31%
	All Other	19,877	27%
Renewable Energy		466	1%
		73,001	

Figure 2: Energy Consumption in Toronto

[a] "ekWh" is a term meaning "equivalent kilowatt hour" that is used to give comparative values for thermal and electric energy, converting conventional thermal units such as British Thermal Units (BTU) or Mega Joules (MJ) into kilowatt-hours (kWh), the unit of measure commonly used with electricity. 1 kWh = 3412 BTU.

[b] The energy used in the manufacturing of products and goods is often referred to as "embedded energy." Embedded energy of products used but not made in Toronto is not included in the energy totals.

We consume the equivalent of almost 30,000 kilowatt-hours (ekWh) for each city resident – the same amount of energy as if each Torontonian were to leave on thirty-three 100-watt light bulbs 24 hours a day, 365 days a year.

Access to affordable, safe and reliable sources of energy is a critical element in making Toronto's quality of life one of the best in the world. Energy is used to heat and cool the buildings we live, work and play in; it is used to drive the industrial and commercial processes that generate Toronto's wealth; it lets us move goods and people and brings food into our city, and it runs our critical infrastructure needs such as our supply of clean water.

Energy is a critical part of our daily lives. However, Toronto is facing growing energy challenges. Rising energy costs, growing demand for energy, higher peak energy demand due to changing weather conditions, aging energy infrastructures and the increasing impact of our energy choices on the environment - both locally and globally – are just some of the challenges we face.

Toronto also faces risks to our current quality of life from climate change impacts. These will range from greater energy use in the summer that can cause energy brownouts or revolving power cuts, heat waves that will affect the poor, the sick and the elderly the most, and extreme storms leading to transmission failures, power blackouts and death. These risks are real and potentially costly for Toronto's infrastructure, our health and the local economy. They are risks that we face now, but they will grow significantly during the lifetime of our children.

All these challenges are driving Toronto's need to better plan how we generate, use and manage energy.

Torontonians already know there is a need to deal with energy differently than in the past. Many Toronto businesses and households are already taking steps to incorporate energy-wise features into their operations and lives – and realizing financial savings from their actions. Some are already looking at new energy sources that provide cleaner and more local power.

Toronto's Sustainable Energy Plan is a detailed analysis of how our city uses energy. It will help the city government and other stakeholders to plan strategically for the future. This document provides a strategic framework for Toronto's Sustainable Energy Plan that deals comprehensively with the energy challenges that we face.

3. Developing Toronto's Sustainable Energy Plan

Throughout the development of Toronto's Sustainable Energy Plan, the message from stakeholders, both inside City government and in the community, was very clear. There is a need for action. The City cannot afford to produce a report that, once completed, is seldom referred to again. It must have specific recommendations for concrete actions that the City government can implement now that will begin to resolve the city's energy challenges, and help change the way energy is dealt with in the City.

Toronto has a tremendous resource in its people and the knowledge they possess. This resource, if unleashed, can make Toronto a global leader in developing innovative energy solutions that can resolve the environmental and energy challenges that cities around the globe face and provide an engine for future economic prosperity in Toronto.

This resource was tapped in the development of this plan. Staff received significant input from the community during the process of its development. Numerous suggestions were made on how Toronto could overcome the energy challenges it is facing. In categorizing these recommendations a number of themes became apparent:

- **High Level** – These recommendations focus on how Toronto and its citizens deal with energy issues – these are the strategic directions that guide us to a sustainable future.
- **Preparing for the Future** – While these recommendations may not have an immediate impact on Toronto's energy patterns they were felt to be crucial in laying the groundwork for building a sustainable energy future in Toronto.
- **Leading by Example** – Toronto's city government leadership on energy issues is pivotal to moving us to a sustainable energy future. Leading by example is one of the most effective methods of showing Torontonians the path forward.
- **Energy in the Community** – These recommendations outline how the city government can assist the various communities in Toronto deal with energy issues.
- **Early Actions** – Early opportunities that can lead to immediate successes are crucial in moving us towards a sustainable future. These recommendations explore new ways of dealing with energy challenges we face.

Many recommendations were felt to have merit; however, with limited resources in the City government, the recommendations were further categorized as:

- **Immediate Recommendations** – These were considered to be the priority actions that needed approval by council immediately. These are highlighted and boxed separate to the text. *Example*
- **Suggestions for Action** – These were considered to be important ideas or opportunities that the city and other stakeholders may wish to consider. A number of important recommendations were downgraded to "suggestions" to prevent "action overload" in the first stages of implementation of the plan. *Example*

Energy Sustainability – A Vision for Toronto's Energy Future

When considering the cities that are global leaders in developing a sustainable future it is very clear that their planning processes share a clear vision. For example, the City of Copenhagen is aiming to be fossil fuel-free by 2020, and has set a goal to cut its greenhouse gas emissions by 80 percent. This vision has focused their actions, and has helped drive their success in becoming one of the most energy efficient and innovative cities globally. The average Dane uses 64% less energy that the average Canadian.

Toronto's Sustainable Energy Plan needs not only to recommend immediate actions but also must be visionary. Goals must be clearly articulated, targets must be based on realistic projections of current and future capacity, actions must have clear paths forward and successes must be measurable and transparent. The Energy Plan can play a pivotal role for all Torontonians - it can give businesses a clear direction which they can base their plans around, it can motivate citizens to work together in developing local energy solutions for their communities, and it can provide a clear course for City Council and staff.

It is very apparent, particularly with the enormity of the task facing us in reducing climate change, that there is a need to change our thinking about energy. The term sustainability[c] has one of its roots in self-sufficiency – providing for one's own needs by the endeavours of one's own hands – and only taking what can be replenished.

It was not too long ago that Toronto's energy use was self-sufficient and sustainable. The water mills along the Don that powered local saw and grain mills, the wind mills that pumped water from the ground, the wood stoves with which each family heated their homes, and the blocks of ice that were cut from Toronto Harbour to keep food cold through the summer are all examples of local energy self-sufficiency and sustainability.

There is an energy revolution happening today around the globe. While it has partially bypassed Canada due to our bountiful supply of conventional energy resources, Europe, Japan and China are all seeing a trend towards more local energy solutions. Only now are we in North America beginning to awaken to the opportunities and advantages of this new energy model. Cities, being the main centres of energy use, have a major role to play in moving society to this new energy future.

Buildings are now being constructed that produce all of their own energy. Two "net zero" homes are currently being built in Toronto with support from CMHC. The first zero energy high-rise office building is now being built in China. The community development of BedZED in London England and the municipality of Malmo, Sweden are approaching energy self-sufficiency.

Toronto has an abundance of local energy resources – although largely untapped and still costly using conventional accounting methods. We have options to our current energy supply.

Toronto has the ability to be energy self-sufficient and use energy in a sustainable manner – as it did when it was founded. While it is beyond the scope of this plan to project when this can occur, it must certainly occur within the lifetime of our youngest citizens if we are to escape the worst of the ravages of climate change.

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[c] An oft-quoted definition of sustainable development is "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" From Our Common Future (the Brundtland Report); UN World Commission on Environment and Development; 1987

Starting with an overarching objective of energy sustainability and self-sufficiency provides us a framework with in to assess energy options and city decision-making.

Thus the vision of Toronto's Sustainable Energy Plan is that Toronto will work to become energy self-sufficient and sustainable.

Toronto's Energy Vision

Toronto will become a world leader in the sustainable use of energy from local, clean and renewable sources. It will strive to achieve energy self-sufficiency.

Toronto's Energy Goals:

To ensure that Toronto's energy supply becomes and remains environmentally sustainable, safe, secure and affordable.

Toronto's Energy Objectives:

- Maximize energy efficiency in Toronto's buildings and infrastructure
- Become a leader in renewable and clean energy sources
- Develop local sources of energy generation and distribution
- Turn Toronto's sustainable energy advantage into an economic advantage

Toronto's Strategic Energy Framework:

The City will achieve its objectives by:

- Developing and delivering effective programs throughout the City
- Securing the resources necessary to deliver its programs
- Demonstrating leadership through making City facilities models of energy use and generation
- Developing partnerships with building owners and managers, energy providers, businesses, unions, not-for-profit agencies, community members and others
- Identifying and addressing barriers to achieving its objectives, along with its partners
- Coordinating its work with its partners and others
- Setting targets
- Benchmarking, monitoring and reporting regularly on our progress in meeting those targets.

Setting the Planning Framework for Toronto's Energy Self Sufficiency

The direction provided by City Council in June 2006 on the development of the Energy Plan for Toronto was specific:

"To adopt a "conservation first" energy strategy that positions conservation and demand management as the preferred first action with renewable energy being the next highest priority to meet the energy needs of the City of Toronto's Divisions, Agencies, Boards, Commissions, and Corporations and the city as a whole."[1]

Council has articulated, in a very fundamental form, a sequential energy problem-solving methodology that has become very popular globally. Often called the "California Loading

Order" or, more commonly, "Trias Energetica" (borrowed from the famous Trias Politica of Montesquieu) it is a simple and logical planning approach that helps to achieve significant energy savings, reduces the dependence on non-renewable energy sources, and helps reduce environmental impacts that can be applied to a wide range of planning processes.

The basis of Trias Energetica is the integration into all planning processes of the following three review steps:

- **Step 1:** Have all reasonable measures been taken to maximize the energy and water efficiency in buildings, industry and infrastructure and to shift energy use to low consumption periods?
- **Step 2:** Have all reasonable measures been taken to maximize the efficient use of fossil fuels including combined heat and power solutions?
- **Step 3:** Have all reasonable measures been taken to incorporate renewable energy sources or to insure that they can be incorporated in the future?

Only when each step has been fully satisfied is the review process moved to the next step.

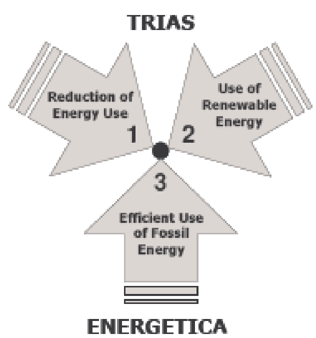

Figure 3: The 3 Actions in Trias Energetica

While providing a simple directive may sound inconsequential, it has huge implications, as it creates a review process for an issue which has rarely been considered in the past – namely that, as energy is now so interwoven into the fabric of our society, many decisions we make unknowingly have long lasting energy implications.

California achieved zero growth in electricity consumption over the last 30 years, and saved individuals and businesses in the state $56 billion US by adopting the "California Loading Order" for all state planning decisions.[2] It is unlikely that the multinational firm, Dupont, would have reduced its energy consumption in 2006 to 6% below 1990 levels (while growing 30% during the same time frame) and saved $3 billion US[3] in energy costs without its managers applying the integrated Trias Energetica approach to the firm's energy productivity plans.

Suggestion for Action

Toronto should consider how it can follow the leadership taken in other jurisdictions and integrate a methodology such as Trias Energetica into all decision-making processes. This is one of the first steps in moving Toronto towards a sustainable energy future.

Development of the Energy Plan

The City has a long history of involvement in energy issues, which was drawn on in preparing this document. In addition, there are significant resources available both federally (particularly from Natural Resources Canada[4]) and internationally.

Much was learned from the development of energy plans in other municipalities. In particular, the energy planning processes in Guelph, Dawson Creek (BC), London (England), and Chicago were referenced in the plan's development. Municipal staff from each of these communities provided valuable insight into the processes and challenges that they dealt with in developing their visions of a sustainable energy future for their community.

To understand Toronto's energy challenges there was an obvious need to analyze certain issues in greater detail. The consulting firm, PricewaterhouseCoopers LLP (PwC), was retained for this purpose. Their background report is attached to the Climate Change, Clean Air and Sustainable Energy Action Plan.

The key sections of Toronto's Sustainable Energy Plan follow the standard methodology for community energy planning:

Background

- **The Current State of Energy Use in Toronto –** Understanding the key issues that underlie the use of energy in Toronto is critical in developing any long-term energy plan. This element appears in the PwC report.
- **Energy Challenges –** During the development of the plan there were a significant number of energy issues or "challenges" identified. Some of these were well known – others became apparent as issues were explored in more depth.

Energy in the City

Energy issues can be evaluated in a number of different ways: whether they are electrical or thermal in nature; by building sector; or by the type of application such as air conditioning or space heating. There is no single preferred path to evaluate energy issues and options. However, it became clear during the development of the plan that many Toronto stakeholders preferred to characterize energy issues in a specific way.

- **Energy in Buildings** – A "one building at a time" approach allows opportunities to be identified that are unique to specific building type. This section includes forecasting of energy need in the built environment. This element is addressed in the background report by PwC.
- **Energy Systems in the Community** – How energy issues interact, issues affecting energy infrastructure in Toronto, and energy in the community are covered in this section.
- **The Opportunity of Renewable Energy –** Renewable energy technologies should be integrated into the built environment and community. However, most stakeholders felt that the low level of renewable energy currently being used in Toronto (and Canada) compared to international norms created the need for renewables to be addressed separately so that a focus on renewable energy issues would more clearly identify actions needed.

- **The Role of City Government –** Stakeholders made the need for city government leadership on local energy issues very clear. This section outlines the various roles that City Hall should play.
- **The State of Toronto's Energy in 2030 –** Finally, it was very clear that if Toronto's Sustainable Energy Plan is to succeed, it will need long-term goals and benchmarks that can measure its successes.

4. Turning Energy Challenges into Energy Opportunities

During the development of this plan both challenges and opportunities were identified. Turning those challenges into opportunities soon became a theme of the energy plan. The more challenges that were uncovered the more staff searched out how these challenges could actually benefit Torontonians.

If Toronto's government is smart and willing to be innovative, if Toronto's business community can seize the opportunities, and if Toronto's residents can commit to work together to overcome the challenges, then these energy challenges can be turned into opportunities.

4.1 Toronto's Current Energy Use

Canadians use more energy than most other major nations. It is estimated that 50% of our oil and gas and 75% of our electricity is wasted.[5]

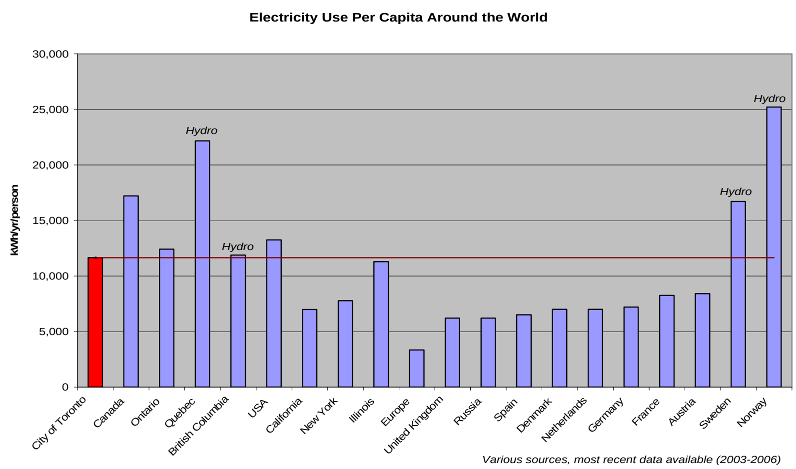

Figure 4: Electricity Use Per Capita Around the World

National level comparisons include energy used in transportation and the natural resource industries. This could be used to support the argument that Canada's energy use is greater due to the size of our country and the energy used in our industries. However, if we consider the energy used by cities globally, the same trend of greater use of energy in Canada can be seen.

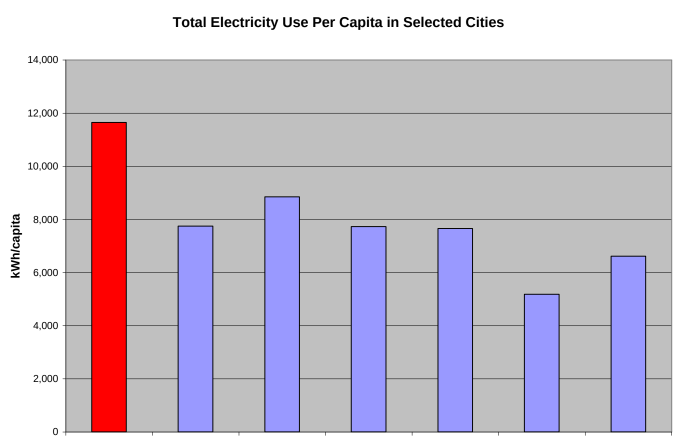

Figure 5: Electricity Use per Capita in Selected Cities

Torontonians – both the public and City officials - are not generally aware of the tremendous potential for conservation and renewable energy that exists. In the last 10 years an energy revolution has been sweeping many industrialized countries outside of North America. North America and Toronto lag far behind in being innovators on energy issues.

Suggestion for Action

Toronto needs to focus on increasing its knowledge of what can be done to improve our efficient use of energy and renewable energy and how this is being done elsewhere.

4.2 The Challenge of Our Energy Costs

Toronto spends over $4.45 billion dollars a year on energy, little of which stays in the local economy. Further, Ontario has only a small amount of natural gas resources and we are considering importing more electricity. Energy dollars drain out of Toronto and out of Ontario and this trend is increasing.

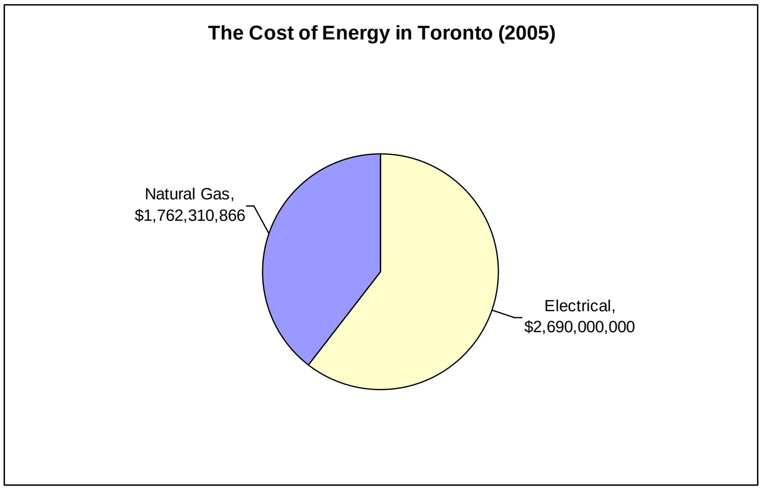

Figure 6: The Cost of Energy in Toronto (2005)

Energy import displacement by increasing our energy efficiency, reducing our energy use and using local, renewable energy sources can provide sizeable benefits to Toronto's economy through direct job creation, increased tax revenues and retention of currency for local spending and investments.

Suggestion for Action

Toronto should know where its energy dollars flow and how many are retained in the local economy. This would provide an important benchmark to understand and monitor the financial impact of energy decisions.

While current energy costs are considered high by historical standards, if they are placed in international perspective we begin to appreciate how fortunate we are in Canada (Figure 7). However, our inexpensive energy has helped lead us to the situation we are in today – wasting most of our energy and damaging our environment.

A focus on simply the unit price of energy (i.e. $/kWh) does not address the real concern of homeowners and businesses. Their concern is the cost to provide energy services. How much does it cost to heat my home? How much does it cost to produce my goods? Energy cost is the price of energy ($/kWh) multiplied by the amount of energy used (kWh). Toronto can mitigate energy price increases by decreasing its energy usage through energy efficiency, energy use reductions and local energy production.

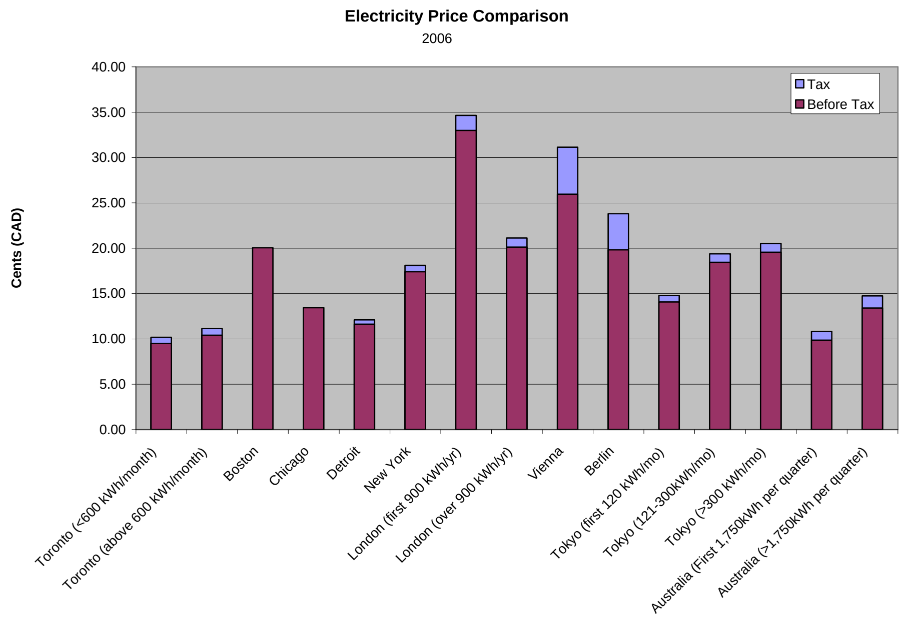

Figure 7: Electricity Price Comparisons (2006)

4.3 The Challenge of A Changing Climate

Toronto's climate is changing – it has been since the start of data collection in the 1870s. Toronto has seen an average increase of 2°C over the last 140 years.

