CLIMATE CHANGE MITIGATION:

a Strategic Approach for Cities

TORONTO AND REGION Conservation

for The Living City

Toronto and Region Conservation (TRCA) has become a trusted source of information on climate change adaptation and mitigation. Getting to Carbon Neutral is one in a series of TRCA publications designed to encourage environmental projects and partnerships for a livable, sustainable future. For more information on combating climate change and the ways communities, companies and individuals can reduce their carbon footprints, visit our website at www.trca.on.ca.

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Based on the report, Getting to Carbon Neutral: A Guide for Canadian Municipalities, by the Sustainable Infrastructure Group at the University of Toronto for Toronto and Region Conservation

Funding provided by

Region of Peel
York Region
City of Toronto

An Overview of

GETTING TO CARBON NEUTRAL: A GUIDE FOR CANADIAN MUNICIPALITIES

Using readily available, proven and affordable technologies, Canadian municipalities could cut their greenhouse gas (GHG) emissions by 70 per cent or even more. Getting to Carbon Neutral: A Guide for Canadian Municipalities, commissioned by Toronto and Region Conservation (TRCA), demonstrates how communities around the world are tackling the root cause of climate change. More importantly, it shows how Canadian municipalities can do it too.

The detailed guide, developed by the Sustainable Infrastructure Group in the University of Toronto's Department of Civil Engineering, analyzes a suite of 22 technical options and urban planning policies that can be used to substantially reduce a municipality's greenhouse gas (GHG) emissions. Canadian examples include Calgary's wind-powered C-train, Toronto's deep lake water cooling project, and a bike-to-work initiative in Whitehorse. International experiences are captured as well in case studies exploring projects such as passive building design in Austria or a process for detecting and repairing leaks in Tokyo's water distribution system.

Getting to Carbon Neutral also provides:

- Guidelines for estimating the GHG emission reductions that can be achieved by each of the technologies or policies
- More than 70 case studies that illustrate the best practices in sustainable urban design and planning in action worldwide
- Examples of how these options can be utilized to develop a comprehensive strategy to reduce a municipality's GHG emissions
- Examples of methods to overcome barriers to implementation

About 1.6 million tonnes of methane gas is captured by the City of Toronto's landfill gas collection system each year and used to generate enough electricity to power roughly 24,000 homes. By reducing the demand for coal-powered electricity, the project offsets the release of 135,000 tonnes of CO2e annually.

Getting to Carbon Neutral does not dictate which GHG reduction options are best or how they must be implemented. Rather, it offers a menu of practical and proven options for cutting GHGs. A municipality can develop and evaluate different mitigation scenarios to help it design a unique strategy or action plan, applying only those technologies and policy options that best meet local realities and aspirations. The guide helps to prioritize the strategies that can be implemented in the short term, while laying the policy groundwork for more substantive, long term changes.

RESPONDING TO CLIMATE RISK

Climate change is emerging as the defining challenge of our time. Greenhouse gases generated by human activity – primarily carbon dioxide, as well as methane, ozone and several others – have risen sharply as the world's population expands, industrialization spreads and the consumption of resources accelerates. The inescapable consequence of all this growth is an inexorable increase in greenhouse gas emissions, leading to a rise in average global temperature, the disruption of climate patterns and the irreversible alteration of the ecological balance of our planet. The effects of climate change are pervasive, and left unchecked, could have both severe and indiscriminate impacts on our social and economic systems.

Though daunting, addressing climate change offers a focal point for global collaboration and innovation. A well-crafted response to climate change will spur technological advances, create new sources of employment and stimulate the economic growth needed to propel us forward into a more sustainable future. If decisive action is taken today, it is still possible to slow the process and mitigate the resulting damage. However, the window of opportunity is closing quickly.

WHAT IS CARBON NEUTRALITY?

The concept of "carbon neutrality" is an important benchmark for gauging our progress toward overall sustainability. In a municipal context, it means that all the GHG emissions generated, directly or indirectly, by a city and it residents, less those sequestered in the urban forest, stored or offset in other ways, sum to zero.

Without balancing the rate of GHG emission generation with the rate of sequestration, climate change is inevitable. A commitment to work toward "carbon neutrality" is a commitment to live within one's ecological means, to make sustainability a priority and to consume resources at a rate that does not compromise the legacy we bequeath future generations.

Achieving GHG reduction targets – proceeding down the path to carbon neutrality – within the necessary timeframe will require coordinated effort from all levels of government, corporations and individuals. With more than half of the world's human population living in urban areas, municipalities are uniquely positioned to leverage their skill base and financial resources and assume a leadership role in reducing global GHG emissions. By individually and collectively embracing the goal of carbon neutrality, municipalities can significantly lessen the rate and impact of climate change.

