Partners
for Climate
Protection

Developing Inventories for Greenhouse Gas Emissions and Energy Consumption:

A Guidance Document for Partners for Climate Protection in Canada

ICLEI Local Governments for Sustainability

FCM | Centre for Sustainable Community Development

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Cette publication est aussi disponible en français.

Prepared with financial support from the Province of British Columbia, Ministry of Environment.

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Table of Contents

Preface

Partners for Climate Protection (PCP) is a program managed by the Federation of Canadian Municipalities (FCM) and ICLEI – Local Governments for Sustainability. This handbook explains how to complete inventories and forecasts of greenhouse gas (GHG) emissions that result in recognition of Milestone One of the PCP program. The primary users of this handbook will be local government staff or consultants who have been asked to develop an emissions inventory. Besides helping to ensure that the work of those individuals meets program requirements, the handbook will also be useful to senior staff and council members who want to review the requirements for Milestone One before joining the PCP program or who are planning budgets to complete Milestone One.

The true value of inventories of GHG emissions becomes apparent when local governments begin to set reduction targets for local government operations and the community (Milestone Two of the PCP program) and begin to develop GHG reduction plans (Milestone Three of the PCP program). The emissions inventory is essential to setting realistic reduction targets. It provides an emissions baseline that a local government will strive to reduce over time through its GHG reduction plan. Without a baseline, the local government risks underestimating or overestimating its potential emissions reductions. More importantly, the local government will be unable to quantify progress toward established targets.

Section I: Introduction

1. Background

i) What is the Partners for Climate Protection program?

Local governments can make an important contribution to climate protection. Up to half of Canada's greenhouse gas (GHG) emissions are under the direct or indirect control or influence of local governments, and those governments also play an important role in supporting reduction measures begun by the federal and provincial governments. The FCM–ICLEI (ICLEI – Local Governments for Sustainability) Partners for Climate Protection (PCP) program offers services and tools to a national capacity-building network that supports local governments in using sustainable community planning to reduce GHG emissions.

The PCP program was formed in 1999 by merging the Cities for Climate Protection (CCP) Campaign run by ICLEI with FCM's 20% Club. The managers of the program are the FCM Centre for Sustainable Community Development (CSCD) and ICLEI. Joint support of the PCP program by FCM and ICLEI is a component of FCM's capacity building efforts within the energy sector.

The PCP framework is based on ICLEI's CCP Campaign, which is used by more than 800 local governments around the world. In Canada, more than 150 local governments participate in the PCP program. PCP members follow a five-milestone framework (see PCP Milestone Framework sidebar) that that they use to develop GHG inventories, to set targets, to prepare action plans, to implement reduction measures, and to monitor and evaluate the results.

PCP Milestone Framework

Local government councils and boards that adopt the PCP model resolution voluntarily commit to five milestones:

Milestone One

Create a greenhouse gas (GHG) inventory and forecast. Complete GHG and energy use inventories and forecasts for both local government operations and the community.

Milestone Two

Set an emissions reduction target. Suggested PCP targets are a 20 per cent reduction in GHG emissions from local government operations and a 6 per cent reduction from the community, both within 10 years of making the commitment.

Milestone Three

Develop a local action plan. The plan should set out how emissions and energy use in local government operations and the community will be reduced.

Milestone Four

Implement the local action plan. Establish a close working relationship with community partners to carry through on commitments and maximize the benefits from GHG reductions.

Milestone Five

Monitor progress and report results. Maintain local government and community support by monitoring, verifying and reporting GHG reductions.

The PCP brochure and PCP Milestone Kit provide general information about the program. PCP also offers several tools and resources that provide background information on subsequent milestones:

1. *Model Climate Change Action Plan* — A template for completing a PCP GHG reduction plan. Offers a template action plan for Milestone Three and sets out the content that it must include if the action plan is to receive recognition for the milestone.
2. *Citizen Participation and Community Engagement in the Local Action Plan Process: A Guide for Municipal Governments* — Profiles eight municipal regions and their experiences developing PCP plans.
3. *The Business Case for Cutting Greenhouse Gas Emissions from Municipal Operations* — Shows how climate protection activities benefit the economy, the environment and society, and also reviews the necessary planning steps.