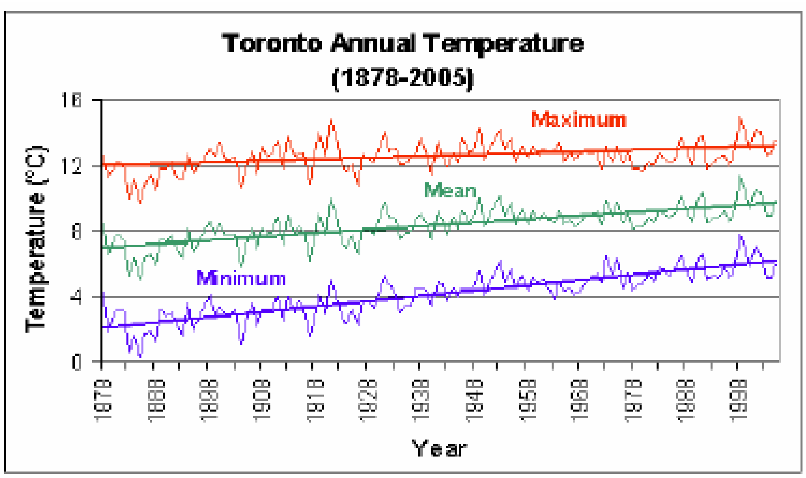

Figure 8: Toronto's Annual Temperature (1878-2005)[6]

Climate change will accelerate this temperature increase. A further 2°C increase is projected in the next 30 years alone. The number of days that Toronto experiences temperatures above 30°C is expected to grow from an average of 17 days per year in the period of 1961-1990 to 38 days per year by the 2050s.

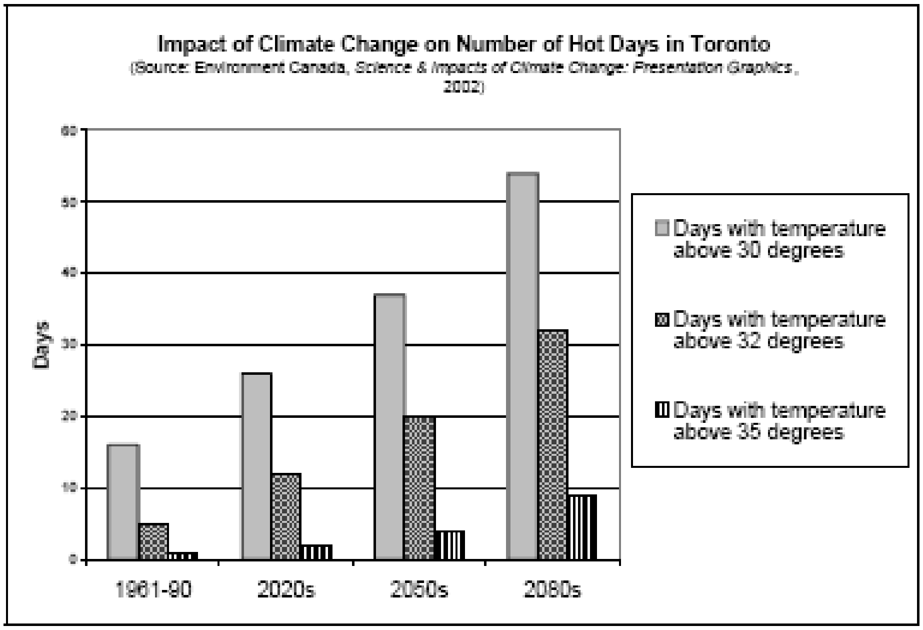

Figure 9: Impact of Climate Change on Number of Hot Days in Toronto[7]

While a 2^{o}C temperature change does not seem significant, it creates huge environmental impacts that are beyond the scope of this report. For energy use in Toronto it has implications:

- Demand for thermal energy to heat our buildings will go down – this will impact our use of natural gas
- Demand for electricity energy to cool our building will go up – this will impact our use of electricity.

While the efficiency of natural gas networks is unaffected by temperature conditions, the efficiency of District Energy Systems will generally improve in more moderate climates.

However, for electrical systems the efficiency of the transmission and distribution system is very dependent on the air temperature. As air temperatures increase, transmission systems are able to carry less energy and transformers become less efficient in converting high transmission voltages to the voltage levels needed to run Toronto's homes and businesses.

Suggestion for Action

Toronto and other jurisdictions should begin to develop energy models that take into account climate change impacts. In reviewing this issue it was found that there is little modeling being done in Canada on energy infrastructure or usage patterns due to climate change.

Toronto is moving from a climate of warm summers and cold winters to a climate more associated with the Mediterranean, California or the south-eastern US with hot summers and mild winters. However, Toronto’s buildings are not designed for this new climate – they tend to keep the heat *in* rather than keeping it *out*. The demand for air conditioning is expected to increase.

Suggestion for Action

Toronto needs to begin encouraging building designers, architects and builders to start building homes and buildings that take into account the warming climate – this can reduce Toronto’s need for air conditioning in the future.

4.4 The Challenge of the Urban Heat Island Effect

Urban areas have average temperatures 3-5 ^{o}C higher than surrounding regions. This is known as the Urban Heat Island Effect (UHIE). As every single degree Celsius increase in temperature results in a 5 percent increase in smog formation, cooling the ambient temperature has profound effects on air quality and health. Health and productivity also improve with reductions in rates of heat exhaustion and heat stroke.

The “Cool Cities” program by the International Council for Local Environmental Initiatives aims at reducing the heat island effect by the use of lighter-coloured paving and roofing, green roofs, and extensive tree planting.

Reducing the Urban Heat Island Effect also has profound impacts on energy use. While planting trees will not immediately reduce electrical demand, 3 mature trees around the average home reduces air conditioning demand by 25-40%. Tree planting today can have a dramatic impact on electrical demand in the summers of the future. Toronto’s Green Roof Initiative addresses one mechanism to combat urban heating.

4.5 The Challenge of Air Conditioners in Toronto

In general, electricity demand drops as temperatures increase – less energy is needed to run furnaces and other heating loads, and warmer weather implies longer hours of sunlight so our lights are on less and Torontonians are out and about more often. However, this demand for energy takes a dramatic turn upwards as air conditioners begin to be turned on.

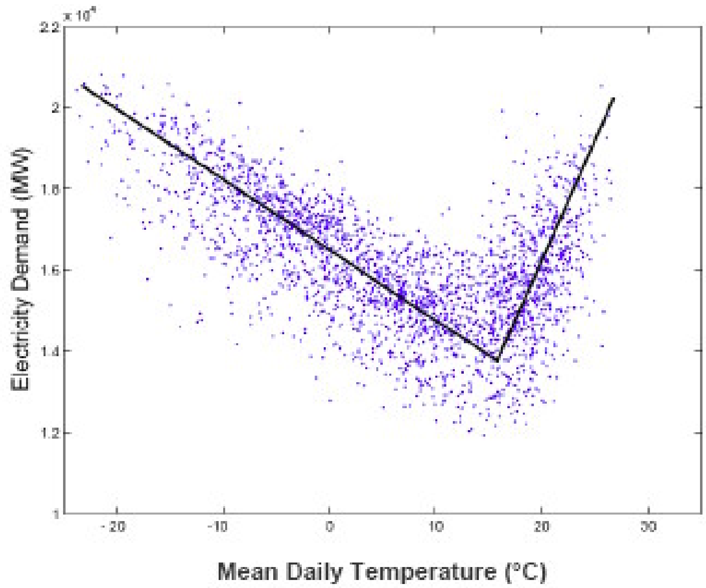

Figure 10: Electricity Demand vs. Air Temperature in Toronto[8]

Toronto is experiencing a rapid growth in demand for residential air conditioning. This is being driven by a number of factors:

- Toronto's climate is warming up due to climate change and the urban heat island effect
- Our buildings are not designed to reduce cooling loads
- Our aging population is more impacted by hot weather, creating a greater need for air conditioning
- Electricity prices are relatively low so the cost of operating an air conditioner is not a major issue for many

Already in Ontario the residential energy load is dominated by air conditioning. On the hot days of summer when our electricity system demand peaks, residential air conditioning is the source of over 50% of demand in the average Toronto home (Figure 11).

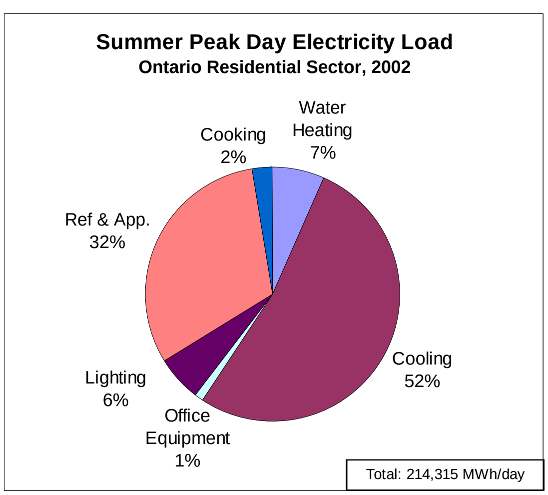

Figure 11: Summer Peak Day Electricity Load (Residential Sector)

Air conditioning creates significant summer peak electrical requirements for a relatively short time period, driving high levels of investment for the electrical utility. There are huge opportunities to reduce air conditioning load; however, we in Toronto are not accustomed to dealing with this energy issue. We must look to jurisdictions in more southerly climates to see how they have dealt with the summer cooling load.

Air-conditioning loads are a serious issue in Ontario as we have more central air conditioners per household than other Canadian provinces and the US states that neighbour us.[9]

While central air conditioners are more efficient than wall or window mounted units, they consume more energy as they condition the entire house, while a window unit can provide cooling for a single room (such as a bedroom).

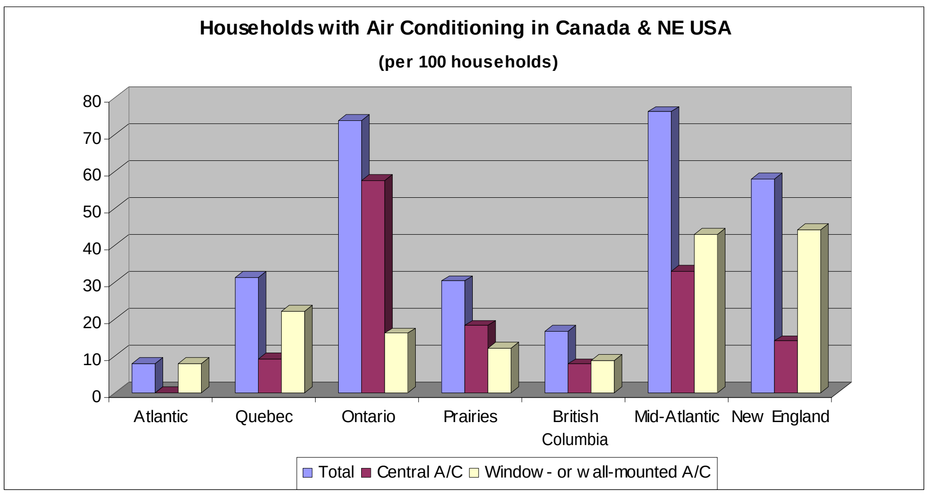

Figure 12: Households with Air Conditioning

Suggestion for Action

Toronto should develop an overall cooling strategy that addresses our changing climate, the urban heat island effect, the changing energy needs of our buildings and our huge use of air conditioners.

4.6 Toronto's Built Environment

Toronto's buildings typically last 60–80 years before major renewal needs to occur. As most of Toronto's buildings were built in the 1970s or later, this means that most of Toronto's building infrastructure will not normally need renewal until after 2030. In the consultant's *Background Report on the Energy Plan for Toronto* it is assumed that almost 90% of the buildings in existence in 2030 will have been built by 2007.

While there are huge opportunities to affect the energy efficiency of new buildings, the greatest challenge will be to incorporate energy savings in the current building stock.

Suggestion for Action

Toronto's new buildings need to be models for what is possible in energy efficiency, in order to help owners of existing buildings learn how to integrate these features.

4.7 Smart Metering & Energy Monitoring

The Ontario government has announced it intends to have all electricity meters converted to "smart meters."

A "smart meter" is an advanced electronic meter that records energy usage on an hourly basis. Smart meters are a necessary part of introducing time of day billing as it provides interval data, which allows utilities to charge for electricity at different rates through the day.

Many households in apartments pay their energy costs as a portion of their monthly rental fees – they are unaware of their energy usage and do not bear any financial responsibility. It is well accepted that downloading the cost of energy to the consumer will result in immediate energy savings. The detailed information captured by the Smart Meter can become an invaluable tool to evaluate energy consumption patters and can assist the consumer in managing their electricity costs. However, the current initiative is focused on financial billing and not the consumer monitoring of the energy they use.

Building energy monitoring is at a very rudimentary level in Ontario. A typical car has more performance monitoring than a typical house, yet it costs a fraction as much. Homeowners have little understanding of the energy flows in their homes and have limited tools to give them detailed information. Energy bills provide information on energy used in the past – not currently. What good would a car's gas gauge be if it only told its driver how much gas it had yesterday?

Advanced energy monitors that provide feedback and control are critical in reducing energy usage in buildings and are a key mitigation recommendation in the International Panel on Climate Change Fourth Assessment Report.[10]

Advanced energy monitors increase consumer energy awareness by providing real-time electricity usage in kW, kWh and dollars per hour. In addition many can show the GHG emissions in kg/hour. Advanced monitors act like an 'electricity speedometer' in the home, building awareness of electricity cost on a real-time basis.

These building energy monitors are already popular in Europe and Japan and are starting to become available in Canada. A number of leading municipalities such as Ottawa are already partnering with suppliers to pilot the use of advanced energy monitors in their jurisdiction. While advanced energy monitors can cost $1,000 and provide full house control including monitoring furnace performance, duty-cycling refrigerators and water heaters, basic units that provide instantaneous and cumulative energy readings cost under $200 and can be installed by the average consumer.

Suggestion for Action

The Energy Efficiency Office should begin to test the use of advanced energy monitors in the single-family residential sector in Toronto. This can be integrated into the various programs in the community that the EEO is already involved in.

4.8 Energy Performance Labelling of Buildings

Clear, reliable information about the energy performance of dwellings is crucial to guide policy and push the market towards more efficient homes and building. Information on energy use can be reported to householders through a variety of means, including energy bills and advanced energy monitors. Building energy labelling which is included in real estate listings has proven to be a successful technique in stimulating energy improvements in the market place.

All EU member states are now required to have a methodology in place for providing information on the energy performance of all buildings when they are built, sold or rented, as set out in the Energy Performance of Buildings Directive (EPBD).

When a house is sold in Europe the energy rating of the building is now required to be included in the House Information Package that provides potential buyers information on the home. Potential owners can evaluate and compare the relative energy performance (and cost) of the home they are considering purchasing – much as they can compare house prices and other important features.

In Canada the discontinued federal Energuide for Homes program had developed a very rudimentary house energy rating system using a scale of from 0 (least efficient) to 100 (most efficient) that provided a method to qualify for federal support for energy efficiency improvements.

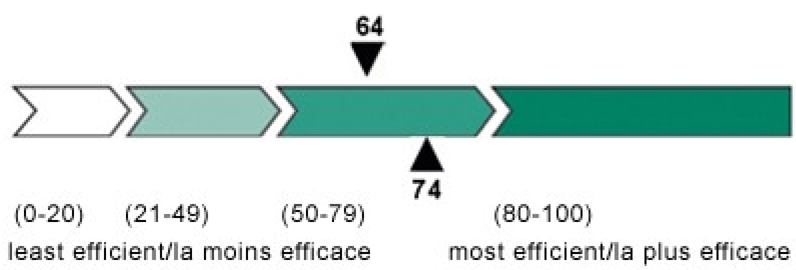

Figure 13: EnerGuide for Homes Energy Rating

Both the federal and provincial government are in the process of engaging local stakeholders to develop and pilot an energy performance labelling system for residential buildings. In discussions with various stakeholders in the building and real estate sectors in Toronto there was interest in working collaboratively in introducing a voluntary energy performance labelling system in Toronto that conforms to national and international standards.

While environmental or "green" labelling of buildings has significant long-term benefits there are many complex issues that are still being resolved. Further there is no firm direction on methodology or reporting practices that have been developed at the national or international levels. The initial step to green labelling of buildings is to first deal with the energy performance aspects.

Recommendation #1: Energy Performance Labelling for Toronto Homes

The City should develop a voluntary Energy Performance Labelling system in the low-rise residential section in Toronto, in conjunction with Natural Resources Canada and other partners.

5. Energy Systems in the Community

Energy planning in North America typically involves tackling separately the overall efficiency of homes, buildings, industry and the energy supply. The focus is to make improvements "one building at a time" and to deal with each energy issue separately.

This planning process can be successful in providing incremental improvements in energy efficiency at a building scale, and is covered in the Background Report to the Energy Plan. However, it can miss huge opportunities through changing the energy infrastructure of the community. Greater energy savings can be achieved due to economies of scale, while individual building projects can miss opportunities of tackling multiple issues with a single solution that might be available at a community level.

Toronto needs to have energy efficient buildings and an energy efficient community.

While it is possible to make a single building energy efficient and develop an integrated energy plan for the building, moving from the scale of one building to making Toronto as a whole energy efficient is a major step. Due to the complexity of the energy issues faced in a city of 2.6 million people, the scope of the challenge can become too much for the resources of the community and, while the vision may remain, implementation can stall.

5.1 Community Energy Zones

There is a need for an intermediate stage – working on energy issues larger than at a building scale, but smaller than at the city scale of a half million buildings. In looking at the cities that have successful sustainable energy strategies, particularly in Europe, it is very clear that their successes are due to the willingness of the community to embark on implementing multiple improvements in a focused district or part of the city during the early stage of the energy planning process. Often these improvements, done at a smaller scale, allowed the needed infrastructure changes to be funded under budgetary constraints and resulted in a successful local template that could be used to support further local district changes.

Moving to a sustainable energy future for Toronto requires an intermediate step of building sustainable communities inside the city.

For large communities, energy zoning is the first step in the preparation of an integrated municipal energy plan and is a common practice in Europe. Energy zones anticipate future changes and divide a municipality into smaller areas that have similar energy patterns. Each zone is analysed to determine scenarios for future energy needs in the zone. Combining this with knowledge of the existing and planned building types, and the timing of neighbourhood developments, the energy demands for heating, cooling, lighting and other energy needs can then be assessed and a long-term zone or community energy plan developed.

The community energy zones may often have distinct energy solutions due to the makeup of the buildings in the zone. When the various zones that make up a larger community are analysed, synergies often become apparent between adjacent zones and opportunities can be integrated into an energy master plan for the city. For example, one commercial energy zone may have excess energy that an adjacent neighbourhood energy zone can use. Communities such as Guelph[11] are already beginning to adopt this European approach to community energy planning.

5.2 Integrated Community Energy Planning

Toronto is a community of neighbourhoods. Some neighbourhoods are defined by building type, such as residential or industrial. Others are divided by physical boundaries or cultural distinctions. Dividing Toronto into community energy zones allows for energy issues to be fully integrated into the needs and desires of the local community. Once Toronto's energy zones are defined then the community energy plan can follow.

The key components of successful Integrated Community Energy Planning include:

- **Community Size –** The community should be of a size to encompass customized energy strategies as well as large scale efficiencies. This will vary depending on the project but typically would be one that would have an overall energy demand of at least of 25 MW (electrical and thermal).
- **Clear Definition of the Community -** The community needs to be clearly defined so that energy solutions can be identified and the various stakeholders engaged. A crucial aspect of the community approach is to demonstrate the many aspects of a sustainable energy future. Half- measures should not be accepted, particularly at the early stages where these communities are models for future replication.
- **Community Engagement and Leadership** - Leadership can come from many directions. But most importantly, it must come from the community – motivated commercial developers, engaged local politicians, strong community groups. Local energy solutions need to be controlled at the local level.
- **Partnerships with Energy Suppliers** - A key element of community energy planning is the role of local energy suppliers and service firms. They need to be engaged as partners in the process and have a financial stake in its success.
- **Acceptance of Innovation** - Community energy systems are still unique in North America – many of the issues have not been dealt with yet in building codes, product standards, and government policies. There must be a firm commitment at the political and staff level in the City to accept different energy supply, design guidelines and building efficiency standards than may be the norm for the rest of the city.

Toronto already has many communities that can serve as the first successful templates for Toronto's sustainable energy future. For example, areas under development can integrate district energy systems into the infrastructure from the beginning. Some of these community opportunities include:

- **High Density Urban Neighbourhoods –** Neighbourhoods that are either up for renewal (e.g. Toronto's high rise apartment neighbourhoods) or are new developments such as condo developments downtown offer unique opportunities.
- **Industrial/Commercial Parks** - Areas such as the city's Employment Lands, with a diversity of industries with diverse energy needs, have great potential.
- **Greenfield Smart Growth** - The growing trend for mixed use, aimed at reducing suburban sprawl and creating liveable communities also creates opportunities for innovative energy solutions.

- **Academic Campuses** - Toronto is fortunate in that it has a large number of academic campuses that are the centres of excellence and innovation (Centennial, George Brown, Humber, OCAD, Seneca, Sheridan, Toronto, Ryerson, and York). All have high potential to be early adopters of integrated community energy networks.

Toronto must begin to set standards for community energy usage. New development presents a large opportunity. For example, new developments could be required to show why they will not be connected to a community energy system for heating and cooling if one is available, or pay a charge to be independent.

Recommendation #2: Developing Community Energy Planning
City staff should report on a process for developing an integrated approach for community energy planning based on community energy zones.

Some of the actions that would support the development of community energy systems include:

- Supporting neighbourhood and community groups involved in community energy issues, ensuring there is a high level of local understanding, engagement, and involvement in the broader goals.
- Utilizing Toronto's universities and colleges as a focus for innovative energy solutions. They can provide education in moving towards a sustainable urban community. This can include formal curriculum, offering training around energy resource planning and management, design, construction and maintenance of energy systems and building structures, public awareness, and building the first local district energy systems.
- Involving Toronto's School Boards and other schools in Toronto, which provide a unique opportunity to educate students and the community in all aspects of energy initiatives. Schools can become hubs of local Community Energy Systems. The buildings and the property they sit on should be considered a valuable asset that should not be wasted.

5.3 District Energy Systems

A District Energy System (DES) can deliver heat (for space heating and domestic hot water) and cooling. A thermal energy network allows heat to be moved about in much the same way as electricity. It allows the redistribution of the vast amounts of heat traditionally wasted in industrial processes and in the generation of electricity, and dramatically increases energy system efficiencies.