A 1.6 km-long district energy system in Revelstoke (BC) delivers steam to local industry and hot water for space and water heating to residents. By burning wood waste from a nearby mill, the system replaces 45,000 GJ of fossil fuels and reduces GHG emissions by 3,700 tonnes annually.

TENS STEPS TO CARBON NEUTRALITY

Getting to Carbon Neutral offers a set of ten basic strategies that, in combination, would be highly effective at bringing reducing a city's carbon footprint. These recommendations coincide with the key areas identified in the guide as having the greatest potential to reduce GHG emissions, such as energy efficiency in buildings and reducing vehicle use. In many cases, maximizing the GHG reduction potential of these strategies will require a collaborative effort between multiple levels of government.

1. Develop bold, ambitious building codes and municipal by-laws that ensure new construction incorporates green design and building techniques to conserve energy, reduce demand, and utilize renewable solar and even geothermal heat sources.
2. Accelerate the retrofitting of the existing energy inefficient building stock to modern building standards and incorporate solar and other renewable energy features.
3. Build transit systems supported by appropriate land use and sustainable financing mechanisms that could include road tolls, area pricing, higher parking fees and other innovative sources.
4. Design neighbourhoods that support public transit and where residents love to walk and cycle.
5. Encourage the use of electric or low-emissions vehicles by greening municipal fleets, regulating taxi fleets and providing reduced parking fees or other advantages for green vehicles.
6. Green the electricity supply. Reaching carbon neutral will be particularly challenging for those municipalities that depend on high carbon intensity electricity. They will need to consider investing in larger scale green electricity supply systems based on wind, small hydro, wave and tidal, solar and geothermal power sources.
7. Harness energy from a variety of community-scale sources, such as aquifer and borehole thermal energy storage, combined heat and power facilities, or other energy technologies that tap waste streams.
8. Keep 'harvesting' your solid wastes. Reduce GHG emissions through recycling, pursuing energy-from waste opportunities and capturing methane gas from landfill.
9. Seek efficiency in municipal services. Implement energy conservation opportunities in municipal buildings and services. Increase the efficiency of water and wastewater systems.
10. Green the city. Promoting green roofs, urban agriculture and CO_2 enriched greenhouses, while expanding the 'urban forest', will reduce GHG emissions while mitigating the impact of climate change.

WHERE DO OUR GHG EMISSIONS COME FROM?

Many Canadian cities have already taken the first step toward reducing carbon emissions by conducting an inventory of GHG emissions. This work has shown that the 'big three' sources – electrical generation, transportation and the combustion of heating fuels – account for up to 95 per cent of a community's direct GHG emissions. The remainder comes from the management and disposal of municipal waste and the emissions from certain industrial processes, such as cement production, steel making and chemical processing. This statistical breakdown varies from one municipality to the next, depending on a number of factors including the mix of heating fuels, the availability of public transit, and the source of their electrical power. For example, coal and gas-

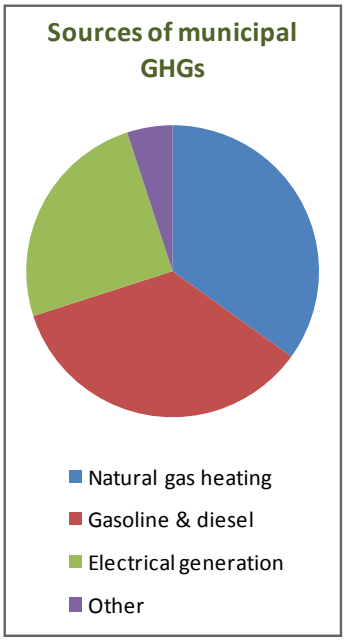
The Enwave district energy system in Toronto, pumping cold water from the bottom of Lake Ontario, provides enough cooling for 100 downtown office towers. The water, which also supplies a share of the drinking water needs of the city, eliminates 79,000 tonnes of CO2e per year, and reduces electricity demand by 90%.

fired generating stations emit large amounts of carbon dioxide and other pollutants, while hydroelectric and nuclear facilities produce almost no GHGs, therefore the carbon footprint of a municipality varies significantly based on the source of electricity generation.