District Energy Systems are the final link to an integrated approach to energy – tying together electrical and thermal energy issues and allowing for balancing in the energy system.

The availability of a District Energy System facilitates the connection of multiple energy sources into an efficient thermal network. Copenhagen has had a district energy system in its downtown core since 1973 that is powered by coal, natural gas, energy from waste, wood chips (bio-mass) and solar thermal sources. Mannheim, Germany has a similar district energy system which operates on the excess heat produced in an industrial park as well as natural gas, municipal waste, recycled lumber from building demolition and tree trimmings and a solar hot water system installed in its City Hall.

Toronto has a long experience with District Energy Systems, with two of Canada's largest servicing the downtown core. Enwave (formerly Toronto District Heating Corp) is Canada's largest at 276 MW, while the University of Toronto's system is the third largest (at a reported 195 MW rating).[12]

However, Toronto can do more with the potential of district energy systems in the downtown core, in community energy zones, and even at the city block level. If Toronto desires a sustainable energy future then it should begin implementing a district energy strategy for the city – one community at a time.

District Energy Systems will drive an integrated approach to energy in Toronto where buildings are seen less as energy consuming facilities than as the spine that connects energy supply units integrated through community energy systems, and contributing to overall supply through solar PV/solar thermal, cogeneration and geothermal technologies.

Suggestion for Action

District Energy Systems are an integral part of Toronto's sustainable energy future. City staff and other partners should begin a long-term process of developing a city wide thermal energy network by:

- *Creating local district heating systems that cover high-density areas of Toronto.*
- *Taking advantage of early opportunities for neighbourhood thermal energy networks.*
- *Create a long-term plan to interlink the local networks into a citywide structure.*

If we are to implement a long-term vision of district energy systems in Toronto, we must begin the process immediately. Buildings built today will have a 60 – 100 year lifespan. This will result in lost opportunities unless these buildings are prepared now for integration into District Energy Systems. The heating systems of new large buildings (commercial and residential) should be compatible with district energy systems to allow them to be connected in the future.

Suggestion for Action

Toronto should begin defining the building integration requirements for connecting buildings to future District Energy Systems and identify the policies and regulations that would make new buildings today "District Energy System Ready."

5.4 Enwave

While Enwave is Canada's largest District Energy System, it has only tapped the surface of its potential to provide solutions to Toronto's energy challenges. Presently it obtains its energy from natural gas- powered thermal plants and electric chillers that it owns, and geo-energy from deep lake water cooling.

District Energy Systems in Europe often act as utilities and local distribution companies – generating and buying energy, transmitting this energy to where a customer has need, and then selling the energy for a profit. While Enwave has the potential to be an effective tool for Toronto's plan for a sustainable energy future, it does not have all the attributes of a true local distribution company.

Enwave could be encouraged by the City to purchase renewable thermal energy from independent suppliers, which it would then transmit and sell for a profit. There are a number of policy and fiscal tools to facilitate this transformation, including:

- Setting up a thermal energy, or feed-in, tariff that would incent suppliers to sell Enwave green heat. This is similar to the OPA's Standard Offer Contract for renewable electrical generators. The Ontario government is currently studying how a thermal "standard offer" program would operate. Toronto and Enwave have an opportunity to take a world lead on this issue.
- Governments could pay a premium for green heat supplied by Enwave to their buildings similar to the City's Green Power purchase.

There are a number of added benefits to providing a diverse "renewable fuel" mix from external suppliers:

- Enwave does not bear the capital costs or risks associated with new power plants. It only pays for the energy supplied to it.
- It reduces future price shocks from natural gas (from heating) and electricity (from cooling).
- It increases the capacity of Enwave's distribution system.
- It can increase system energy efficiencies and provide significant cost saving for many Toronto businesses and building operators that have wasted thermal energy, which they now simply dispose of.

Suggestion for Action

Opportunities for the future:

- *Toronto should support the use of District Energy Systems to increase the generation and distribution of renewable thermal energy in the City.*
- *Toronto should study opportunities for supporting greater use of renewable thermal energy in District Energy Systems through the use of a thermal Advanced Renewable Tariff, similar to the one currently offered by the OPA for renewable energy electrical generators.*
- *Toronto should consider supporting the greater use of renewable thermal energy in city government building through a Green Heat power purchase similar to the Green Power purchase program.*
- *Identify energy zones outside the downtown core that could utilize deep lake water cooling provided through the RC Harris, FJ Horgan or RL Clark filtration plants.*

Currently Enwave restricts itself to the downtown core's District Energy System. Toronto's Sustainable Energy Plan envisions district energy systems becoming the core of Community Energy Zones. Enwave could explore setting up small district energy centres in areas outside the downtown core, such as the Leaside Industrial Park, the North York Centre, or the Scarborough Town Centre.

Building on Enwave's Potential

At present, Enwave is a winter peaking energy supplier; that is, it produces steam mostly in the winter for heating purposes and very little in the summer (mainly for domestic hot water heating). That means that the boilers are mostly idle in the summer even though by law a full complement of stationary engineers is required.

Parallel to this, Enwave generates cooling for downtown office buildings in the summer utilizing mainly deep lake water cooling. At the present time the capacity for this is limited by the capacity of the intake pipes at the Toronto Island filtration plant.

Many stakeholders mentioned that integrated energy solutions could significantly enhance the capacity of Enwave's District Energy System. Some of the opportunities that were mentioned include:

- The deep-lake cooling capacity of the system might be able to be expanded by as much as four-fold if it took advantage of nightly low periods to chill blocks of ice using the cooling capacity of lake water to enhance the efficiency of the compressors, then using the ice during the day for heat transfer. This technology is well developed and used in Chicago, where the city centre is cooled by an ice storage system.
- Enwave could consider converting its steam boilers to highly efficient tri-generation to supply electricity, heat and cooling. The recently completed tri-generation system at Exhibition Place provides a good example of this opportunity. An intermediate step would be to utilize the steam boiler capacity in the summer by using absorption cooling to "polish" the coldness supplied to buildings, rather than using the current electric chillers.
- Expanding the intake of one of the other filtration plants and connecting it to the downtown loop.

5.5 Neighbourhood District Energy Systems

District energy systems do not have to be large. There are district energy systems that encompass single city blocks or communities of only a few dozen buildings such as the four systems now being built in Markham.

Moving excess energy from one place to another place that has a demand requires the community to be considered as a whole – the community energy zone process described previously. A manufacturing plant may have excess heat but is unaware that the building next door has a huge heat demand. A school may have a modern efficient heating and cooling plant that is used only during the day and which sits idle nights and school holidays while the social housing apartments next door use electric baseboard heaters and window air conditioners.

A good example of a neighborhood district energy system is the Drake Landing subdivision project in Okotoks, Alberta. This community consists of 52 R-2000 homes centred on a ground-source heating system that stores large quantities of summer solar heat for use in the winter. The system is backed up with natural gas and is operated by ATCO Gas as a utility, from whom the homeowners buy their solar/geo/natural gas energy. While a first in North America, this integrated approach has been gaining in popularity in Europe since the 1990s. Drake Landing is about one-tenth the size of average neighbourhood district energy systems in Europe.

An opportunity that was mentioned by a number of stakeholders is the role that Toronto schools could play in becoming the hub of neighbourhood district energy systems:

- In many cases the local school is the only large building in the neighbourhood – with an existing mechanical system and trained operation staff.
- Schools do not have a constant thermal energy load so their energy systems do not run at maximum efficiency.
- Schools have large roof spaces that are well suited for solar collectors.
- The schools' open playground spaces provide an easily accessible geo-energy bore hole field.
- Schools have an intimate link to the neighbourhood community.

Suggestion for Action

With declining school enrolment there are ongoing discussions about closing neighbourhood schools. The schools and the property they sit on are a valuable energy resource, and this should be considered during any discussions of asset disposal.

The Toronto School Board is currently exploring opportunities for geo energy systems; however, they are looking just at the needs of their schools. There are huge opportunities for increased energy efficiencies here as the incremental equipment costs are minor for an expanded system and the school board could generate a financial gain by selling excess energy to the neighbourhood. However there are currently huge regulatory barriers in the process of becoming a generator and an energy distributor.

Suggestion for Action

City staff should begin working with the community to identify neighbourhood district energy opportunities and the city should study how it can support the efficient transmission of local thermal energy.

5.6 The Opportunity of Co-gen

C-generation (co-gen), or combined heat and power (CHP) merges production of useful heat with electrical production at a level of efficiency that simple generation cannot approach. A single-stage gas-fired electrical plant extracts 33% of the energy in fossil fuels as electricity and dumps the rest as waste heat. A combined-cycle generator turns some of the waste heat into more electricity, raising efficiency to 55%. Co-gen can achieve efficiencies higher than 90% by using the heat directly. As a result, co-gen is widely considered to be the preferred energy choice.

Co-gen systems can be as small as a single household or as large as a 500 MW central power plant. The Toronto Hydro proposal for the Portlands Energy Centre was for a co-gen system.

There are real cogeneration opportunities that the City should explore. Heat-intensive industries, for example, should be encouraged to produce electricity as a byproduct of their operations. To enhance the overall economics and increase system efficiencies, co-gen needs to be done in conjunction with integrated community energy planning to incorporate the energy production into emerging district energy systems.

Co-gen systems can help resolve a number of Toronto energy challenges:

- Local electrical generation is critical to reduce stress on Toronto's electrical infrastructure and increase energy security. Toronto's downtown core is only served by two transmission lines. A single line would be unable to carry the entire load if there was a transmission failure.
- Local electrical generation can be used to reduce peak. Peak electricity is expensive and additional incentives can be used to encourage "marginal" cost effective co-gen systems.
- Natural gas co-gen is cleaner than the coal powered plants that are part of Ontario's energy mix – it will help reduce Toronto's contribution to greenhouse gas emissions.

While larger co-gen systems have economics of scale, and current energy policy makers are comfortable with them as they follow the conventional paradigm of central generation, the same is not true with smaller co-gen systems. There are many barriers in Toronto towards the greater use of co-gen systems under 500 kW in size. This represents an opportunity for City government.

Small co-gen

The tri-generation (electricity, heating and cooling) facility installed in March 2007 at Exhibition Place is Canada's largest tri-gen system and the first owned by a municipality. It is the sole source of power and heat for the Direct Energy Centre and consists of a 1.6 MW natural gas-fired generator with a heat recovery package and a hot water driven absorption chiller.

Micro co-gen

Micro cogeneration occurs where a household (single or multi) cogeneration plant replaces the gas furnace, and reduces peak demand for electricity while providing space heating and heating domestic hot water.

While this concept may sound unique, it is becoming a common technology globally. These systems are commercially available and are manufactured by Japanese companies like Honda and Canadian companies like Ballard Power. There are an estimated 30,000 micro co-gen systems installed in homes in Japan. In England there are now four micro co-gen system manufacturers whose products on average can reduce a household's greenhouse gas emissions by 25 per cent. While twice the price of a traditional high-end furnace, micro co-gen systems can have a 10-15% return on investment (7 to 10 year payback).

A unique aspect of micro co-gen systems is their potential to address larger energy issues. With advanced smart metering they can be controlled by the local electrical utility to turn on during periods of high peak electrical demand in the community.

Suggestion for Action

The City should develop a pilot program to demonstrate the use of micro co-gen systems in Toronto's communities.

The OPA's proposed Clean Energy Standard Offer includes natural gas co-gen systems. However the price being set is expected to reflect only the cost of larger co-gen systems typically owned by energy suppliers.

Suggestion for Action

Toronto should advocate for a price setting that is dependent on the size of the system to encourage more local generation of electricity. Feed-in Tariffs in Europe consider the price support necessary for different technologies and size of individual units.

As with larger co-gen systems, the micro systems have significant opportunities when tied in to District Energy Systems. This allows the co-gen system to run at maximum efficiency continuously while feeding excess thermal and electrical energy into the community. The City of Mannheim, Germany has recently announced (May 2007) that the city government is piloting the introduction of 100 micro-co gen systems that will be integrated in the district energy system.

5.7 Energy Sources for District Energy Systems

One of the advantages of District Energy Systems is there ability to integrate multiple energy sources into the supply mix, such as is done in the cities of Copenhagen or Mannheim.

Drake's Landing in Okotoks is the first in North America to integrate multiple energy sources, both renewable and non-renewable, into a district energy system that takes advantages of the unique attributes of the different energy resources.

Natural Gas

Enbridge Gas owns the natural gas distribution system in Toronto with minor competitive market options. Gas will be a significant fuel source for Toronto's district energy systems at first; however its share can be expected to diminish over time as local renewable thermal energy sources are developed. District heating can be considered a functional competitor with natural gas heating. Experience in Europe shows that sustained competition between the two models is not in the best interest of the community. Further, there would be duplication of thermal energy infrastructures (natural gas pipelines and thermal energy pipelines), which would increase Toronto's energy infrastructure costs. Given the growing interest in district energy systems in Toronto, these future marketing concerns must be addressed.

Renewable Energy in District Energy Systems

Renewable energy will have a significant role to play both in the energy mix of Toronto's energy systems (both electrical and thermal) and in contributing to the local energy needs of individual buildings. Renewable Energy is covered in detail in the Renewable Energy section of the Plan. When discussing renewable thermal technologies such as geo-energy or solar thermal, they are often only considered as a *building* energy issue, while renewable electrical technologies are considered primarily as an energy *systems* issue. This section reviews the opportunities for renewable thermal technologies in thermal energy systems.

Geo Energy

The opportunity for extracting energy from the earth (through ground source heat pumps and deep lake water cooling) grows significantly with the integration into District Energy Systems. Toronto's geo energy resource has not been studied but it is expected to be able to provide the majority of energy needed for cooling (after implementing a comprehensive cooling strategy for Toronto). The primary barrier to greater use of geo-energy in Toronto is access to land where the bore holes can be drilled that are used to extract (or transfer) the earth's energy.

Thus the opportunity for geo-energy is using community open space resources – schoolyards, playgrounds, and parking lots – to provide the much access to ground space while still being used for their design purposes.

Wood Waste - Bio Mass Energy

Toronto is well placed to source large quantities of biomass fuels, generally from regional forestry waste but also from building renovation and the tree maintenance program of Toronto Parks and Toronto Hydro. While priority should be to reduce, reuse, and recycle wood resource, there are significant opportunities to divert wood waste from landfills.

In Europe, where wood based biomass is increasingly common as a large-scale fuel source, the experience is that prices rapidly align with natural gas. As natural gas prices are expected to increase significantly, the earlier that long-term arrangements are made, the more savings will be generated.

As shown in Europe, biomass energy is effective in local district heating systems. Biomass is a very effective base-load heat source for the 3,500 heating hours needed in Toronto's winter.

Bio Gas

Biogas is typically considered the methane produced from organic waste; however there is a developing industry in Europe and the Far East where agricultural crops are grown specifically for their methane, ethanol, or bio-diesel producing value. Biogas can, with cleaning, be mixed with or even replace natural gas, heating oil and diesel as a fuel source for furnaces and co-gen power plants.

An early opportunity for Toronto is to use the biogas generated in the solid waste and wastewater streams in co-gen systems that are connected to District Energy Systems.

Solar Thermal

One of the possible co-opportunities is connecting solar thermal systems to a district energy system. Excess solar energy they produce during the summer and the peak sunshine days through the year could be fed into the district system as in the case of Copenhagen and Mannheim.

Solar hot water systems are attractive energy sources for complementing district energy systems that use natural gas. They can provide the reduced heat load in summer for domestic hot water, and the excess energy can be transformed to cooling. Solar systems can provide peak load during the winter as peak heating requirements are generally done on cold, clear winter days when the sun shines the strongest.

An exciting opportunity for solar thermal is the use of the sun's rays to provide cooling during the summer and heating during the winter. Commercial systems are already being installed in communities in Europe. Toronto is well positioned to take a North American lead in this technology. Canada has recently joined the International Energy Agency Task Group looking at solar cooling.[13]

Suggestion for Action

Toronto should consider a pilot project to integrate solar cooling into the Enwave cooling system.

5.8 Energy Storage

Energy systems are designed to provide power during the greatest energy demand on the system, which occurs for only one hour each year. This short period of high demand increases energy infrastructure costs significantly. There are a number of options to deal with peak demand:

- Expand energy infrastructures (i.e. distribution lines, transformers, generating stations);
- Shift load to low demand times;
- Store energy locally to reduce the need for the energy distribution lines.

The City's Energy Efficiency Office is currently in discussions with the OPA on a program that will attempt to reduce the City's peak electricity demand by 20 megawatts in its own facilities, as part of the City's commitment to achieve a 90-megawatt reduction in electricity demand in the city. Some of the measures being considered in this program are control systems that allow for lights to be dimmed/turned off automatically during times of high demand, and the activation of backup on-site natural gas generators to offset peak demand.

In North America we have in the past typically dealt with peak issues by building larger energy infrastructures. Only recently has the value of load shifting become appreciated.

Electrical storage is possible now - certain regions like Quebec are fortunate that dammed hydropower can be used as a source of stored energy. There are growing opportunities to store electricity locally using next generation batteries such as Flow Batteries.

Suggestion for Action

Toronto should begin to evaluate these technologies as they can contribute to energy sustainability – a pilot project of Flow Batteries in Toronto would provide Toronto leadership in dealing with electricity peak surge issues.

The potential of thermal storage at a building level has only been addressed lightly in Canada. Hydro Place, on the corner of College and University, is one of only a few examples in Canada that uses long-term thermal storage. The hot/cold water storage system at Hydro Place has the capacity to meet the building's heating and cooling needs for almost a week with no external sources.[14] Many large buildings use chillers that freeze water during off peak periods to use when demand for cooling is the highest (and when the electrical rates are also the highest).

Greater use of community energy systems that include thermal energy storage techniques would be a clear way to harness Ontario's sunny summers to supply our colder winters with renewable solar heat. Geo-energy technologies can play the role of both an energy supply and a storage mechanism.

Toronto's sustainable energy future must include provisions to reduce peak load through energy storage mechanisms. All District Energy Systems should consider energy storage mechanisms and new building consider opportunities for energy storage for both thermal and electricity.

5.9 Energy Sustainability and Self Sufficiency in Toronto

The vision of energy self-sufficiency in Toronto can only be accomplished using an integrated approach to energy. By considering thermal and electrical energy together, by considering the energy needs of the community as a whole, significant opportunities will become apparent to reduce energy use, use more renewable energy resources and increase efficiencies in the energy systems.

As Toronto develops more integrated, local energy solutions it will reduce its energy consumption and the goal of energy sustainability will become closer to reality.

6. The Opportunity of Renewable Energy

6.1 Defining Renewable Energy

Renewable energy technologies can provide energy in both electrical and thermal forms. In the case of some thermal technologies they produce enough heat (or they can be burned) so that they can run a generator and are potential suppliers of electricity (this is referred to as co-generation or co-gen).

A number of renewable energy technologies use the same resource (such as solar or bio-energy) and this can sometimes lead to confusion amongst stakeholders (i.e. when talking about the potential of solar energy). Further in some cases the technology is application driven (i.e. solar pool heating) which then requires a more detailed analysis of the potential on an application-by-application basis.

The renewable energy technologies considered in the energy plan are outlined in the following table.

Table 1: Renewable Energy Sources Considered in the Energy Plan

Source	Technology	Energy Form	Location	Application
Solar	Photovoltaic	Electricity	Distributed, Central	Building integrated, residential, commercial, solar parks
Solar	Thermal – water	Water heating	Distributed	Residential, commercial, swimming pools
Solar	Thermal – air	Space heating	Distributed	Commercial and industrial, make up air
Solar	Passive	Space heating, day lighting	Distributed	Residential, commercial
Wind	Wind Turbines	Electricity	Distributed, Central	Residential, wind turbines, wind farms
Hydro	Water Turbines	Electricity	Central	Run of river, impounded water
Geo-Energy	Ground & Water	Space heating & cooling, water heating	Distributed, Central	Residential, commercial, central generation
Bio-Energy	Bio-mass	Space & water heating, co-gen	Distributed, Central	Residential, commercial, central generation
	Bio-gas	Space & water heating, co-gen	Central	Commercial, power plants, generation, displacement of NG in supply distribution
	Bio-fuels	Space & water heating, co-gen, transportation fuels	Central	Commercial, central generation

6.2 Renewables Energy In Ontario

Ontario is extremely fortunate in that we already have a strong renewable base to our electricity supply due to our hydro (water) resources. While Ontario's energy mix includes 23% sourced from renewable energies, Germany for example, despite being the world leader in the use of wind and solar energy, obtains only 9% of its electricity from renewables[15]. The Ontario government has set a target of removing coal-based generation from the supply mix by 2014 and replacing it with new renewable energy sources (Figures 14-14).

Historically, Toronto has always contributed to the power generation in the province – through the Richard L. Hearn Generating Station (1,200 MW – closed in 1983) and the Lakeview Generating Station (2,400 MW – closed in 2005). However this is no longer the case. The new Portlands Energy Centre at 550 MW (expected by end of 2009) is designed to provide power only during peak - when demand is highest. Thus much of Ontario's electrical challenges are due to Toronto's energy appetite (20% of Ontario's electricity is consumed in Toronto) and the need to transmit this electricity from outside Toronto's boarders.

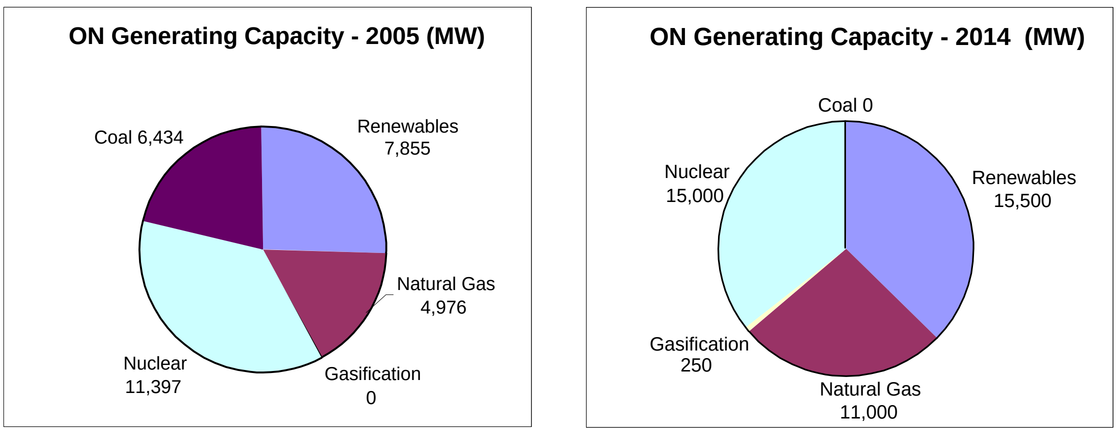

Figure 14: Ontario's Supply Mix (MW) - 2005 & 2014[16]

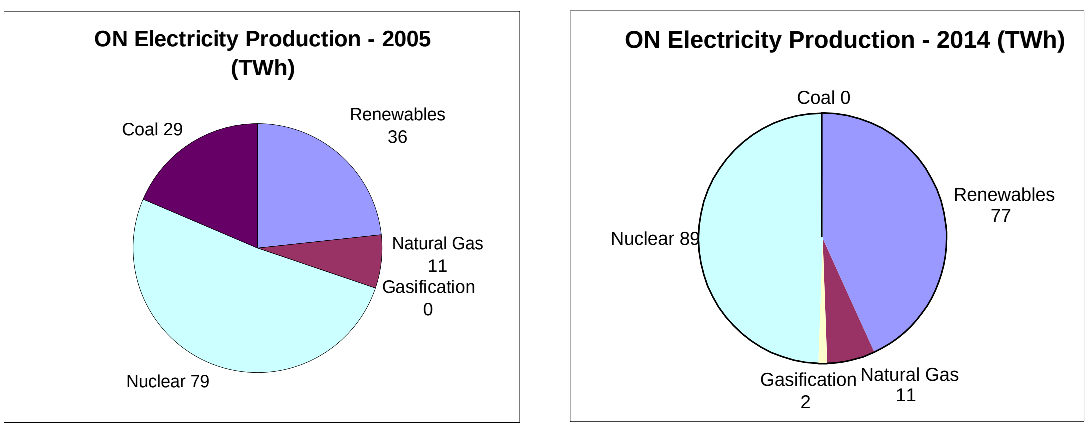

Figure 15: Ontario's Electrical Energy Mix (TWh) - 2005 & 2014

Toronto should contribute to power generation in the province, but Toronto should also be selective about the type of generation we accept. Toronto's Medical Officer of Health estimates that 1,700 Torontonians died in 1999 due to air pollution. Much of this pollution comes from the way we use energy for transportation, in buildings, and in our infrastructure.

One 500 MW or 100,000 5 kW power plants are the same. But in practice many small units are more reliable and efficient than a few big ones – particularly if they run on different energy sources and if they are installed near the customer.

One of the advantages of most renewable energy technologies are that they are distributed energy sources – i.e. they can be installed close to the demand for energy. This reduces distribution costs, increases efficiency (10-20% of energy can be lost in transmission) and provides a more reliable energy supply (98% of Canadian power outages are originated in the transmission/distribution grid[17]).

Toronto can contribute to Ontario's goal of a cleaner electricity supply in three ways:

- It can advocate for policies and programs that support cleaner energy sources at the provincial and federal level.
- It can reduce its own energy use through increased energy efficiency and demand management.
- It can assist Toronto stakeholders in producing their own energy through a variety of policy and fiscal measures.

Ontario's Thermal Energy

While electricity issues tend to dominate public discussions as outlined in the section on Toronto's energy challenges and opportunities, in the long term our use of natural gas will be one of Ontario's greatest challenges for a sustainable future. Ontario has few indigenous fossil fuel reserves left. We rely on imported natural gas from other provinces and our energy dollars flow out of Toronto and Ontario for this energy.

A sustainable future for Toronto implies ending our addiction to natural gas. While we can get our electricity from the provincial grid (which is getting cleaner), replacing natural gas can only be accomplished with local, or at best regional sources of renewable energy. One other possible solution is that, while currently we must discourage the use of electricity for thermal energy needs, in the longer term we may consider the use of electricity for part of our heating needs.

Advocating for a strong Ontario and local electrical infrastructure can prepare Toronto for a future where electricity provides us with more sustainable energy options.

6.3 The Renewable Energy Resource in Toronto

Canada is blessed with an abundance of natural resources, including renewable energy sources such as wind, solar, and hydro energy. While Toronto may not have an over abundance of any one renewable energy resource, it does have the potential to take advantage of a wider selection of renewable resources than most other cities globally. For example while we do not have the wind resource of Copenhagen, we do have a viable wind resource due to our proximity to Lake Ontario. Wind energy out in the lake is an economically viable energy source now. While Toronto may not have the solar resource of more southerly regions, it has a much better solar resource than Germany and it has an exceptional solar resource during the hot sunny days of summer when our air conditioners are overloading the system. During the summer Toronto's solar resource is better than Miami's.

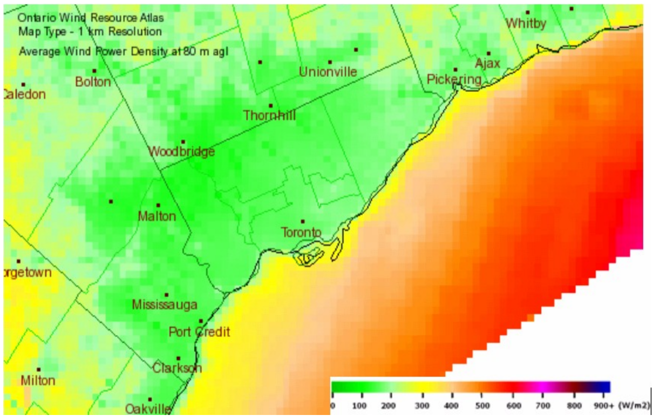

Figure 16: Toronto's Wind Resource: Average Wind Power Density at 80 m (W/m2) [18]

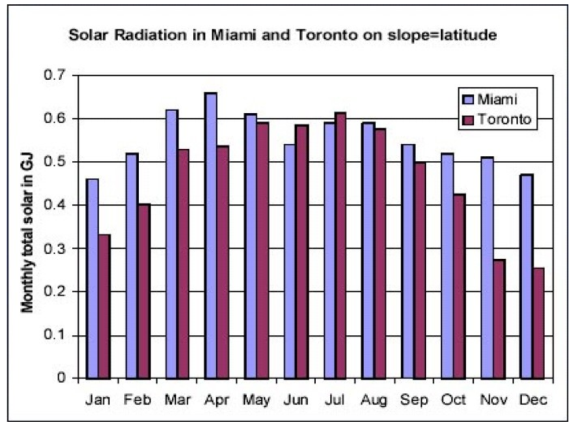

Figure 17: Toronto & Miami's Solar Resource[19]

While the resource potential for wind and solar are well documented from provincial or federal sources there is a significant shortage of information on the resource potential of the other renewable technologies.

For geo-energy, the energy we get from the ground and from water sources, it was difficult to obtain an estimate of the energy potential per “power unit” of the technology (kWh/kW). Similar to wind, geo energy’s potential is driven by site specific factors including ground water and soil type. The Canadian Geo-Exchange Coalition has identified this lack of resource data as one of the key barriers to the greater use of geo-energy[20]. A number of municipalities, such as the City of Kelowna, are beginning to explore ways to collect subsurface data to allow for long term integration of geo-energy technologies into the City’s energy planning process.

Suggestion for Action

Toronto should consider working with industry and other governments on developing local geo-energy resource mapping.

Bio-energy, the energy we can extract from organic material such as trees, from food waste (green bins) and from sewage, is a diverse energy resource that, like geo-energy, does not have reliable local resource estimates. In part this is due to the many streams of bio-energy that flow through our city and the various stakeholders involved. Toronto will need to carry out a detailed resource assessment of this renewable energy source before firm estimates on its potential can be established. However the preliminary review of its potential in the energy plan indicates it can be a significant part of the answer in moving Toronto towards a sustainable energy future.

Table 2: Renewable Energy Potential Assumptions

Technology	Energy Output
Photovoltaic	1,100 kWh per kW of rated power
Solar Domestic Hot Water	750 ekWh per kW of rated power
Solar Pool Heating	1,550 ekWh per kW of rated power (for 3 month period)
Wind	1,500 kWh per kW of rated output
Geo Energy – Ground Source	500 ekWh per kW of rated output (cooling only, net of energy consumption)
Bio Energy – Green Bin	110 m^3 of methane per tonne of bio-degradable waste

6.4 The Potential of Renewables in Toronto

The potential of energy efficiency improvements and systemic improvement in the energy infrastructure can be estimated using general trend lines and modeling of buildings. However forecasting the potential of renewable energy technologies is driven by the resource, the potential market uptake, and capacity issues affecting the technology. The assumptions used in forecasting the renewable energy potential in Toronto are:

- **The Renewable Resource –** For some technologies the renewable energy resource is well known and can be generalized (i.e. solar and bio-energy), while some are very site specific (wind) or unknown (geo-energy). Wherever possible an estimate was based on an average resource value. There are also limitations to the use of certain technologies (i.e. for solar there is a limit to roof space and shading is a barrier).

- **Market Uptake –** This is driven by both the cost of the technology, the various market barriers (such as codes and standards) and by market transformation policies. For the projections it is assumed that market transformation policies will overcome price barriers. Pricing is also driven by the market stage of the technology and as most renewable technologies are only in the early stages of development there is significant potential for price reductions in the medium term.

- **Capacity Issues –** The ability of the industry to supply products to the market place and how fast the industry can expand (both in manufacturing capacity and providing a skilled workforce) will place serious restrictions to growth in the short term.

Beyond hydropower, Canada is only beginning to exploit its renewable energy resources. It is very much an "early adopter" market in Canada where the first users are often considered "pioneers" and where the industries are very small and dominated by small entrepreneurial firms with poor financial resources, preventing them from expanding rapidly. There are thus severe limitations to the short-term growth of all renewables in Toronto in installed capacity. With market barriers removed, market transformation policies in place, and support for industrial growth, the growth of renewables will follow a classic market curve which will see very high growth rates (but low volumes of installation) as industry builds capacity which will slowly evolve to lower growth rates but greater annual sales. Experience from other nations and technologies suggest that renewables in Toronto can grow 100-200% a year for a short time (5 years) and then growth will level off to 35% annually (a doubling of sales every 3 years) as was experienced in the home computer market between 1980 and 2000. This is illustrated in the following chart.

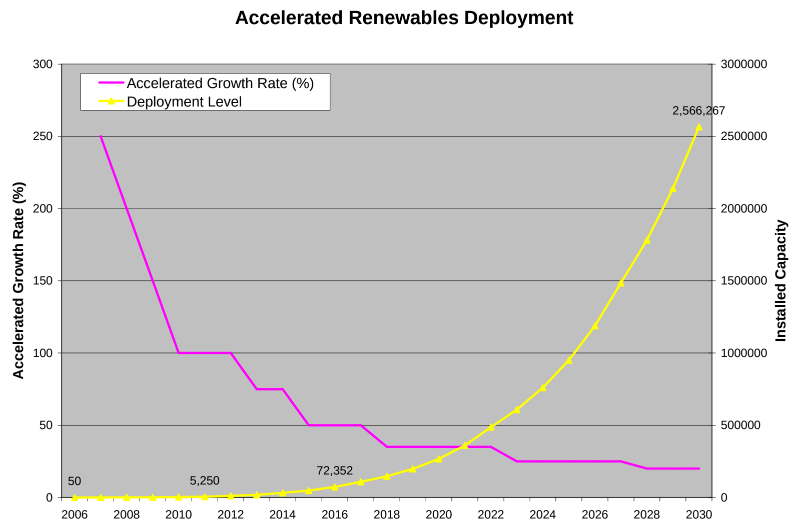

Figure 18: Typical Renewable Energy Growth Pattern in Toronto

As the renewable energy sector is diverse and each technology (and often application) requires a separate analysis the projections of potential were only done on certain technologies that consulted stakeholders felt had either the highest potential or had good early action potential in Toronto. As mentioned, there is a significant shortage of data on many of the technologies' potential and it is recommended that the City undertake a more thorough study of the potential of renewable technologies in Toronto.

Table 3: The Potential of Renewable Energies in Toronto on the following page was a result of consultations with the renewable energy industries in Canada and with stakeholders in Toronto. It provides a broad assessment in two areas of the potential of all renewable technologies and their specific applications:

- Potential of the Resource – This considers the amount of energy that the technology could contribute relative to the energy used (either in the community or in the application).
- Development of the Resource – This considers when the resource could be exploited. This is based on both the size of the market that the technology is in as well as the stage of development of the technology.

Table 4: Renewable Energy Projection - is the result of the analysis of the market potential of certain renewable technologies in Toronto. It is not designed to be all-inclusive but provides guidance on where some of the opportunities lie.

In general it was found that there was at least 3,200 GWh of local renewable energy potential in Toronto by 2030 (compared to less than 500 GWh now) and this would provide about 5% of Toronto's energy in 2030. If we include the potential Ontario electrical mix (based on the OPA projections) then renewables would supply at least 21% of Toronto's energy (compared to 9% now). It should be noted here that it was not possible to evaluate all of the various technologies potentials and the evaluations done are very preliminary. Geo-energy's full potential, especially in local district energy systems, has perhaps a potential equal to the total projection used here. Tables outlining the energy scenario in 2030 can be found in the Toronto's Sustainable Energy Future section.

In the short term there are good opportunities for Toronto to exploit:

- Solar thermal technologies for heating residential hot water and swimming pools
- Photovoltaics for residential, commercial and solar parks due to the Ontario Standard Offer program, which will see "early adopter" uptake of small systems.
- Geo energy both at the distributed level (individual buildings) and more central (district heating and cooling)
- Bio-energy technologies such as green bin waste bio-digesters. Exploiting bio-energy technologies represent a number of unique opportunities as they can reduce city government operational costs (i.e. from selling the energy produced, reducing the use of purchased energy, reducing infrastructure costs such as landfills) and reducing Toronto's impact on the environment.

Longer term many of the technologies have excellent potential. Those with the greatest potential include:

- All solar thermal technologies;
- Photovoltaics for residential and commercial applications including building integrated PV;
- Geo-energy technologies for all applications.

Those technologies that, long-term, are viewed to have limited potential include:

- Large solar PV "parks" due to a lack of open space – the size of these systems generally are greater than 5-10 MW. However systems up to 3 MW present a huge opportunity due to the large low rise commercial sector in Toronto;[d]
- Residential wind energy – due to limitations of the wind resource on buildings;
- Hydro power – due to the lack of the resource.

[d] 1 MW of PV requires approximately 10,000 m^2 of roof or ground space – approximately the size of six hockey rinks or 2 football fields.

Table 3: Renewable Energy Potential in Toronto

Technology	Application (*Projection of potential is done in next table)	Energy	Potential (relative to energy used in application)	Development of the Resource (level of impact on sector)			Limitations & Barriers
				Short Term	Medium Term	Long Term	
Photovoltaic	Residential (existing)*	Electricity	Medium	Low	Medium	High	
	Residential (new) – zero energy homes		High	Low	Low	Medium	Number of new homes built
	Commercial Roof		Medium	Low	Low	High	
	Commercial – Building Integrated		Medium	Low	Low	Medium	Number of new building built
	Solar Park*		Low	Low	Medium	Low	Lack of large open spaces in Toronto
Solar Thermal	Residential Domestic Hot Water*	Thermal	High	Medium	High	High	
	Commercial Hot Water		Medium	Low	Medium	High	
	Pool Heating*		High	High	High	High	
	Space Heating – Residential (combi)		Medium	Low	Low	High	
	Make Up Air – Commercial/Industrial		Medium	Low	Medium	High	Limitation of new industrial buildings being built in Toronto
	Air Conditioning	Electricity (Displacement)	High	Low	Low	High	
Passive	Residential	Thermal	Medium	Low	Low	Medium	Number of new homes built
	Commercial – Day Lighting	Electricity	Medium	Low	Low	Medium	Number of new buildings built
Wind	Wind Farms/Large Turbines*	Electricity	Low	Low	Medium	Medium	Access to waterfront or in the lake
	Residential		Low	Low	Low	Low	Low resource in the city
	Wind in the Build Environment		Low	Low	Low	Medium	Technology is only in very early stage of development
Hydro	Run of River, Impounded*	Electricity	Low	Low	Low	Low	Few rivers in Toronto
	Rain Water Catchments		Low	Low	Low	Medium	Height and roof area of high buildings
Geo Energy	Residential*	Cooling (displacement of electricity), Heating (thermal)	High	Medium	High	High	Access to ground space
	Commercial*		High	Medium	High	High	
	Community Energy Systems		Medium	Low	Medium	High	Need for integrated community energy planning
	District Energy Systems (Enwave)		Medium	Low	Medium	High	Access to deep water
Bio Energy	Waste Water*	Co-gen	Low	Medium	Medium	Medium	
	Solid Waste*		Medium	Low	Medium	Medium	Landfills are not in Toronto – need to capture in waste stream
	Bio Mass		Low	Low	Medium	High	Public Perception of energy from waste
	Bio-Gas/ Bio Fuels		High	Low	Low	High	Import from agricultural communities

Table 4: Renewable Energy Projections in Toronto

Technology	Application		Current			Short Term (2010)			Medium Term (2015)			Long Term (2030)		
			Capacity (MW)	Energy ($_e$GWh)	Description	Capacity (MW)	Energy ($_e$GWh)	Description	Capacity (MW)	Energy ($_e$GWh)	Description	Capacity (MW)	Energy ($_e$GWh)	Description
Photovoltaic	Residential (existing)	Electricity	0.1	0.1	100 systems (0.2 - 2.0 kW each)	1.0	1.1	500 systems (1 – 2 kW each)	9.0	10.0	2,800 systems (2 – 3 kW)	900	990	260,00 systems (3 – 4 kW each)
	Solar Parks		0	0		10	11.0		30	33.0		50	55	
Solar Thermal	Residential Domestic Hot Water	Thermal	1.5	1.1	300 systems	3.3	2.5	850 systems	21.0	15.7	5,300 systems	1,444	1,083	360,000 systems (reaches technical potential)
	Pool Heating		5.0	1.8	300-800 systems	34	14.0	2,000 systems	86	34.0	5,100 systems	530	211	30,000 systems (reaches technical potential)
Wind	Wind Farms & Large Turbines	Electricity	0.75	1.1		2	3.0		20	30.0		200	300	
Hydro	Run of River, Impounded	Electricity	0	0		0	0		0.5	4.4		1	9	
Geo Thermal	Residential & small commercial	Cooling – displacement of electricity	15.5	7.5	900 systems	42.6	21.0	2,600 systems	85.6	41.9	5,000 systems	350	171	27,500 systems (reaches technical potential)
	District Energy Systems (i.e. Enwave)	Cooling – displacement of Electricity		104	Based on full capacity (about 10- 20% of this is derived from electricity & NG)		104	Enwave at capacity in 2007 -2008		104	No projection for potential increase done		104	No projection for potential increase done
Bio Energy	Waste Water	Co-gen	7.4	?		7.4	?		12	?		12	?	
	Solid Waste	Co-gen (electricity only)	40	350		40	375		50	375	(reaches technical capacity from waste stream)	40	300	Landfills now supplying only 50% of 2007 output
Total	Electricity			462.7			515.1			598.3			1,929	
	Thermal			2.9			16.5			49.7			1,294	
	Total			465.6			531.6			648.0			3,223	

6.5 Solar

Solar energy can be harnessed using several different technologies to produce electricity, heat, or light. While solar technologies share the same resource they are very distinct technologies that sometimes share few common attributes.

However the one common attribute – the need to access the sun's energy – presents one of the biggest potential challenges to the long-term growth of solar technologies in Canada.

Currently Canada is the only industrialized nation that has not addressed property owners' "right" to access the solar energy falling on their property. If a homeowner in Toronto installs a solar water heater, pool heater or a PV system, they have little recourse if a new building casts a shadow over their solar generator. A $5,000 - $20,000 investment then becomes of little value.

Solar access legislation is not new – in fact Canada had "right to ancient light" legislation in place in the 1800s when we adopted British Common Law. However the needs of urban development in the early 1900s led to this legislation being rescinded across Canada. In Europe and Asia most countries have had historical solar access regulations, which have been updated. In the US a process to develop solar access guidelines was developed in the 1980s and now over 40 states and 90 municipalities have defined the solar rights of property owners. For example, San Diego requires that site plans for new developments demonstrate that the development preserves solar access of adjacent properties.[21]

There are three options for protecting homeowner's access to solar energy – provincial regulation through the building code; a property owner's legal covenant with neighbours, or municipal regulations. Municipal regulation has proven to be the easiest to develop and enforce. The City of Brampton for example adopted solar access in its zoning regulations in the 1980s. There are workable solutions that provide protection to property owners' rights while at the same time growing the urban tree canopy, and increasing the building intensity in Toronto. However this issue needs to be addressed soon if Toronto wants to encourage solar energy.

Suggestion for Action

It is suggested that the City should, in consultation with stakeholders, develop local regulations protecting solar energy system owners' access to the sunlight falling on their property.

Solar technologies have a strong long term potential to supply energy at a local level. The National Round Table on the Environment and Economy's fifty year climate and clean energy scenario projects that solar photovoltaic technology would be used by one in every ten houses, solar water heating systems would be in a third of all single family homes and solar thermal systems would be in used on virtually all commercial buildings. Toronto could take a national leadership role in developing this energy resource that Toronto has an abundance of.

Photovoltaics: Electricity from the Sun

Photovoltaic (PV) modules transform solar energy directly into electricity. Currently most of our electricity in Ontario is produced using steam technology (in nuclear, coal and natural gas generating stations) that has basically remainded unchanged for over 100 years. Photovoltaics represents the first new source of electricity in over 60 years.