Carbon inventories are a critical first step to understanding a city's emissions and to developing appropriate plans to address municipal contributions to climate change. Under the Partners for Climate Protection (PCP) program, more than 200 Canadian municipalities have agreed to compile accurate inventories of their GHG emissions. A joint initiative of the Federation of Canadian Municipalities and ICLEI (founded as the International Council for Local Environmental Initiatives), the PCP program ensures that emission sources are quantified in a systematic and comparable manner. These comprehensive inventories will provide a solid baseline for developing an effective GHG control strategy, tracking subsequent reductions, and participating in carbon trading schemes.

USING THE MUNTAG MODEL

Getting to Carbon Neutral presents an innovative and user-friendly mathematical model for estimating the per capita passengers kilometres travelled in a community and translating them into GHG emissions for the entire transportation network. The MUNicipal Transportation And Greenhouse gases – or MUNTAG – model integrates the series of individual Estimation Guidelines devised to estimate the impacts of land use, public transportation, walking and biking, the various financial policies designed to promote greener transport, and alternative vehicle technologies. MUNTAG is a powerful planning tool for assessing the potential GHG reductions that can be achieved by addressing urban transportation issues.



MUNICIPALITIES LEADING THE WAY

Municipalities have the capacity to be powerful agents of change in reducing global GHG emissions, and a carbon inventory is a critical first step to assuming this leadership role.

But just as the emission profiles of no two communities are identical, there is no generic, one-size-fits-all solution for addressing climate change that works for every municipality.

Once we know the origins of our GHGs, we can start targeting the primary sources. Organized into four strategic categories – buildings, transportation, energy supply and municipal services – the guide covers 22 different technological and policy options for reducing municipal GHGs. The summary table (on pages 7-9) illustrates the diversity and breadth of the options discussed.

The 52 homes in the Drake Landing Solar Community, Okotoks (AB), are connected to a district heating system that includes solar collectors and a borehole energy storage system. With 90% of space heating needs met by solar energy, the network saves more than 110 GJ of energy and 5 tonnes of GHG per home each year.

GHG REDUCTION STRATEGIES

Sector	Description of Approach	Technological and Policy Options
Buildings	As major consumers of heating fuels and electricity, the operation and maintenance of buildings account for up to 40% of GHG emissions. Fortunately, the state-of-the-art in sustainable building design is capable of producing carbon neutral buildings even in Canada. By employing modern technologies, such as energy efficient envelopes, photovoltaics, solar water and air heaters, passive solar design and ground source heat pumps, GHG emissions from buildings can be cut to nearly zero.	1. Reduce energy demand by: retrofitting residential, commercial and industrial buildings to increase the level of insulation; upgrading windows; minimizing air leakage; and installing energy efficient appliances and equipment. 2. Utilize solar energy through photovoltaics, solar water and space heating and passive solar design. 3. Exploit waste heat through ground source heat pumps.
Transportation	There are two fundamental approaches to reducing transport-related GHG emissions: (1) reduce automobile use by encouraging electric public transit, walking and cycling; and (2) promote the use of low emission vehicles, including electric cars, by providing the necessary infrastructure and offering financial incentives to vehicle owners to change behaviour.	4. Maintain appropriate land use and population densities to reduce the average passenger kilometres travelled. 5. Improve public transportation (i.e. bus rapid transit, light rail transit, subways and commuter rail). 6. Support active transport modes, such as biking and walking. 7. Introduce financial policies to reduce vehicle use, including tolls, taxes, HOV lanes and increased parking fees. 8. Promote the use of alternative vehicles powered by biomass, fuel cells and electricity.

In 2002, the Toronto Renewable Energy Cooperative installed the first urban wind turbine in North America. The single 750 kW turbine located in Exhibition Place on the shore of Lake Ontario has an average annual production of 1,400 MWh and displaces up to 380 tonnes of GHG per year.

Sector	Description of Approach	Technological and Policy Options
Energy Supply	Municipalities have a wide array of options for reducing the carbon footprint of their energy supplies. To approach carbon neutrality, greater investments in renewable energy technology will be needed. On a community or neighbourhood scale they can promote and facilitate the development of more efficient district heating and cooling, underground thermal storage, cogeneration, and combined heat and power systems. The same strategic land use planning principles that reduce transportation emissions – density, diversity and site design – resonate in planning low-carbon community energy systems.	9. Develop electricity from renewable sources, including wind, solar radiation, tides, waves, and geothermal. 10. Promote underground thermal energy storage that uses aquifers or boreholes. 11. Promote highly efficient district heating and cooling systems that directly service a group of buildings through a network of piping. 12. Promote co-generation or combined heat and power systems that recover waste heat and improve system efficiencies. 13. Promote integrated community energy systems that provide an economy of scale for infrastructure investment and resource recovery.