The use of PV produced electricity has grown significantly internationally over the last 10 years with annual growth rates exceeding 30% and prices dropping 3-5% annually for the last 20 years. Most projections are that PV electricity will be competitive to power produced by large non-renewable power plants by the middle or end of the next decade.

Canada lags significantly behind the internationally community in our use of PV. We have less than 3% of the installed base per capita compared to Germany which is the world leader. We are behind even nations such as Mexico and South Korea. As Canada's PV installations are mainly in remote applications where there is no access to conventional power, Toronto (and other urban areas) lag significantly behind even the low Canadian average.

Table 5: Installed Capacity of PV

Current Installed Capacity[22]	W/capita
Toronto	0.29
Canada (Average)	0.43
USA	1.23
Japan	8.87
Germany	9.62

In the early 1990's Toronto was home to Canada' largest PV array – an 80 kW array on top of the Hugh MacMillan Centre. The system was taken down when the hospital was demolished in the early 2000s.

One of the first users of PV in Toronto was the Toronto Parking Authority, which starting in 1999 began switching over its individual parking meters to "pay and display" kiosks that are powered by small 10-watt PV modules. Savings to the parking authority are substantial as the kiosks are easier to maintain and require less servicing. Without the use of solar to power them, the kiosks would not be practical as the cost to trench and connect them to power lines would have been prohibitive. Now the City also uses PV to power all its road repair message boards and has installed over 260 solar illuminated Transit Shelters.

In 1999 GreenPeace undertook a project to bulk purchase PV systems for homeowners in Toronto, modeled after a similar GreenPeace initiative in the

Netherlands. While 20 homeowners purchased small systems and a small system was installed on Toronto's City Hall (since taken down), the low energy prices that Torontonians pay and the lack of any incentive programs resulted in a low uptake in this first attempt of a community solar initiative.

In 2005 Toronto Hydro began the "modern" era of PV in Toronto, installing a 35 kW grid-connected system at its Commissioner Street facilities. Exhibition Place was the next to install a major PV array with a 100 kW PV system on the roof of the "Horse Palace" in 2006. This is currently Canada's largest PV system although a 108 kW system to be installed in Charlottetown this summer will soon displace it. Exhibition Place is studying ways to increase the Horse Palace system to 2 MW over the next few years.

Community engagement and participation has always played a major role in attempts to expand the use of renewables in Toronto but while interest in renewables, and particularly solar PV, has always been high in Toronto there have been few success stories.

However this is beginning to change since the Ontario government announced in March 2006 a feed-in tariff program (Standard Offer Program) through the Ontario Power Authority (OPA) that pays PV generators $0.42/kWh.

One of the first to take opportunity of this impending program was a community group in Toronto, the Riverdale Initiative for Solar Energy (RISE), which built on locally community interest to buy collectively 30 systems for individual homeowners. While the formation of the buyer co-op helped reduce the price, just as importantly it provides a support mechanism for individual homeowners that wanted to take the "leap into solar." It has also led to a dramatic increase in interest in using renewable energy in the broader community. The success of RISE has spawned similar community solar buying co-ops across Toronto and now over 10 groups are exploring purchasing solar PV and solar water heating systems. One community group, Zero Footprint, is exploring the opportunity for purchasing and installing residential geo-energy heating systems in Little Italy.

Another recent community success story comes from the commercial sector. The Toronto Association of Business Improvements Areas (TABIA), an alliance of 60 local Business Improvement Areas that represent more than 22,000 small business owners recently completed a pilot project along Bloor Street West that will see solar powered decorative lights along that street.

The City is now exploring the possibility of installing up to 50 kW of PV on city buildings across the city.

While all these activities are positive for the future of PV in Toronto, this interest may not translate to a significant contribution to Toronto's energy mix without the City's engagement. Significant challenges still remain that need to be addressed:

- Property owners' protection of the right to the solar energy falling on their land or building.
- Zoning regulations that are being interpreted in a way that restricts solar electric systems that are connected to the grid to be only allowed in areas that are zoned commercial.
- The lack of a PV industry or installer base in Toronto. Most of Ontario's PV industry is based in rural and remote regions. Canada's PV manufacturing is mainly centred in BC.
- Concerns of the long term commitment to the use of PV by the OPA in the Standard Offer Program.
- The current rate offered by OPA may be adequate to attract early adopters and large central PV systems (solar parks). PV prices will need to drop significantly or the rate will need to increase in order to significantly build the PV capacity in Toronto.
- The high upfront cost of PV prevents many from exploring the opportunity of generating their own electricity.

One of PV's most attractive energy attributes is its ability to generate electricty when Toronto most needs it – during the hot sunny days of summer. In fact PV's capacity factor (the amount of energy it produces per name plate rating) increases as more energy is needed in Toronto.[23]

Recent studies by the OPA and documented by the Ontario Clean Air Alliance[24] indicate that it costs $1.64 per kWh to produce electricity during peak times in Ontario (compared to the average charge of $0.13 per kWh that we pay for delivered electricity). Further, Toronto is facing stresses on its electrical transmission and distribution systems due to high summer peak, caused mainly by residential air conditioners, and the growth of high-density residential areas in the downtown.

This represents one of the greatest opportunities for PV in Toronto – focused installations of PV to reduce stress on local electrical infrastructures that are reaching their peak delivery capacity. Development of local energy zones that integrate Toronto Hydro's forecasting on electrical system stress points would be one of the first steps to maximizing the benefit of PV in Toronto. PV's ability to provide peak power solutions in targeted, often urban settings has been the primary driver to the development of PV in other jurisdictions such as Germany and California.

Suggestion for Action

Toronto should develop a PV strategy in conjuntion with the development of community energy zones to identify opportunities where PV in the community can address challenges in the Toronto electrical distribution system. Focused installations in these peak demand- "challenged" communities will save or defer costs in upgrading distribution system elements.

If Toronto were to maximize its solar potential for PV then by 2030 it could have almost 1,000 MW of PV on residential homes. The potential for commercial buildings (on large flat roofs) as well as integration into the façade of new buildings could possibly equal this potential. With continued support from the province and additional support at the federal and muncipal level Toronto could achieve the same level of deployment (on a per capita basis) as Germany now has by 2019.

Table 6: Toronto Targets for PV

	2006	2010	2015	2030
Watts/capita	0.1	0.3	2.9	300

Toronto could help facilitate the use of PV by:

- Overcoming the various barriers that are in place at different levels of government (resolving local issues and advocating at higher levels);
- Understanding the value of PV for Toronto (providing peak power to reduce summer loads) and integrating PV power in the community energy planning process;
- Leading by Example – installing PV on City buildings – particularly in energy zones that are experiencing capacity issues;
- Providing a central resource of information and advice;
- Assisting in providing financing mechanisms to overcome the high upfront cost.

Solar Thermal Technologies – An Introduction

Solar thermal technologies are those that use the sun's energy to produce heat. There are many applications of solar thermal – solar hot water heating, solar swimming pool heating and solar space heating. Each of these applications has residential institutional/commercial and industrial applications and may require slightly different policy tools to maximize their potentials.

Experts see solar thermal technology as being much closer to being ready for large-scale deployment than many other renewable energy technologies with life cycle costs in the range of $0.06 - $0.12 per ekWh. It is an under-appreciated fact that globally, installed solar thermal technologies out-powers wind power technologies (118 GW vs. 70 GW).[25]

Though the largest solar resource is available in the summer, winter heating loads can still be met in large part with solar during the winter. Peak heating requirements are generally on cold, clear winter days. Even when it is freezing out, solar energy can be collected to produce hot water.

Solar thermal tends to be undervalued because unlike electricity it produces heat that is not directly metered. Energy savings for a building are reflected in a reduced energy bill, but energy bills are dependent on numerous factors such as energy usage, outside temperature and occupancy activities. Therefore it is not obvious to a building owner what impact a solar system is having.

Tracking energy output of thermal energy generators (such as solar thermal and geo-energy) through reductions of energy use on energy bills creates performance problems with systems as:

- Energy bills are dependent on a numerous factors – the impact of a thermal generator is not explicit;
- Energy bills are often 1-2 months in the past – they do not show current performance (note that advanced energy meters can resolve this issue);
- For commercial systems the billing process is often separated from the people who do system maintenance. Performance issues cannot be identified by maintenance personnel except where there is a catastrophic failure (e.g. a water pump breaks down).

The use of thermal energy meters is becoming popular in Europe and elsewhere to quickly identify and resolve performance issues. Toronto should consider leading by example on the use of thermal energy meters.

Suggestion for Action

All city renewable energy thermal systems should have their energy output directly metered so that they will be valued as energy sources (and not just as a conservation method). Direct monitoring also provides verification of performance and provides speedier resolution to maintenance and operation problems.

One of Toronto's world leading renewable energy firms, Mondial Energy Inc., is looking at solving this problem as well as overcoming the high initial cost of solar thermal system by acting as a "solar utility." Mondial owns and maintains solar thermal energy projects, mainly on the roofs of client's buildings, and directly meters the solar energy and then sells the thermal energy to the building owner. Mondial prices this energy competitively and commits to a long-term stable price contract.

Recently Mondial has partnered with Fats Spaniel, a internet based energy metering firm, to meter the thermal energy output of one of its largest Toronto projects, a 110 kW (thermal) solar water heating system that provides the domestic hot water for 110 apartments in two adjoining buildings. This is the first commercial solar thermal system to be metered by this method and the energy output can be viewed on the internet[e]. This provides valuable information to Mondial's customers as well as a powerful tool to show the value of solar energy.

Suggestion for Action

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[e] www.mondial-energy.com/live-solar-energy-monitoring/11-Main.htm

The City should consider monitoring all the city government's large renewable energy systems using web-based technology. This virtual power plant will showcase the City's Leading by Example Initiative and will highlight the value of multiple, distributed sources of energy – both thermal and electrical.

Solar Pool Heating

There are an estimated 94,000 swimming pools in Toronto and over 22,000 of them are heated by natural gas.[26] Heating a swimming pool requires approximately the same amount of energy as heating an average house. Further, an additional 1,000 swimming pools are installed each year – adding another 300 natural gas heaters to the energy demand of Toronto. Upwards of 500 GWh of natural gas (worth $26 million) is used to heat the pools of Toronto.

Swimming pools, with their expensive heating bills, are a natural for solar heating in Toronto with our excellent summer solar resource. Solar pool heating systems typically have a payback of 3- 4 years (equivalent to a 24-35% interest rate if the money was invested) and are generally viewed as the most cost effective method to heat a swimming pool. In Canada almost 75% of solar water heating system sales are for the heating of pools[27] – however only the surface has been scratched of this opportunity. There are less than 800 solar heated pools in Toronto while an estimated 40%[28] of pools (38,000) could tap this renewable resource. Solar pool heating could displace almost 9,000 natural gas heaters now and up to 15,000 heaters in 2030.

The City operates 63 indoor and outdoor swimming pools and spends over $4.5 million annually to heat them. Recently the City has taken a lead in Canada in exploring the use of solar pool heating and has just completed the first phase of an energy efficiency retrofit program for arenas and recreation centres that installed four solar pool-heating systems. The solar pool heating systems at the Jimmie Simpson Recreation Center is the largest solar pool system in Canada and the four systems represent the largest number installed by any one municipality in Canada. As a follow up to this highly successful first stage the City is considering installing solar heating systems on a further ten pools in 2007 and 2008.

Table 7: City of Toronto's Solar Heated Public Pools

Toronto Recreation Centers	Power (ekW)
Jimmie Simpson (large pool)	250 kW
Jimmie Simpson (small pool)	94 kW
Centennial	200 kW
Agincourt	193 kW
TOTAL	**737 kW**

The success that the City is having with solar pool heating could be replicated in the community if barriers to its greater adoption are overcome. Recent studies in Canada have concluded that two of the major barriers to increased market share are the lack of awareness of this solar technology and its high savings, and the high upfront cost of a system (typically $3,000 - $4,000 compared to $1,500 for a natural gas heater).[29]

In 2001 Natural Resources Canada carried out 3 one-year pilot programs to promote solar pool heating in BC, Niagara Falls and Montreal.[30] The results were impressive. Even though the pilot lasted only one year, participants reported that sales of solar pool heaters skyrocketed the following year.

This has also been the experience internationally where a coordinated marketing campaign along with the removal of key barriers such as financing can stimulate the uptake of this practical use of solar energy. In Australia for example, it is estimated that 50% of domestic swimming pools (vs. 1% for Toronto) are solar heated and this was brought about by a publicity campaign supported by state and municipal governments. Toronto's summer solar resource is the same as Perth, Australia.

Experiences learned elsewhere indicate that solar pool heating could have a significantly increased uptake in the pool heating market by:

- Increasing the awareness of solar pool heating;
- Providing information on the cost effectiveness compared to other heating options (such as natural gas);
- Reducing barriers such as permit fees and providing assured access to the solar resource;
- Discouraging the use of conventional heaters through increasing building or introducing annual licensing fees;
- Providing easy access to low interest financing.

Table 8: Estimated Impact of a Solar Pool Program in Toronto

Years	Total Solar Pool Heaters Installed	Number of Displaced Natural Gas Heaters	Energy Savings GWh (only from Displaced Natural Gas Heaters)
2010	2,000	1,000	7
2015	5,000	2,500	17
2030	30,000	15,000	105

While pool heating is an often neglected area of potential energy savings it has a number of attributes that make it an opportunity for an early action on renewable for Toronto:

- Toronto government's own solar pool heating successes can be highlighted;
- It is an economically viable energy source now;
- It would provide increased public awareness of other solar technologies;
- It would provide for early industry building capacity as skills learned in installing solar pool heaters could be transferred to the other solar sectors;
- Increased sales in Toronto along with industry-based incentives could encourage manufacturing to be established in Toronto. There are 3 solar pool manufacturers in Canada – most of their product is exported to the US.

Recommendation #3: Pilot Solar Heating Program for Swimming Pools
Council should request the Energy Efficiency Office to develop a pilot solar heating program for privately owned swimming pools and report back on the resources required to implement this program.

Residential Solar Domestic Hot Water

Solar water heating is an economically viable energy source now, with an energy cost comparable to current conventional sources. In the 1980s Canada was a world leader in the manufacturing and sales of solar water heaters. However the abrupt cancellation of all support programs both federally and provincially created a collapse of the solar thermal industry in Canada. This collapse resulted in massive system failures, as there were no firms to repair products that were rushed to market to take advantage of government support. Canada's solar thermal industry is about ½ the size it was in the 1980s. Toronto had four solar manufacturers in the early 1980s – currently there are none.

While the market for solar water heating has been dormant in Canada over the last 20 years sales have continued internationally so that now Canada ranks significantly behind most of our trading partners.

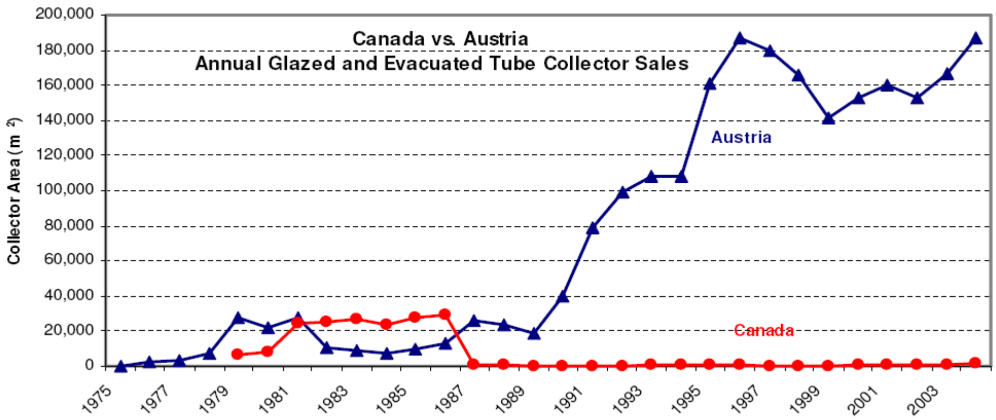

Figure 19: Sales of Solar Hot Water in Canada & Austria[31]

While there is little data on the sales of solar water heaters in Toronto it is anticipated that it is similar to the Canadian average.

Table 9: Solar Water Heating Installed Capacity

Current Installed Capacity[32]	W/capita
Toronto	13
Canada (Average)	13
China	35
USA	59
Austria	182

Suggestion for Action

Toronto Buildings could play an effective and nation leading role in providing statistics on distributed generation by reporting the annual number of building permits issued for various renewable technologies. Federally there are few resources applied to maintaining statistics on geo-energy, photovoltaics and solar thermal technology and Toronto's statistics would be invaluable.

The heating of domestic hot water is a major energy consumer in Toronto. The majority of low rise residences (single and detached family homes) use natural gas, while the majority of apartments and condominiums use electricity. Approximately 20-25% of the energy used in a household is for water heating.

Table 10: Residential Water Heating In Toronto

Household water Heating	5,000 ekWh/year
Number of households in Toronto (2007)	520,000
Estimated energy used for water heating in Toronto	2,600 GWh

Based on experiences of municipalities such as Perth (ON) and Bathurst (NS) that have completed community solar resource assessments it is estimated that approximately 70% of Toronto homes could install a solar water heater. In Toronto solar can provide approximately 50% of the annual energy needed for hot water. More importantly it can provide almost 100% of the heating needs during the summer when Toronto experiences increased smog conditions. Natural gas water heaters are a significant contributor to smog in Toronto.

There are growing opportunities that indicate that the market, particularly for residential solar domestic hot water (SDHW), may soon begin experiencing rapid growth in Canada.

In Toronto there is a convergence of opportunities for solar water heating:

- Natural Resources Canada (NRCan) has recently announced that they will be solicitation of Expressions of Interest to develop pilot SDHW programs in different areas in Canada. Approximately $9 million is available over 4 years.
- The provincial government has expressed interest in providing equal funding for federal supported renewable energy initiatives in Ontario.
- EcoEnergy Energy Efficiency Program (the old EnerGuide for Homes) has increased their support for SDHW to $500 per system.
- The Portlands Energy Centre has indicated that it would provide funding for local environmental initiatives in south Riverdale. These could include funding to displace natural gas consumption from water heaters.
- There are a growing number of local community groups in Toronto that are interested in assisting in deploying SDHW systems in Toronto through local efforts (i.e. buyer co-ops). The groups are beginning to coordinate their efforts.

Recommendation #4: A Pilot Program for Residential Solar Water Heating

Council should request the Energy Efficiency Office to develop a pilot program for residential solar hot water heating, and to report back on the resources required to implement this program.

The principle barriers to SDHW are[33]:

- Lack of awareness of SDHW by homeowners and builders;
- Lack of industry infrastructure, including qualified installers and product certification;
- Lack of experienced and knowledgeable building inspectors;
- High up front cost;
- Lack of easily accessible financing at reasonable rates.

A program in Toronto would need to ensure that these barriers are addressed.

If Toronto were to introduce a program to support residential solar water heating it is projected that sales would follow international growth values and that by about 2027 Toronto would have installed the same amount as Austria has now on a per capita basis.

Table 11: Toronto Targets for Solar Hot Water

	2006	2010	2015	2030
Watt/capita	0.6	1.2	7.2	450

Co-benefits of a solar water heating program in Toronto include:

- Residential solar water heating creates more local jobs per energy unit than any other energy source. By 2015 the solar thermal industry in Toronto could provide 200 skilled jobs in trades and by 2030 up to 1,700 jobs.[34]
- Reduction of natural gas use in the summer will contribute to the reduction of smog.

Industrial/Commercial Solar Hot Water

While the potential for commercial opportunities for solar water heating is not detailed in this report, it was noted that in Canada the majority of solar hot water heating system sales are in this sector. This trend is different than in other nations due to the lack of any support for residential solar water heating in Canada while commercial solar systems qualify for a 25% grant from Natural Resources Canada through the EcoEnergy for Heat Initiative.

Not included in the assessment of residential solar water heating is the potential in the multi-unit residential market. While limited compared to single-family homes this market can have better economics due to cost reductions from scale. As well the concept of a “solar utility,” where a separate owner of the solar system sells the solar energy to the building owner (or tenants), can be more easily introduced.

While the commercial potential was not estimated for Toronto, the report Smart Generation: Powering Ontario with Renewable Energy[35] estimates it at about 20% of the residential potential.

Solar Air Conditioning

The concept of getting coldness from heat may sound foreign to many; however, "absorption" cooling is one of the main methods that large buildings use to obtain their air conditioning. In Europe there are a number of large solar thermal cooling projects that have been successfully completed. In Spain, for example, the Technical University of Seville uses solar cooling to provide air conditioning to its energy research building. The International Energy Agency has recently established a working group to develop and expand the market for solar thermal cooling.[36] What is particularly attractive about this technology in climates that have both heating and cooling needs is the ability to use solar thermal systems for the two purposes – potentially reducing the effective energy costs of the system.

Canada is a member of the International Energy Agency (IEA) working group on active solar cooling and NRCan has expressed interest in the past in developing a pilot project for solar air conditioning. This could be a unique opportunity for Toronto.

Solar Air Heating

Solar air heating is a solar thermal technology that is cost-effective for pre-heating large amounts of outdoor air required for ventilation. It has found wide acceptance in Canada and elsewhere, particularly in industrial applications.

Toronto is home of Conserval Engineering, the manufacturer of Solar Wall™, the leading solar air-heating product worldwide. Solar Walls are used in many buildings in Toronto including a community centre in Toronto's downtown core, the City's vehicle maintenance building and a recently completed fire station at Toronto's international airport.

While not covered in the projections for renewable energy's contribution for Toronto, the David Suzuki Foundation's report, *Smart Generation*, projects a potential of almost 1,000 GWh of energy to reduce natural gas use in Ontario by 2025.[37]

Passive Solar

Perhaps one of the most undervalued energy sources that we use in the City is passive solar – the sunlight that enters our homes through windows on clear sunny winter days and which lights our homes and offices every day of the year. CMHC estimates that the sun shinning through south facing windows reduces the average home's energy bill by over 10% annually.[38]

Passive solar includes approaches to substitute or complement daylight for artificial lighting and solar heat for conventional space heating. Passive solar is mainly a building technique related to the orientation and design of buildings and communities and the selection of materials.

Integrating passive solar into new buildings and building retrofits can be an important, low-cost opportunity to decrease a building's energy use over its life cycle. Reasons that passive solar techniques are not more widespread are similar barriers to the use of other sustainable building techniques such as lack of awareness or perceived extra cost. Initiatives such as green buildings provide a strong opportunity to increase the role of passive solar.

6.6 Wind

In 2003 the first urban-sited large (750 kW) wind turbine in North America was installed in downtown Toronto on the grounds of Exhibition Place.

The installation of this turbine was driven by the Toronto Renewable Energy Co-op (TREC), a local community group that followed the wind community co-op model developed successfully in Denmark. This project created many North American "firsts" – including the first turbine owned jointly by a publicly owned electricity company (Toronto Hydro) and a community based co-operative, and it helped spawn the creation of similar community energy groups in other cities and towns throughout Ontario.

The decisions that City Council rendered in allowing the installation of the Exhibition Place wind turbine were landmarks for the wind energy in North America and have been used as municipal models by many other municipalities in Canada and the US.[39]

However, while Toronto was the first community to accept a large wind turbine in an urban setting in North America there are currently no clear regulations outlining the use of wind turbines in Toronto.

Suggestion for Action

Toronto should, in consultation with various stakeholders including the Canadian Wind Energy Association, develop regulations that facilitate the use of wind power in Toronto on public and privately owned spaces.

Wind power in Toronto is economical today. Construction costs are estimated to be lower than those for nuclear reactors. Operating costs are very low, and there are no issues with long term hazardous waste storage. In addition, winds tend to blow on winter evenings when winter demand peaks. The two limitations of wind energy in Toronto are availablity of locations and intermitency of the resource. Toronto's greatest potential for capturing strong winds is along the lake. A 60 MW wind farm was being considered by Toronto Hydro in the lake near the Scarborough Bluffs; however the province has placed a freeze on all off-shore wind projects pending further study on their environmental impacts.

Suggestion for Action

Toronto should advocate for a speedy environmental assessment of wind power on the Great Lakes – the process to develop a review process on the environmental impact has not been outlined by the provincial government yet.

Additional potential exists on the land or water near the Toronto Islands and the Western Beaches. A consortium of private and community groups, “Spitting in the Wind”, is looking at installing wind generators in this area. With sufficient support, it is estimated that an additional 20-50 MW of wind generation could be built within the few years, and that in the long term up to 200 MW could be installed in Toronto and offshore.

Wind generators require both high wind speeds and “laminar” wind flow to produce significant quantities of power – these are achieved in flat open spaces and high above the ground For this reason smaller wind machines are generally not viable in urban settings and the potential of small residential wind turbines is considered small in Toronto.

However, there is growing international interest in the development of special wind generators specifically designed for the “urban form.” These turbines are designed for the tops of high buildings and are expected to become popular in the future generations of high rise buildings that will be zero energy. While this is a technology that is largely undeveloped, Toronto should ensure that its local regulations do not unneccisarily prohibit this power source.

6.7 Hydro Power

In the 1800s there were many small water mills in Toronto. While those water mills are gone, the water’s potential remains. Modern hydroelectric generators tend to require high head (fall of water) to power the turbines and the potential for this type of system is limited in Toronto. However there are small generators that can operate on very low head and some can actually run on the flow of the river. Various stakeholders provided some potential locations in Toronto – particularly along the Humber and the Rouge and storm water reservoirs. Estimates ranged from 1-5 MW of potential in Toronto. As part of the suggested renewable resource assessment, a preliminary study should be done on this small, but potential resource.

One interesting possibility that was mentioned during the consultations is the potential of rainwater harvesting from the tops of high buildings. The long term potential of this possibility could be explored further.

6.8 Bio-Energy

Like solar, bio-energy is an energy source whose technologies are only related through the energy source they share. For bio-energy technologies the energy comes from carbon based organic material – primarily from vegetation.

While there has been considerable discussion in Toronto surrounding "energy from waste," this has focused on incineration. Incineration is only one of many options of utilizing the potential energy found in organic matter. This discussion has tended to overpower any evaluation of other opportunities now being used to exploit this energy source both cleanly and efficiently.

Suggestion for Action

Numerous stakeholders who were consulted on the energy plan suggested that Toronto needs to hold a serious dialogue on bio-energy issues and learn how other leading cities have dealt with concerns.

While this section of the energy plan does not attempt to consider all the options of "energy from waste", it does consider the current technologies being used in Toronto plus opportunities from other sources of bio-energy.

The technologies evaluated here can be broken into three primary categories:

- **Bio gas** - organic material for the waste stream (solid waste and waste water) that is converted to methane
- **Bio mass** – typically wood waste which is usually burned – wood and pellet stoves are good examples
- **Biofuels** – production of ethanol, biodiesel and methane from plant crops such as corn, soy and switchgrass.

There are severe capacity limits to the use of bio-energy in Toronto related to the waste streams. While there is some additional potential to exploit, the energy produced from the organic matter in Toronto is relatively small compared to the potential of other renewables such as geo or solar energy. However, it is a significant resource that is immediately available.

In the long term past 2030 however, bio-energy from outside of Toronto's borders is one of only a few renewable energy sources that can significantly replace natural gas as an on-demand thermal energy source. As such the full potential of bio-energy should be exploited in Toronto to begin building the necessary infrastructure and to learn about this valuable energy resource.

Bio Gas

The City has been a long term user of bio-gas. Toronto has been tapping its landfill sites for methane gas capture, and electricity production, since the early 1990s, recovering more than 50% of methane that the sites produce.

In considering biogas there are three technology areas that can capture methane production:

- Solid waste – captured in landfills
- Solid waste – captured in the processing
- Waste water – captured in the processing

Landfills

Toronto currently owns three landfills (Beare, Keele Valley, and Brock West) where the methane is converted into energy. Currently the three landfills produce about 340 GWh/year. It should be noted that except for Beare, the landfills are not in Toronto and should be considered part of the Ontario supply mix.

Toronto also has a large number of old small landfills that are producing small quantities of methane that is vented directly or flared. The quantity (and quality) of methane is so low that it is deemed uneconomic to produce electricity from them. However, in considering community and district energy systems these resources could be captured as sources of potential heat (rather than wasted through flaring).

Methane production in landfills decreases over time unless more organic material is added to them. It is projected that the current three landfill methane power plants will be able to operate for a further 20-30 years before they become uneconomical.

Solid Waste

The City also produces methane from the anaerobic digestion of about 25% of the bio-degradable waste collected from Toronto homes in a pilot project at the Dufferin waste management site. However the methane is simply flared and not used to generate energy. The City is in the early stages of a study to evaluate how this methane could be used economically.

If the City were to capture the energy potential of 100% of the organic waste then there is a short-term potential of 76 GWh/yr and a long-term potential of just over 100 GWh/yr.

Table 12: Toronto's Organic Waste Energy Potential

	Organic Waste	Potential Biogas	Potential Energy	Potential Power
Current	120,000 tonnes	110 m^3/tonne	76.5 GWh/yr	8.7 MW
Potential (2010)	160,000 tonnes	110 m^3/tonne	102 GWH/yr	11.6 MW

Waste Water

The City operates four waste water treatment plants and is in the process of introducing bio-gas co-gen energy systems into the two largest plants. Currently, the methane produced in the treatment of sewage is utilized within the plants for heating requirements or is simply flared off. The potential energy output from the four plants is uncertain; however, the system at Humber is designed to provide about 4.7 MW of electricity and 5.8 MW of thermal heat. If this is extrapolated to the four plants this would provide a maximum potential of about 22 MW electricity and 30 MW thermal energy.

All waste water plants should be considered as potential hubs to local district energy systems able to supply or use excess thermal energy.

Bio-mass

The oldest source of energy used in Toronto is biomass – the burning of wood. Biomass however has changed significantly since those days and has been growing steadily in popularity globally.

As outlined in Energy in the Community section, biomass is increasingly being used in Europe to displace coal and natural gas in district heating systems.

Biomass use in Toronto currently comprises of residential wood stoves and pellet stoves. Fireplaces are not considered energy sources as they draw more energy up the chimney than they produce. There is no reliable source of data on installed capacity or annual sales in Toronto; however, various stakeholders have mentioned that pellet stoves, particularly ones imported from Europe, are gaining in popularity.

While not a largely readily local energy source there are nevertheless some opportunities such as through park maintenance done by the Parks, Forestry and Recreation Division, tree trimming and removal by Toronto Hydro, construction site and building renovation waste and wood waste from the commercial/industrial sector in Toronto

While the priority on the bio-mass waste streams should be to recycle and reuse wherever possible, and Toronto Parks in particular has an excellent program of converting what would be normally considered waste wood into valuable material for local craft shops, there are opportunities here to divert wood waste from the land fill stream. No estimate was derived on the potential due to the lack of data.

Suggestion for Action

Toronto should, in conjunction with Toronto Hydro and the Ontario Ministry of Agriculture and Food and other stakeholders, explore opportunities for diverting wood waste from the solid waste stream for use in bio-matter energy systems (either for use in Toronto or elsewhere).

Bio-gas

In Europe, US and China there are ongoing pilot projects where crops, specifically grown for their methane production value, are used to displace natural gas to run co-gen systems for electricity and heat. In California PG& E has recently announced a partnership with the farm industry to provide methane that will run a pilot generating plant of 10 MW. As well there is on-going research, particularly in Europe, on how to inject methane into the natural gas pipeline infrastructure to reduce reliance on natural gas.

It can be envisioned that biogas will one day displace natural gas as the primary source of thermal energy in Toronto. This can provide a provincial source of energy that would support Ontario's rural communities; however there are a variety of complex issues such as competition for agriculture resources for food or fuel that must be considered. Toronto should encourage the provincial and federal governments in resolving these issues as our need for bio energy expands.

6.9 Zero Energy Buildings

Zero Energy Buildings are buildings that produce all their own energy. Advances in this concept are being made around the world with the first zero energy homes being built now, zero energy high rise buildings being built in a few years and zero energy communities in the not-too-distant future.

A zero energy building is a building that maximizes the use of passive solar energy and daylighting, energy efficient design, construction and appliances, and incorporates on-site renewable energy systems to make the net energy consumption zero.

In Canada, CMHC has a long-term vision that foresees that by 2030 all new homes will be built to the net zero energy level. As a start to introducing zero energy homes in Canada, CMHC has initiated a pilot program, the Equilibrium Healthy Housing Initiative, [40] which will see 12 net zero energy homes built in Canada over the next 2 years. Two of these are in Toronto.

The Now House™ project is a retrofit of an existing post-World War II home. It will utilize insulation upgrades, new windows, Energy Star appliances, wastewater heat recovery, and solar panels. This project will demonstrate how an existing house can be made into a zero energy home.

The Top of the Annex TownHomes project involves three town houses that are being built in the downtown Annex area. The design includes high level of insulation, a ground source heat pump, spectrally selective window glazing, and a solar domestic hot water heating system and PV modules on the roof of each unit.

With a high energy demand, commercial buildings are more difficult to design to meet the net zero energy target. Yet commercial buildings are now being designed to achieve net zero energy use.

The Pearl River Tower[41] is a 300-metre tower in Guangdong, China that will require no net energy to operate. The project's green elements are a water-retention area; basement fuel cells; façade-integrated photovoltaics; a condensate reclamation system that collects water and reuses it; and stack ventilation. The building is designed to direct air through two apertures (in two mechanical floors) where it is then passed through wind turbines. Construction for this building is predicted to be finished in 2009.[42]

Net zero energy communities are already becoming a reality around the globe. The community of BedZED, located in London, England and the municipality of Malmö, in Sweden are two prime examples of communities that are approaching net zero energy. They both provide enough energy, from renewable sources, required by the residents to make the residential energy consumption net zero. Exhibition Place announced a target to be energy self sufficient, or net zero energy, by 2010.

Suggestion for Action

Toronto should encourage innovative buildings and work to support the concept of zero energy homes, commercial buildings and communities.

6.10 Renewable Energy Opportunities for Toronto

Renewable energies can help us meet our demand for energy in two ways. Large projects can feed the electric grid or District Energy Systems in much the same way as conventional generators. Smaller projects operated by consumers can reduce demand and provide infrasturcture suppport to reduce surges in demand that stresses the energy infrastructure. Small, dispersed energy projects also help provide security and continuity of supply in case of massive system failure as well as reducing infrastructure costs and increasing system efficiencies.

Renewable energy technologies in Canada are only in the early market stage. It has taken other nations nearly 25 years of coordinated, continuous efforts to achieve the levels we see today. Toronto can learn from the experience of other cities and speed the market transformaton for renewables; however, it will still take time. But this should not be used as an excuse for inaction. In Toronto renewables' contribution will be small through to 2030, but will grow exponentially faster than conventional energy sources. If, by 2030, renewable achieves a 5% energy contribution but is growing at 35% annually, then by 2033 its contribution will double, and then double again by 2036 and so on.

An international conference on renewable energy held in Bonn, Germany in 2004 saw 154 countries agree on a set of goals for an increased role for renewable energy[43]. This conference is considered a landmark for renewable energies globally, as it saw governments develop a set of voluntary policy recommendations on actions that they would undertake. The international conference set three priority areas for renewable energy policies:

- Establishing policies for renewable energy markets;
- Expanding financing options;
- Developing the capacity required.

During the conference it was noted that local governments had a major role in the development of renewable energy.

Key municipal policies that could impact the growth of renewables include:

- Use building codes to encourage uptake of renewable technologies;
- Overcome licensing and siting barriers by strengthening staff and stakeholder knowledge;
- Lead by example with government purchases;
- Increase awareness of local stakeholders that come into contact with renewable energy technologies (such as builders, realtors, property appraisers, inspectors);
- Establish funding mechanisms (such as public-private investment funds or low interest financing);
- Integrate renewable energy into non-energy policies like planning, transportation and waste management.

Recently, the City established the Renewable Energy Action Plan (REAP) Working Group, which consists of staff from various departments such as City Building, City Planning, the Energy Efficiency Office, and the Toronto Environment Office to coordinate joint policy making across the City departments. This is a ground breaking step for the City had will help Toronto in its transformation to a sustainable city.

The role that municipalities have to play in providing market transformation of renewables is well understood globally. In Germany it was cities that first developed the feed-in tariffs in the early 1990s that we see now being introduced by the OPA in Ontario. In Spain, Barcelona first introduced a requirement to install solar water heaters in every new building and renovation. This requirement has now been introduced as a EU directive to all member states.

However, in Canada the role of municipalities in renewable energy is not as well understood. There has been an expectation that municipal governments will follow the lead of the provincial and federal governments on energy policy, when in fact international experience indicates that the reverse actually happens. Cities have many tools that can provide for market transformation for energy sources inside their boundaries.

Financing Renewable Energies

One of the critical roles that municipalities have played internationally is establishing financial support for smaller renewable energy projects. Zero fuel costs and low operating costs are one of the prime advantages of most renewable energy technologies; however, renewable energy projects, like large energy projects, have high capital costs. Larger energy projects such as nuclear power plants or the oil sands rely on the market to provide financing at very low interest rates. Similarly, very few people pay the full upfront costs on their homes or vehicles. Instead businesses and individuals use a variety of financing mechanisms for these large costs. However, these options are not available for small renewable energy projects in the early market stages as they are considered risky by financial institutions and interest rates are usually at unsecured lines of credit (currently 10-12% annually).

Interest rates can very quickly eat up savings from a renewable energy project as illustrated in the following table:

Table 13: Financing Costs of a Residential Solar Water Heating System

	Installed Cost	Current Annual Saving	Annual Interest Charges		
			10%	**5%**	**0%**
Cost of a Residential Solar Water Heating System	$5,000	$400	$500	$200	$0
Financial Return on Investment			-2%	4%	8%

Municipal low-interest loan programs for renewable energy projects were popular in Europe during the 1980s and 1990s but have largely been phased out as financial institutions become more comfortable with the savings and the asset worth of projects. In the US there are now over 57 municipal or state loan programs that support the deployment of renewable energy projects at the local level.[44] In Canada there is only one program, which is offered by VanCity Finance and supported by funding through the BC Sustainable Energy Association.

While the energy benefits are hard to quantify without a detailed analysis, the energy production (saving) benefit for Toronto would be quite large, as a municipal loan program would help overcome one of the greatest barriers that renewable energy stakeholders[f] mention most often: access to low cost financing. In using the above example of residential solar water heating as a template, the potential impact of a Toronto renewable energy loan program can be illustrated in the following table.[45]

Table 14: Impact of a Toronto Financing Program on Solar Water Heating

Years	Total Number of Systems Supported	Installed Capacity	Annual Energy Generation
2010	4,000	18 MW	9 GWh
2015	10,700	48 MW	24 GWh
2030	31,000	138 MW	69 GWh

Solar water heating systems are only one of a variety of renewable energy technologies that require financing mechanisms. Geo energy, photovoltaics, community energy systems all need access to low-cost financing.

[f] There are documented briefings from the Ontario Sustainable Energy Association, the Canadian GeoExchange Coalition and the Canadian Solar Industries Association that identify access to financing as one of the major barriers to greater deployment of renewable energy technologies.

Recommendation #5: Overcoming the Financial Barriers to Renewable Energies

Council should endorse the creation of a $20 million Toronto Green Energy Fund to provide support for renewable energy installations in Toronto.

7. The Role of Toronto's Government

7.1 Additional Financial Support for Community Energy Retrofits

The creation of a Toronto Energy Conservation Fund (TECF) would provide the financial support necessary for the advancement of energy based sustainability projects. The City's existing Better Buildings Partnership (BBP) revolving loan fund of $8 million and the Energy Retrofit Program (ERP) of $35 million are well subscribed by the municipal, university/college, school and hospital (MUSH) and not-for-profit sectors, and by City facilities respectively. Additional funding in this amount would allow the Funds to undertake significant additional energy conservation retrofits, and could make it possible to extend financing to other buildings sectors in the city.

A review of the BBP experience to date illustrates the opportunities for new funding to engage broader participation and penetration rates from the key building sectors noted above.

At its inception, the BBP revolving loan fund provided zero-interest funding for up to two-thirds of the financed portion of energy retrofit project costs. However, there has been no significant new injection of capital into the BBP loan fund in over ten years. This fact, coupled with the impact of a zero-interest loan rate which effectively diminishes the value of the fund over time, has compelled the scaling back of incentive levels from the original 66% of the total financed energy project value to typically less than 20% of the total financed project value. Indeed, the majority of pending applications will be limited to 10% or less of the total energy retrofit cost.

The reduction in real incentive levels offered has resulted in a decline and participation in the BBP program. In many cases, an incentive which only provides zero percent financing on less than 10% of the total financed energy retrofit costs is insufficient support to advance the project beyond the "go – no go" economic feasibility threshold.

Based on the experience of the BBP, a higher incentive level, comparable to that offered in the first phase of the BBP in the mid 1990s, would generate sufficient interest to subscribe another $22 million in energy retrofit loans.

To date, the BBP has provided about $10 million in zero-interest financing which has directly contributed to the reduction of more than 22 MW in electricity demand and over 54,000 MWh savings in electricity, over 6 million cubic metres of natural gas and reduced CO_2 emissions by almost 70,000 tonnes per year.

In comparison to results from other energy retrofit incentive programs, and in consideration of the variables in forecasting participation in a voluntary program, it is estimated that a new injection of funds into the BBP revolving fund of approximately

$42 Million would potentially save in the range of 70 MW of electricity demand and reduce CO_2 emissions by more than 200,000 tonnes per year.

Recommendation #6: Creating a Toronto Energy Conservation Fund
Council should endorse the creation of a Toronto Energy Conservation Fund, for revolving loans to finance enhanced energy conservation initiatives in City facilities and buildings in the Municipal, University/College, School and Hospital (MUSH) sector and not-for-profit organizations in Toronto. Consideration should be given to expanding access to the Toronto Energy Conservation Fund to other building sectors if legislation permits.

7.2 The Low-rise Residential Sector

As noted above, and in the attached consultant's *Background Report on the Energy Plan for Toronto*, much of Toronto's energy is consumed in the low-rise residential sector. While there is great interest in energy conservation among homeowners, there are barriers to carrying out retrofits in that building sector.

One of the most significant barriers homeowners face in carrying out energy retrofits is the lack of access to easily accessible, and affordable, financing. The province recently announced a program to help subsidize the cost of home energy audits. Federal programs provide incentives for energy retrofits after the retrofits have been completed.

However, experience with audit and post-audit programs indicates that homeowner followup on them is very low. One of the reasons for this is that homeowners cannot afford the upfront retrofit costs suggested by the energy audit, notwithstanding the fact that there could be an incentive payment at the end of the retrofit process.

A City program that helps homeowners deal with the up-front capital costs of making their homes more energy efficient could increase the uptake of complementary government programs. Toronto should create a fund to help finance the up-front costs faced by low-rise residential buildings in carrying out energy retrofits.

The low rise fund should be separate from the TECF, because the many small-scale transactions that would flow from this initiative make it operationally different from the TECF, which will handle relatively fewer and larger projects.

Recommendation #7: Creating a Fund for Energy Retrofits in Low-Rise Residential Buildings
Council should endorse the creation of a program to provide financial assistance to owners of low-rise residential buildings for energy retrofits.

7.3 City-owned Buildings

The City's Energy Retrofit Program

At the 2004 Smog Summit, the City launched the Energy Retrofit Program (ERP), which increased the funding available to retrofit City buildings and facilities to $35 million. The Federation of Canadian Municipalities (FCM) also provided an $8.75 million low-interest loan to help finance retrofit projects. The City funds the retrofit projects through low-interest loans and repays these loans with energy savings, using a maximum eight-year simple payback period.