The City of Whitehorse's "Wheel 2 Work" campaign offers prizes to encourage bicycle use by commuters during the summer months. In 2006, the program attracted 210 participants who logged about 40,000 km and cut their GHG emissions by an estimated 4.5 tonnes.

Sector	Description of Approach	Technological and Policy Options
Municipal Services	Cities exercise direct control over how they manage waste, deliver water, and maintain the urban tree canopy. While the GHG emissions reductions are relatively modest, climate-friendly waste management is cost effective, affordable and readily available. At the same time, greater use of the "3Rs" (Reduce, Reuse & Recycle) and waste-to-energy projects support diversion targets. Capturing methane from landfills helps control a powerful GHG, while protecting local air quality. And increasing urban vegetation sequesters CO_2, while reducing energy consumption for air conditioning.	14. Support the 3Rs and increase sorting and recycling to divert wastes from landfill and offset the demand for virgin materials. 15. Divert organic wastes from landfill to produce biogas and compost. 16. Support waste incineration and gasification that replace fossil fuels, divert wastes from landfill and recover the Btu value of feedstocks. 17. Capture methane from landfills. 18. Manage water demand and increase treatment / delivery efficiencies. 19. Maintain and expand urban greenery and the tree canopy. 20. Support and promote urban agriculture and CO_2-enriched greenhouses. 21. Investigate geological sequestration. 22. Purchase carbon offsets.

Many cities are finding it difficult to take this next step, translating their inventory data into an effective strategy of programs, policies and projects designed to reduce GHG emissions. *Getting to Carbon Neutral* facilitates the transition from data collection to strategic action.

Nearly 70 case studies are used to showcase the successful implementation of municipal GHG reduction technologies and policies. Each example describes the application of a particular control option, weighs the advantages, considers the costs, and calculates the GHG reduction benefits that have been realized. Before investing in its own emission mitigation program, a municipality has a chance to benefit from the experience of others, learning how they overcame barriers and solved problems to maximize results.

The C-Train, Calgary's light rail transit system, is powered by 12 wind turbines installed in the hills of southern Alberta to catch the westerly winds coming through the Rockies. The C-Train is now 100% emissions free, saving 590 kilotonnes of CO2e when compared to automobile use.

A climate change action strategy need not be restricted by the size or location of a municipality. The case studies in the guide cover the experiences of large, medium and smaller communities selected from across Canada, North America and around the world. There is a wide array of practical options available to a municipality attempting to reduce its carbon footprint. *Getting to Carbon Neutral* lets a municipality select the mix that best fits its individual economic, social and environmental conditions.

BUILDING A STRONG ECONOMIC CASE FOR ACTION

To provide the environmental rationale for action, *Getting to Carbon Neutral* lays out a series of basic formulae –"Estimation Guidelines" – for calculating the GHG reductions that accrue to each of the selected options. For example, these Estimation Guidelines can be used to predict the expected GHG reductions from: installing X kilometres of light rail; constructing a gasification plant to process Y tonnes of solid waste; or servicing Z hectares of a municipality using a district energy scheme.

Once a municipality has calculated the potential GHG reductions that may be achieved, the guide shows users how to integrate different combinations of control options and compare scenarios of multiple GHG reduction strategies. This analysis can assist municipal users in making decisions based on the cost-effectiveness of various options to meet their individual emission targets.

The GHG reduction actions described in *Getting to Carbon Neutral* have already proven effective in municipal projects and undertakings throughout the world. They will also make a significant impact on the GHG emissions of Canadian municipalities.

Some communities may be in a position to take a more aggressive approach to GHG reduction. Others may adopt a more measured, step-wise strategy. To illustrate the practicality and versatility of the various approaches, the authors applied the technical matrix to generate two comprehensive GHG reduction scenarios for the City of Toronto.

This analysis highlights the potential of combining various reduction options to create an integrated reduction strategy or action plan that could be successfully applied in any municipality in Canada. Individually, these options have proven to be affordable, feasible and successful in reducing energy use and cutting GHG emissions. Integrated into a bold and innovative municipal plan, they will invigorate and renew our urban infrastructure, and help Canadian municipalities down the path to becoming carbon neutral.

The Metrus Building in Concord (ON) augments its heating and cooling needs with one of the largest ground source heat pump systems in the province. The 28 heat pump units placed throughout the building`s suspended ceiling and 88 boreholes beneath the parking lot will cut GHG emissions by an estimated 2,862 tonnes over the life of the project.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