It was also during this Smog Summit that the City announced a $10.2 million retrofit of 100 City arenas, partly financed by $2.52 million of the FCM loan. These retrofits are expected to pay for themselves over approximately eight years.

Included in the ERP is the civic centre project. This project saves the City $525,000 annually and will pay for itself in 7.6 years.

The latest project involves upgrading all of the City's community centres. These upgrades could save up to 25 per cent on energy bills, which works out to $750,000 a year.

In total, approximately 200 buildings have been retrofitted through the Energy Retrofit Program. These retrofits have reduced greenhouse gas emissions by 20,000 tonnes annually.

Making City Hall an Environmental Showcase

(See Appendix A for more detail)
On May 2, 2007, over 65 planners, environmentalists, engineers and specialists met at City Hall to set Toronto's City Hall and Nathan Phillips Square on the path for a sustainable and energy efficient future.

The group included representatives from the Clinton Climate Initiative and Plant Architect & Shore Tilbe Irwin – the winner of the Nathan Phillips Square design competition. After listening to presentations explaining the possibilities at City Hall, and what was planned as part of the Nathan Phillips Square redesign, the groups were divided up and set to task.

The goal is to reduce the energy and water use at City Hall by more than 75 per cent and then to achieve a net zero carbon impact through the generation of energy from renewable sources.

Ideas included:

- Major lighting changes;
- Revamping of the mechanical systems;
- Linking deep lake water cooling;
- Replacing the windows;

- Generating energy from renewable sources like wind, PV and solar thermal right on Nathan Phillips Square;
- Using rainwater for all water requirements in the building;
- Creating a green roof on the podium level.

A summary of the day's ideas and recommendations is being prepared and will be included as part of a future report. In the meantime, the City can take the first steps towards making City Hall an energy showcase by implementing the recommendations of Toronto Hydro Energy Services.

Recommendation #8: Making City Hall a Showcase for Energy Efficiency
Council should approve $13 million for the implementation of the next phase of energy efficiency and sustainability upgrades at City Hall and Nathan Phillips Square.

Connecting City Buildings to Deep Lake Water Cooling

(See Appendix B for more details)
Metro Hall connected to Enwave's Deep Lake Water Cooling system in June 2006. Savings are detailed below:

Table 15: DLWC at Metro Hall

Item	Value
Power consumption	1,740,480 kilowatt-hours per year less
Power saved is sufficient to supply	174 homes
Reduction in water consumption from cooling towers	4,400 cubic metres per year less
Carbon Dioxide* reduction	1,915 tonnes per year
Number of Cars with equivalent emissions	383

* Estimated full benefit of Enwave DLWC annually based on displacing coal-fired electricity

Partially ownen by the City, Enwave plays a major role in achieving Toronto's environmental goals, as discussed above. The Enwave system is expected to reach full capacity soon. It is important for the City to act quickly to connect as many of its facilities as possible to deep lake water cooling.

Recommendation #9: Connecting City Buildings to Deep Lake Water Cooling
Council should approve $9 million in spending for the implementation of Deep Lake Water Cooling at City Hall, Police Headquarters and Union Station.

Green Power

The City has previously committed to a target to obtain 25 percent of the City's electricity needs from green energy sources. This target could be achieved over a 4-year phase-in plan as follows:

Provincial Supply Mix	10%
City Energy Conservation Initiatives	5%
City Purchase	10%
Total	25%

Province Supply Mix – 10%

The Province's electricity supply mix currently includes about 3 percent green power and therefore the City's current electricity supply also includes about 3 percent green power. Green power in the Province's electricity supply mix is to be increased to 5 percent by 2007 and 10 percent by 2010.

City Energy Conservation Initiatives – 5%

It is generally accepted that energy conservation initiatives or Demand Side Management (DSM) should be given priority consideration in reducing CO_2 emission and DSM is considered as a contribution towards the City's green energy targets as previously adopted by Council. DSM projects currently underway will result in a reduction of about 51.9 million kilowatt-hours (kWh) annually or 5.3 percent of the City divisions' electricity requirements. This represents an equivalent purchase of approximately $2.0 million of green power for the City. If the DSM work is accelerated as envisioned in this report the equivalent green power would be even higher.

City Purchase – 10%

The City would purchase 10% green power at incremental increases of 2.5% for four years. The City green power purchases could be lower if DSM is accelerate

Recommendation #10: Obtaining 25% of the City's Electricity from Green Power

The City should develop a plan to achieve its target of obtaining 25 percent of its own electricity needs from green energy sources over a 4 year phase in period starting in 2008.

7.4 City Policies and Practices

Coordinating Existing and Emerging Initiatives

In February 2006, the Minister of Energy issued a directive to the Ontario Power Authority (OPA) to achieve 300 MW of electricity savings in Toronto by 2010. The directive was issued in response to predictions that the city could suffer from rolling power blackouts as early as 2008. In June 2006, the City signed a Memorandum of Understanding with the OPA agreeing to develop programs and projects that will achieve approximately 90 MW of savings by 2010. The balance of the 300 MW will be achieved by the Building Owners' and Managers' Association, working in the large commercial sector, and Toronto Hydro, which will offer programs primarily to the residential and small commercial sector. These programs will provide incentives for energy retrofits to existing City-owned buildings as well as buildings in the not-for-profit sector, and the high-rise residential sector. Incentives for new buildings to achieve high levels of energy efficiency will also be provided.

The City's OPA program is just one of many existing and emerging initiatives to encourage energy efficiency and renewable energy. The attached consultants' report by PricewaterhouseCoopers identifies over 80 such programs that are available in Toronto. One of the points most frequently heard during the consultations conducted in preparing this report was the need for better information on these programs, and for a coordinated delivery approach among the City, the federal and provincial governments, utility companies and others.

Recommendation #11: Meeting of Stakeholders
Council should approve convening a meeting in the fall of 2007 with representatives from the federal and provincial governments, Toronto Hydro, Enbridge, Enwave, private industry and environmental organizations to discuss the coordination of energy program delivery, and policy barriers to energy efficiency and renewable energy at all levels of government.

Developing Partnerships

Toronto's universities and colleges have much to offer in moving Toronto to a state of energy sustainability. As noted above, their campuses provide significant opportunities for district energy systems and other energy initiatives. The City has existing relationships with many of them through its Better Buildings Partnership Loan Fund, which has provided financial support for their energy retrofits. The City's 90 MW program with the OPA will provide further incentives to colleges and universities to reduce their electricity demand.

The City has also, on a number of occasions, utilized the intellectual resources that these institutions have to offer in energy-related areas. There is a need, and an opportunity, for the City to take greater advantage of these resources as it attempts to meet its energy targets. It would be appropriate for the City to formalize research partnerships with institutions of higher learning in areas that support its efforts to become a world leader in energy sustainability.

Recommendation #12: Developing Research Partnerships
Staff should approach Toronto's universities, colleges and other interested organizations, to discuss forming research partnerships on energy-related issues of mutual interest

Green Vendors Fair

Through the delivery of its energy programs, the City comes into contact with both suppliers and purchasers of products and services. These relationships could be levered to achieve other objectives, such as supporting "green" industries in the city, and training City staff in the application of energy efficient technologies.

Relationships with suppliers must also be developed in an open and transparent manner. A public event, such as a vendors' fair, could create an opportunity for staff to learn about the latest developments in energy efficiency and renewable energy applications, while at the same time respecting the need for fairness in the City's procurement processes.

Recommendation #13: A Green Vendors' Fair

Staff should be requested to organize a "Green Vendors' Fair" for providers of products and services that improve the energy performance of buildings.

Review of City Purchasing Policy

The City established an Environmentally Responsible Procurement Policy in 1999. Its purpose was to increase the development, awareness and purchase of environmentally preferred products and services. While it was a landmark for its time the policy should now be reviewed to take advantage of recent information and changes in green procurement policies and guidelines. For example, Public Works and Government Services Canada is now considered a world leader in developing and training government staff on greening government offices, and has resources to assist other government to improve their environmental purchasing policies[46]. The province's *Energy Conservation Leadership Act* also requires public agencies to consider energy conservation and energy efficiency in their acquisition of goods and services.

Individual divisions, agencies, boards and commissions are initiating provisions that integrate energy efficiency into the purchasing processes of their departments. For example, Toronto Water has developed guidelines on energy management in its procurement documents that include the design of energy efficient building envelopes, use of energy efficient lights and high efficiency motors.

Toronto should consider integrating energy efficiency guidelines into the purchasing process in city government. This could include applicable energy efficiency act provisions, energy star or other specifications for procurement.

Recommendation #14: Environmental Purchasing Policy

Staff should review the City's Environmental Purchasing Policy as it relates to energy efficiency and renewable energy.

Life Cycle Costing

Organizations frequently use the payback accounting method in its evaluation of energy measures for the Energy Retrofit Program. While payback is often used when considering short life expectancy products it does not account for the life "value" of long-term products such as energy efficiency improvements.

When evaluating capital investment options, using Life Cycle Costing (LCC) can help determine the option that is most cost effective. Rather then evaluating projects solely on the basis of initial costs, LCC looks at the total cost of owning, operating and maintaining a project over its useful life (including its fuel, energy, labour, and replacement components). Life cycle costing calculates operating and maintenance costs incurred during the lifetime of the project plus the initial capital costs.

Life cycle costing often shows that a project with a higher initial cost may be more financially beneficial in the long run. It is especially useful for evaluating energy efficiency and renewable energy projects since they often require a higher initial investment, but have lower operating and maintenance costs over the life of the project.

By overlooking the purchase of energy-efficient products because their initial costs may be higher, the City may save money in the short-term but will end up paying more for the project through higher energy costs and other operating costs over the life of the project.

The below simple example illustrates that using payback product 1 would be chosen even though product 2 would actually save more money over its life.

Table 16: Payback vs. Life Cycle Cost

	Costs	Product Life	Saves	Payback	Savings From Product Over Its Life	Life Cycle Cost
Product 1	$100	10 years	$20 per year	5 year	$200	$2.00 saved for every $1 invested
Product 2	$120	15 years	$20 per year	6 years	$300	$2.50 saved for every $1 invested

Many energy investments in buildings are faced with similar hurdles as payback limits the opportunities do provide real energy savings. Often energy life cycle costing is expressed in terms of energy units (i.e. $/kWh) and then comparisons can be made on which product has the lowest energy cost.

Reinvesting Energy Savings to Produce More Savings

Many city staff have stated that there is little incentive for building managers, maintenance staff and ABCs to invest in energy improvements. Savings achieved by city departments or building managers due to energy measures are realized as savings in the general City budget. These measures can create new costs and responsibilities for maintaining and operating the new systems and equipment involved, and these costs are incurred by building managers, and their budgets may not be adjusted accordingly.

The City should study ways of providing incentives to divisions, agencies, boards and commissions that save energy. In other jurisdictions, directing a portion of energy cost savings back into the budgets of those who successfully meet energy goals has proven to be an effective mechanism for increasing long term cost savings. Staff who know that their budgets can improve by finding energy saving opportunities are more likely to become champions for sustainable energy.

Recommendation #15: Moving to Life Cycle Costing for Energy Decisions

Staff should be asked to review the current policy of maximum 8-year paybacks for City energy retrofit measures compared to a Life Cycle costing approach, and also on a policy that would provide incentives for divisions, agencies, boards and commissions that participate in energy savings and/or renewable energy programs.

Phasing out Incandescent Light Bulbs

It is recommended that the City phase out of the use of inefficient standard incandescent light bulbs in common applications in its divisions, agencies, boards and commissions. In most cases the standard incandescent light bulbs can be replaced by a compact fluorescent lamp. Compact fluorescent lamps are four times as efficient and last tens times longer than standard incandescent lamps.

The Province has already announced that it will be phasing out the use of incandescent bulbs in common applications by 2012. The City has been replacing its incandescent bulbs as part of ongoing energy retrofits and it should be quite possible to replace all remaining bulbs by the end of 2008.

One concern surrounding the switch to compact fluorescent lamps (CFLs) is that they, unlike incandescent bulbs, contain mercury. However CFLs actually present an opportunity to prevent mercury from entering the environment. The highest source of mercury in our air comes from burning fossil fuels such as coal. A CFL uses 75% less energy than an incandescent light bulb and lasts at least 6 times longer. A coal power plant will emit 10mg of mercury to produce the electricity to run an incandescent bulb compared to only 2.4mg of mercury to run a CFL for the same time. Additionally, the mercury in a CFL can be reclaimed and reused through recycling. Collected bulbs are crushed in a machine that uses negative pressure ventilation and a mercury absorbing filter. Therefore if you use a CFL with renewable energy and recycle it, the mercury emission level is actually negated completely. Including CFLs in existing household hazardous waste collection programs would reduce end-of-life mercury emissions from CFLs.[47]

Recommendation #16: Phasing out Incandescent Light Bulbs

Council should direct all divisions, agencies, boards and commissions to phase out the use of incandescent light bulbs wherever possible by the end of 2008.

8. The State of Toronto's Energy in 2030 – Monitoring Our Progress

Toronto's Sustainable Energy Plan recommends that the City begin a long-term process of moving towards an energy system that is integrated with other planning processes, encourages local, clean and renewable energy generation, and pursues community-based solutions to energy efficiency challenges.

The plan envisions that by 2030 our total energy consumption had been reduced by 21% (31% on a per capita basis) and that local renewable energy resources, while only accounting for 5% (minimum) of the total energy supply, are on a solid footing and will have the capacity to make dramatic increases in their contribution in the period of 2030-2050.

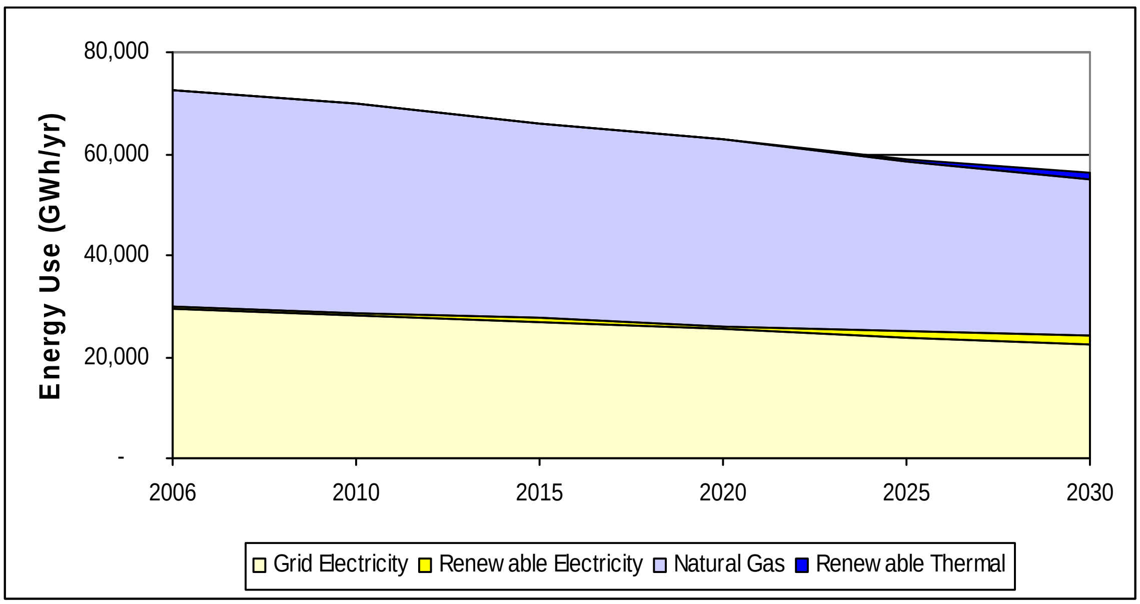

Figure 20: Energy Use in Toronto 2006-2030

Toronto's electricity mix will be increasingly supplied by renewable energy – both from the Ontario supply mix and from local generation and thermal technologies that displace electricity. Renewable energy will supply 47% of the electricity used in Toronto by 2030. However natural gas will continue to dominate the overall energy mix and will provide over 57% of the energy needs of Toronto.

By 2030 District Energy Systems will become prevalent in Toronto and will be supplied increasingly by energy forms other than natural gas.

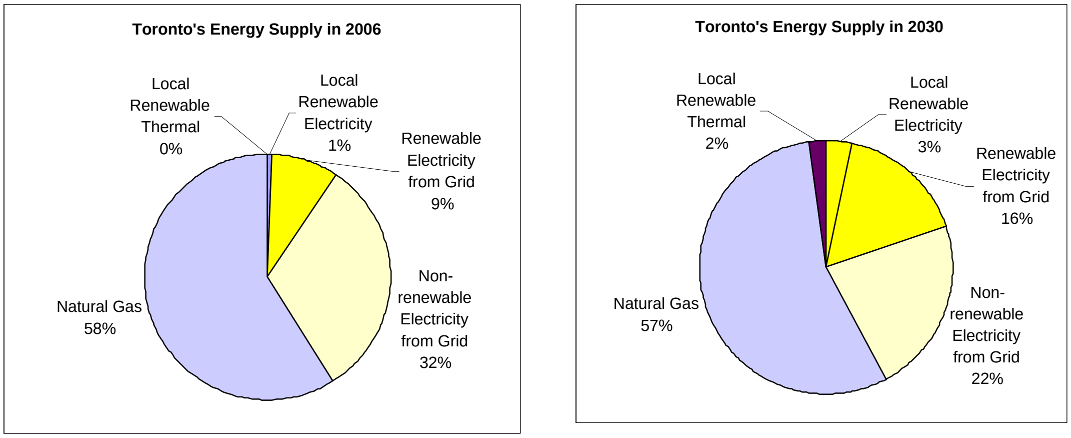

Figure 21: Toronto's Energy Supply in 2006 & 2030

Energy Data in Toronto

The collection of useful data on energy was a challenge. Utilities primary data collection needs are for billing and projecting distribution challenges on a relatively short time horizon. Energy data they collect is not broken down into building categories (i.e. retail or commercial) but rather in customer categories (i.e. residential or large user). Further, the data in some cases is not easily segregated into location (i.e. by city block). The central data management and repository of electricity data for the Smart Metering program presents huge opportunities for providing the needed energy data for municipal energy plans.

Suggestion for Action

The province and the Independent Energy Service Operator (IESO) should engage municipalities in a discussion to identify if reporting requirements can be supplied through the Smart Metering data management and repository mechanism.

In moving towards a sustainable energy future Toronto will need to look at energy at a community level. To develop District Energy Zones we need to develop energy maps of Toronto that can be overlaid to identify energy challenges and opportunities. We will need to know the electrical and natural gas use, the solar and geo-energy potential, and the energy infrastructures on a per zone basis for us to come up with the best integrated local solution.

Recommendation #17: Collecting Energy Data
That Council request energy utility companies in Toronto to provide data to the City, in a manner respectful of customer confidentiality requirements, to assist staff in monitoring the City's progress in meeting its energy targets.

Reporting and Benchmarks

One of the critical aspects in the implementation of this plan is to provide adequate indicators or benchmarks that allow Toronto to measure how successful we are in achieving our energy goals and objectives. Benchmarks can also be good communication tools and stimulate the community in developing local energy solutions. However, creating energy indicators that provide accurate and meaningful data has been identified as a challenge. Further, while the *Energy Conservation Leadership Act, 2006* requires annual reporting of the progress towards energy conservation goals, the indicators to mark this progress have not been identified yet by the province.

Recommendation #18: Annual Reporting on the Energy Plan
The City should report on progress in moving the City to a state of energy sustainability, and update Toronto's Sustainable Energy Plan annually, subject to the terms of the Energy Conservation Leadership Act, 2006.

The following indicators have been identified with the above in mind. It may be necessary to make adjustments to the indicators for the next update of the energy plan.

Table 17: Energy Benchmarks for Toronto

		Current	Recommended Targets		
		2006	**2010**	**2015**	**2030**
Population		2,512,060	2,638,505	2,764,680	2,905,290
Total energy use	GWh/year	72,535.66	69,815	66,127	57,389
Total energy use	MWh/capita	28.87	26.5	23.9	19.8
Total energy cost	$	$4,452,310,866			
Total energy cost per capita	$/capita	$1,772			
Electricity					
Total electricity use	GWh/year	29,878	28,737	27,486	24,170
Total electricity produced (or displaced) by local renewable sources	GWh/year	463	515	600	1,930
Total electricity supplied by renewables (from grid and local supply)	(%)	23%	27%	32%	47%
Natural Gas					
Total natural gas used	GWh/year	42,655	41,061	38,581	31,926
Total thermal energy produced by local renewable sources (that displace heating loads)	GWh/year	3	17	49	1,294
Renewable & Sustainability Indicators					
Total Installed Capacity for PV	W/capita	0.1	0.3	2.9	300
Total Installed Capacity for Solar Hot Water	W/capita	0.6	1.2	7.2	450
Total Installed Capacity for Geo Energy	W/capita	*these benchmarks need to be established*			
Total energy supplied by District Energy Systems (heat and cool)	GWh/year	*these benchmarks need to be established*			
Building Sector Indicators		(2005)			
Office	kWh/m^2/year	360.6			
Retail	kWh/m^2/year	395.0			
Multi Unit Residential	kWh/m^2/year	270.2			
Low Rise Residential	kWh/m^2/year	212.0			
Industrial	kWh/m^2/year	286.3			
Schools	kWh/m^2/year	204.5			
College & Universities	kWh/m^2/year	286.3			
Health Care	kWh/m^2/year	341.2			
Municipal	kWh/m^2/year	305.7			
Other	kWh/m^2/year	212.0			

Appendix A: City Hall: A Showcase of Energy Efficiency

City Hall – Energy Efficiency Status

City Hall was built before energy efficiency became a priority, and is therefore more difficult to bring up to the energy efficiency level expected of today's new buildings. That being said, many energy retrofit measures have been implemented in the past and additional measures are being implemented.

In the mid-1980s the lighting system was upgraded and in 1994 and 1996 further energy efficiency measures were installed including a new energy efficient chiller. In 2002 and 2003 the other two old chillers were replaced.

However, energy use in all City buildings including City Hall has been creeping upwards due to increased occupancy and plug load which includes photocopiers, printers, fax machines and computers.

The total cost of utilities for City Hall including water for 2006 was approximately $3.0 million and it is expected that this cost will increase to over $3.2 million in 2007.

A number of energy retrofit measures are presently being implemented by Toronto Hydro Energy Services Inc. to further improve the energy efficiency of the building including lighting controls and upgraded building automation equipment at a cost of $900,000. Savings of $150,000 per year are expected from these upgrades and an energy reduction of about 5 percent. Once these energy retrofit measures are completed the overall CO_2 emissions will be approximately 15% lower than in 1990.

But even though energy efficiency improvements have been made, City Hall still ranks quite high in comparison to similar buildings on an energy use per square metre basis.

City Hall – Energy Efficiency Study

In response to the Roundtable on the Environment's direction to Toronto City Hall a showcase for energy efficiency and sustainability, Toronto Hydro Energy Services Inc. was hired in the fall of 2006 to conduct a study of all potential energy efficiency all the potential energy efficiency opportunities in the building including the use of renewable energy technologies. Toronto Hydro Energy Services Inc. (THESI) provided the City a draft report of its finding in March 2007. The following table is a summary of their findings:

DESCRIPTION	NET COST	ELECTRICITY saved		STEAM saved		PAYBACK	Maintenance	GHG
	$	kWh/yr	$/yr	kLbs/yr	$/yr	Yrs	$/year	Tonnes/yr
Micro-wind turbine	122,500	86,800	8,680	n/a	n/a	17	1,250	61
Photovoltaics – 120 Panels	290,000	25,260	2,526	n/a	n/a	>25	1,500	17
Green roof systems	1,350,000	198,000	19,800	35	1,030	>25	4,000	151
Window Photovoltaics-132	650,000	6,051	605	n/a	n/a	>25	1,500	5
Deep Lake Water Cooling	2,000,000	3,410,510	n/a	n/a	n/a	n/a	n/a	2,381
Chiller plant VFDs	188,000	113,686	11,369	n/a	n/a	16.5	1,500	79
VIP parking garage	1,800	1,870	187	23.1	678	2.1	9	8
Fountain pump control	3,000	27,994	3,079	n/a	n/a	<1	450	19
Window replacement	2,637,612	808,875	80,888	9,991	293,235	7.1	4,250	7,021
Window film	650,000	342,685	34,269	849	24,931	11	n/a	549
Steam system DHW	70,800	-326,860	-32,686	6,900	201,840	.5	1,000	2,226
Electric control valves	152,000	64,800	6,480	280	8,218	10.4	1,000	226
Council chamber lights	9,650	43,820	4,382	n/a	n/a	2.2	150	30
Daylight harvesting	45,750	78,810	8,669	n/a	n/a	5.3	600	55
Podium and office lights	670,475	350,551	35,054	n/a	n/a	19.1	1,250	245
Office programmable stats	78,660	164,160	16,416	n/a	n/a	4.8	2,000	114
Walkway program stats	1,200	25,000	2,500	n/a	n/a	1	500	17
Induction unit control valves	662,000	157,808	15,781	681	19,987	18.5	4,250	309
External lighting/LED	35,950	40,108	4,011	n/a	n/a	9	750	28
Induction unit upgrades*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Building performance/LEED	20,000	n/a	n/a	n/a	n/a	n/a	12,000	n/a
TOTALS	**9,619,397**	**5,619,928**	**222,010**	**18,759**	**549,919**	**12.5**	**33,709**	**13,541**

City Hall – Phase II

On May 2, 2007 over 65 planners, environmentalists, engineers and specialists met to set Toronto's City Hall and Nathan Phillips Square on the path for a sustainable and energy efficient future and with a goal to make City Hall and Nathan Phillips Square a showcase for sustainability and energy efficiency. The event was co-sponsored by the Clinton Climate Initiative. A report on the next phase of the City Hall initiative will be prepared and presented to Council in the future.

Nathan Phillips Square

In October 2006, the City launched an international design competition for the revitalization of Nathan Phillips Square, which resulted in the competition jury's recent selection of a winning design scheme that has integrated exemplary new sustainability measures. Implementation of the new sustainable measures on the Square are estimated to cost approximately $6.2 million. These measures include:

- "photovoltaic panels on the roof of the new stage;
- energy efficient and full cut-off lighting fixtures and limiting light pollution;

- “Deeproot” soil system that will allow for paving, maximizing trees and a storm water sponge to ensure a healthy forest legacy;
- greening the City Hall podium roof and introducing other green roofs;
- increased biomass and number of trees and other plantings on the site;
- attention to the on-site microclimate;
- heat recovery measures;
- improvements to the underground pedestrian PATH system;
- new facilities for cyclists with bicycle rentals, lockers and change facilities and promotion of cycling;
- high performance building envelopes;
- construction best practices;
- ozone friendly mechanical systems;
- local sourcing of materials; and
- opportunities for public education.

The project will be developed using Toronto’s Green Development Standard. It will also follow the Leadership in Energy and Environmental Design (LEED) rating system and will target achieving the LEED Gold Certification standard, exceeding the LEED Silver standard currently being used for City-owned facilities.

Appendix B: Connecting City Buildings to Deep Lake Water Cooling

Deep Lake Water Cooling (DLWC) is an integrated district cooling system which uses environmentally-friendly technology to provide cooling to the southern part of downtown Toronto, from the Lakeshore up to Queen Street with an extension up to Queen's Park. Clients include the Air Canada Centre, the Metro Convention Centre, the TD Centre, the Steam Whistle Brewing Company, the Royal Bank Tower, Commerce Court, Hudson's Bay Tower, 1 University Ave., Richmond Adelaide Centre and in June 2006 the City's Metro Hall was connected.

DLWC essentially uses the coldness of Lake Ontario water to provide cooling to the buildings connected to the DLWC system.

It is important to note that while a conventional cooling system requires electricity to operate, DLWC uses substantially less (mostly for pumping). Given the recent volatility in electricity pricing, and that the proposed contractual arrangements under a DLWC scenario would include fixed pricing, implementing DLWC offers the City the opportunity to improve its operating cost predictability.

Environmental Considerations

A key consideration for implementing DLWC is the potential environmental benefits. As a clean and renewable energy resource, DLWC would enable the City to reduce its demand for electricity substantially in buildings cooled by DLWC. The reduction in electricity use translates into a substantial annual reduction in CO_2 emissions, equivalent to a 75 percent reduction as compared to conventional chillers. Implementing DLWC at an earlier date would allow the City to benefit from a prolonged reduction in CO_2 emissions.

Furthermore, implementing DLWC would assist the City in meeting its green power targets. The sooner that conversion occurs, the more pronounced the environmental benefits.

Availability of the DLWC Option

Enwave has indicated that cooling capacity of the DLWC system is being sold at a steady rate. The total DLWC capacity is 75,000 tons and 59,000 tons has already been sold. If the City does not act now DLWC capacity may not be available for City Hall or other City buildings in the future.

City Hall

City Hall has a centralized cooling plant consisting of three chillers; one 500 ton chiller installed in 1998 using R123 refrigerant and two 450 ton chillers installed in 2003 and 2004 using 134a refrigerant. These refrigerants are environmentally friendly and do not have to be replaced under current legislation.
Enwave has proposed DLWC as an alternative solution to meet the cooling requirements for City Hall. DLWC is available from Bay Street adjacent to City Hall.

The key benefits of implementing DLWC as compared with a conventional cooling system are as follows:

- As a clean and a renewable energy resource, DLWC would enable the City Hall to reduce its demand for electricity by approximately 1.9 million kilowatt hours annually, which would assist the Province in reducing overall electricity demand, and in phasing-out existing coal-fired electricity generation;
- Implementing DLWC would assist the City in meeting its green power targets;
- Implementing DLWC for City Hall would allow for an annual reduction of approximately 325 tonnes of CO_2 (a 75 percent reduction in CO_2 emissions as compared to conventional chillers, which use electricity);
- Contracting for DLWC at fixed pricing would promote operating cost predictability;
- The reduction in City demand for electricity would relieve pressure on the already over-burdened Provincial electricity grid, especially in the downtown core;
- The City would be further demonstrating its support for Enwave and for DLWC.

While a conventional cooling system has a life expectancy of only 25 years, the building heat exchangers associated with DLWC (the main pieces of equipment) would be required to be replaced only after 50 years. Also the existing chillers at City Hall are fairly new, they would have to be replaced in about 20 years. The capital cost to replace the chillers, in today's dollar terms, is approximately $2.0 million. This capital cost could be avoided if the building were to be connected to DLWC; and DLWC, as a cooling technology, has a much longer life expectancy than conventional cooling technology.

DLWC cooling will reduce the peak demand at City Hall by approximately 1000 KW and therefore will be eligible for a grant from the OPA in the amount of approximately $400,000.

Capital Costs

Estimated capital costs of implementing a DLWC solution at City Hall are compared with those of maintaining a conventional cooling solution as follows:

Capital Costs		
Year	**DLWC**	**Conventional Cooling**
2007	$637,000	$0
2008 (first year of operation)	$270,000	$0
2009	$270,000	
2010	$270,000	
2011	$270,000	
2012	$270,000	
2025		$2,000,000 (new chillers)
Total	$1,987,000	$2,000,000
Present Value	$1,847,730	$2,865,258

The capital cost of $637,000 in 2007 relates to mechanical equipment and work required in City Hall in order to connect to the DLWC system. The remaining capital cost of $1.350 million over the years 2008 – 2012 relate to the City's portion of DLWC infrastructure required to bring cooling to City Hall.

In comparison, the continued use of a conventional cooling solution at City Hall would require a replacement of major existing cooling machinery and equipment at the end of its useful life, anticipated in 2028.

It should be noted that in present value terms, the capital cost of DLWC is $1,017,528 lower than continuing with a conventional cooling solution at City Hall.

Operating Costs

The following table compares operating costs associated with implementing DLWC at City Hall, with continuing to operate a conventional cooling solution.

Operating Costs			
		DLWC	Conventional Cooling
2008	Energy Charges	$274,000	$220,000 (electricity)
	Operations & Maintenance	$5,000	$21,000
	Water & Chemicals	$0	$45,000
	Total	$279,000	$286,000
2008-2037	Present Value	$5,372,900	$12,228,317

Initial operating costs are lower for DLWC at City Hall and on a present value basis, over a 30-year period, operating costs are $6,855,417 lower under a DLWC solution.

This report recommends that City staff be authorized to negotiate and enter into a long-term, fixed price contract for DLWC at City Hall, subject to its terms and conditions being satisfactory to the appropriate City officials. It is likely that the length of the contract would be for 20 years.

Toronto Police Headquarters

Police Headquarters has a centralized cooling plant consisting of two chillers of 450 tons each. These chillers were installed when the building was constructed in 1987. These centrifugal chillers were converted to use R123 refrigerant in 2005.

Enwave has proposed DLWC as an alternative solution to meet the cooling requirements for Police Headquarters. DLWC is available from Bay Street adjacent to Police Headquarters. One of the existing chillers will be kept as a backup.

The key benefits of implementing DLWC as compared with a conventional cooling system are as outlined in the City Hall part of this section.

While a conventional cooling system has a life expectancy of only 25 years, the building heat exchangers associated with DLWC (the main pieces of equipment) would be required to be replaced only after 50 years. The existing chillers at Police Headquarters are nearing the end of their useful life and would have to be replaced in about 5 years. The capital cost to replace the chillers, in today's dollar terms, is approximately $1.0 million. This capital cost could be avoided if the building were to be connected to DLWC; and DLWC, as a cooling technology, has a much longer life expectancy than conventional cooling technology.

DLWC cooling will reduce the peak demand at Police Headquarters by approximately 700 KW and therefore will be eligible for a grant from the OPA in the amount of approximately $280,000.

Capital Costs

Estimated capital costs of implementing a DLWC solution at Police Headquarters are compared with those of maintaining a conventional cooling solution as follows:

Capital Costs		
Year	**DLWC**	**Conventional Cooling**
2007	$450,000	$0
2008 (first year of operation)	$477,000	$0
2009	$477,000	$0
2010	$477,000	$0
2011	$477,000	$0
2012	$477,000	$1,500,000 (new chillers)
Total	$2,835,000	$1,500,000
Present Value	$2,573,336	$1,798,140
Additional Capital Cost 2037	$0	$1,500,000 (new chillers)
Present Value	$2,573,336	$3,500,000

The capital cost of $450,000 in 2008 relates to mechanical equipment and work required in Police Headquarters in order to connect to the DLWC system. The remaining capital cost of $2.385 million over the years 2008 – 2012 relate to the City's portion of DLWC infrastructure required to bring cooling to Police Headquarters.

In comparison, the continued use of a conventional cooling solution at Police Headquarters would require a replacement of major existing cooling machinery and equipment at the end of its useful life, anticipated in 2012 and then again in 2037.

Operating Costs

The following table compares operating costs associated with implementing DLWC at Police Headquarters, with continuing to operate a conventional cooling solution.

Operating Costs			
		DLWC	**Conventional Cooling**
2008	Energy Charges	$163,000	$157,000 (electricity)
	Operations & Maintenance	$3,000	$56,000
	Water & Chemicals	$0	$29,000
		$166,000	$242,000
2008-2027	Present Value	$2,429,896	$4,547,137

Initial operating costs are lower for DLWC at Police Headquarters and on a present value basis and over a 20-year period operating costs are lower by $2,117,241 under a DLWC solution.

This report recommends that City staff be authorized to negotiate and enter into a long-term, fixed price contract for DLWC at Police Headquarters, subject to its terms and conditions being satisfactory to the appropriate City officials. It is likely that the length of the contract would be for 20 years.

Union Station

Discussions are underway with Enwave to explore the possibilities of using DLWC at Union Station. The discussions are preliminary and a report should be forthcoming on this issue in September 2007.

Appendix C: Summary List of Recommendations

Page	Full Recommendation
24	1. The City should develop a voluntary energy Performance Labelling system in the low-rise residential section in Toronto, on conjunction with Natural Resources Canada and other partners.
27	2. City staff should report on a process for developing an integrated approach for community energy planning based on community energy zones.
54	3. Council should request the Energy Efficiency Office to develop a pilot solar heating program for privately owned swimming pools and report back on the resources required to implement this program.
56	4. Council should request the energy Efficiency Office to develop a pilot program for residential solar hot water heating, and to report back on the resources required to implement this program.
67	5. Council should endorse the creation of a $20 million Toronto Green Energy Fund to provide support to renewable energy installations in Toronto.
69	6. Council should endorse the creation of a Toronto Energy Conservation Fund, for revolving loans to finance enhanced energy conservation initiatives in City facilities and buildings in the Municipal, University/College, School and Hospital (MUSH) sector and not-for-profit organizations in Toronto. Consideration should be given to expanding access to the Toronto Energy Conservation Fund to other building sectors if legislation permits.
69	7. Council should endorse the creation of a program to provide financial assistance to owners of low-rise residential buildings for energy retrofits.
71	8. Council should approve $13 million for the implementation of the next phase of energy efficiency and sustainability at City Hall and Nathan Phillips Square.
71	9. Council should approve $9 million in spending for the implementation of Deep Lake Water Cooling at City Hall, Policy Headquarters and Union Station.
72	10. The City should develop a plan to achieve the its target of obtaining 25 percent of its own electricity needs from green energy sources over a 4 year phase in period starting in 2008.
73	11. Council should approve convening a meeting in the fall of 2007 with representatives from the federal and provincial governments, Toronto Hydro, Enbridge, Enwave, private industry and environmental organizations to discuss the coordination of energy program delivery, and policy barriers to energy efficiency and renewable energy at all levels of government.
73	12. Staff should approach Toronto's universities, colleges and other interested organizations, to discuss forming research partnerships on energy-related issues of mutual interest.
74	13. Staff should be requested to organize a "Green Vendors' Fair" for providers of products and services that improve the energy performance of buildings.
74	14. Staff should review the City's Environmental Purchasing Policy as it relates to energy efficiency and renewable energy.

76	15. Staff should be asked to review the current policy of maximum 8-year paybacks for City energy retrofit measures compared to a Live Cycle costing approach, and also on a policy that would provide incentives for divisions, agencies, boards and commissions that participate in energy savings and/or renewable energy programs.
76	16. Council should direct all divisions, agencies, boards and commissions to phase out the use of incandescent light bulbs wherever possible by the end of 2008.
78	17. Council should request energy utility companies in Toronto to provide data to the city, in a manner respectful of customer confidentiality requirements, to assist staff in monitoring the City's progress in meeting its energy targets.
79	18. The City should report on progress in moving the City to a state of energy sustainability, and update Toronto's Sustainable Energy Plan annually subject to the terms of the *Energy Conservation Leadership Act, 2006.*

Appendix D: Suggestions for Action

Toronto should consider how it can follow the leadership taken in other jurisdictions and integrate a methodology such as *Trias Energetica* into all decision-making processes. This is one of the first steps in moving Toronto towards a sustainable energy future.
Toronto needs to focus on increasing its knowledge of what can be done to improve our efficient use of energy and renewable energy and how this is being done elsewhere.
Toronto should know where its energy dollars flow and how many are retained in the local economy. This would provide an important benchmark to understand and monitor the financial impact of energy decisions.
Toronto and other jurisdictions should begin to develop energy models that take into account climate change impacts.
Toronto needs to begin encouraging building designers, architects and builders to start building homes and buildings that take into account the warming climate – this can reduce Toronto's need for air conditioning in the future.
Toronto should develop an overall cooling strategy that addresses our changing climate, the urban heat island effect, the changing energy needs of our buildings and our huge use of air conditioners.
Toronto's new buildings need to be models for what is possible in energy efficiency, in order to help owners of existing buildings learn how to integrate these features.
The Energy Efficiency Office should begin to test the use of advanced energy monitors in the single-family residential sector in Toronto. This can be integrated into the various programs in the community that the EEO is already involved in.
District Energy Systems are an integral part of Toronto's sustainable energy future. City staff and other partners should begin a long-term process of developing a city wide thermal energy network by: • Creating local district heating systems that cover high-density areas of Toronto. • Taking advantage of early opportunities for neighbourhood thermal energy networks. • Create a long-term plan to interlink the local networks into a citywide structure.
Toronto should begin defining the building integration requirements for connecting buildings to future District Energy Systems and identify the policies and regulations that would make new buildings today "District Energy System Ready."
Opportunities for the future: • Toronto should support the use of District Energy Systems to increase the generation and distribution of renewable thermal energy in the City. • Toronto should study opportunities for supporting greater use of renewable thermal energy in District Energy Systems through the use of a thermal Advanced Renewable Tariff, similar to the one currently offered by the OPA for renewable energy electrical generators. • Toronto should consider supporting the greater use of renewable thermal

energy in city government building through a Green Heat power purchase similar to the Green Power purchase program. • Identify energy zones outside the downtown core that could utilize deep lake water cooling provided through the RC Harris, FJ Horgan or RL Clark filtration plants.
With declining school enrolment there are ongoing discussions about closing neighbourhood schools. The schools and the property they sit on are a valuable energy resource, and this should be considered during any discussions of asset disposal.
City staff should begin working with the community to identify neighbourhood district energy opportunities and the city should study how it can support the efficient transmission of local thermal energy.
The City should develop a pilot program to demonstrate the use of micro co-gen systems in Toronto's communities.
Toronto should advocate for a price setting that is dependent on the size of the system to encourage more local generation of electricity. Feed-in Tariffs in Europe consider the price support necessary for different technologies and size of individual units.
Toronto should consider a pilot project to integrate solar cooling into Enwave's cooling system.
Toronto should begin to evaluate these technologies as they can contribute to energy sustainability – a pilot project of Flow Batteries in Toronto would provide Toronto leadership in dealing with electricity peak surge issues.
Toronto should consider working with industry and other governments on developing local geo-energy resource mapping.
Toronto should develop a PV strategy in conjuntion with the development of community energy zones to identify opportunities where PV in the community can address challenges in the Toronto electrical distribution system. Focused installations in these peak demand- "challenged" communities will save or defer costs in upgrading distribution system elements.
All city renewable energy thermal systems should have their energy output directly metered so that they will be valued as energy sources (and not just as a conservation method). Direct monitoring also provides verification of performance and provides speedier resolution to maintenance and operation problems.
The City should consider monitoring all the city government's large renewable energy systems using web-based technology. This virtual power plant will showcase the City's Leading by Example Initiative and will highlight the value of multiple, distributed sources of energy – both thermal and electrical. Toronto Buildings could play an effective and nation leading role in providing statistics on distributed generation by reporting the annual number of building permits issued for various renewable technologies. Federally there are few resources applied to maintaining statistics on geo-energy, photovoltaics and solar thermal technology and Toronto's statistics would be invaluable.
Toronto should, in consultation with various stakeholders including the Canadian Wind Energy Association, develop regulations that facilitate the use of wind power in Toronto on public and privately owned spaces.
Toronto should advocate for a speedy environmental assessment of wind power on

the Great Lakes – the process to develop a review process on the environmental impact has not been outlined by the provincial government yet.
Numerous stakeholders who were consulted on the energy plan suggested that Toronto needs to hold a serious dialogue on bio-energy issues and learn how other leading cities have dealt with concerns.
Toronto should, in conjunction with Toronto Hydro and the Ontario Ministry of Agriculture and Food and other stakeholders, explore opportunities for diverting wood waste from the solid waste stream for use in bio-matter energy systems (either for use in Toronto or elsewhere).
The province and the Independent Energy Service Operator (IESO) should engage municipalities in a discussion to identify if reporting requirements can be supplied through the Smart Metering data management and repository mechanism.

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The only generator [NG cogen] on site is 6 MW. The Central Steam Plant has a maximum generation capacity of 400,000 lbs steam/hr (= **117 MW)**.
[[1 lb of steam delivers 1,000 BTU (source: www.ghgregistries.ca/registry/out/C2014-24OCT00APDX-XLS.PDF); 400,000 lbs steam/hr = 400,000,000 BTU = **117 MW**]]
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