These three documents, the PCP brochure, milestone fact sheets, and the model resolution, are available from the FCM website: <www.sustainablecommunities.fcm.ca>.

ii) Need for a standards and guidance document

Consistency that permits reproducibility is a guiding principle in the preparation of GHG emissions inventories (see Section II). In the absence of a methodology, an inventory may not be consistently reproducible. Originally, PCP members used ICLEI's CCP protocol with the CCP emissions software produced by Torrie Smith Associates (<www.torriesmith.com>) and related help files to produce emissions inventories. The CCP protocol is the standard for reports by local governments to the CCP Campaign.

Over time, funding to support the upkeep and licensing of the CCP software in Canada ended. As an interim solution to this problem, ICLEI produced PCP spreadsheets that provided a basic level of inventory support. However, as local governments continued to submit inventories to the PCP Secretariat, it became clear that a lack of consistency in the reports was making it difficult for the Secretariat to evaluate the inventories and to provide feedback.

As well, inventories were often submitted to the PCP program without accompanying references to data sources and corresponding methodologies. Submissions that lack this background are neither credible nor useful, because PCP program staff cannot verify inventory information, assign uncertainties, or determine whether the inventories have been prepared according to current best practices and existing CCP protocol.

These problems pointed to a need for a standards and guidance document — a need that would become more acute as more local governments began to undertake Milestone One.

2. Purpose of this handbook

This handbook responds to the need for a standards and guidance document. Local government staff who use the handbook in developing their GHG emissions inventories and forecasts should find it easier to achieve recognition for Milestone One of the PCP program.

The standards and methods described here are not exclusive; alternative methods that meet the general requirements of the PCP program may also be used. Alternative methods may gather much more or much less detail than the handbook describes. Detail considerably beyond what is described here should be gathered only if the relevant data can be easily acquired at a reasonable cost in subsequent inventory years, when monitoring and reporting results become important. Methods that gather much less detail are generally employed when relevant datasets are not available or cannot be bought at a reasonable cost.

These are the main objectives of the handbook:

1. **To describe the requirements for recognition of Milestone One of the PCP program.** Emissions inventories must meet these requirements to receive recognition for Milestone One from the PCP Secretariat.
2. **To define a GHG emissions inventory and its components.** The emissions inventory is a crucial step in the PCP milestone process; it establishes a base year quantity of emissions to which the local government can refer when setting emissions reduction targets and forecasts. In the absence of a reliable baseline, progress cannot be tracked. Furthermore, a detailed and credible inventory is required if the local government intends to participate in carbon-offset markets.
3. **To set out a model for preparing a GHG emissions inventory.** The model sets out a common set of "rules" that will help members of the PCP program prepare consistent emissions inventories and forecasts. The rules create a level playing field, encourage consistent emissions accounting practices, and create a common context that may make comparisons between municipalities more useful. With consistent inventories, the PCP secretariat is better able to track local government emissions on a national, aggregate scale.
4. **To set out guiding principles.** Consistency in emissions reporting may make it easier to compare inventories across municipalities. Local governments can see how their current emissions compare with those of other local governments with a similar energy mix and climate. Note: Care should be taken in comparing inventories. Although inventories should never be compared in the absence of a consistent approach or validation of emissions, other indicators should also be considered. Examples include building square footage and use.
5. **To provide guidance on how to arrange the data collected.** This handbook presents principles that should guide the preparation of GHG emissions inventories, outlines three general approaches to the necessary calculations, describes how to report emissions, and introduces the Inventory Quantification Spreadsheet, a tool provided by the PCP Secretariat to calculate emissions.
6. **To make the compiling of GHG emissions inventories less costly,** and thereby help the local government to free up valuable resources.

Local government staff may want to pay particular attention to the rationale for each of the foregoing objectives, because that background could be useful when staff members are preparing reports that recommend to councils and boards that they join the PCP program or move forward with Milestone One. The content of this handbook is also complemented by an Inventory FAQ that is regularly updated. The FAQ can be accessed online at <www.sustainablecommunities.fcm.ca> under Partners for Climate Protection.

3. Greenhouse gas emissions: an overview

i) Greenhouse gases

In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed on targets to reduce GHG emissions. The agreement that set out those targets, including the options available to countries to achieve them, is known as the Kyoto Protocol. Canada's target is to reduce its GHG emissions to 6 per cent below 1990 levels in the period between 2008 and 2012. The Kyoto Protocol entered into force on February 16, 2005.

The Kyoto Protocol identifies these GHGs:

- carbon dioxide (CO_2)
- nitrous oxide (N_2O)
- methane (CH_4)
- perfluorocarbons (PFCs)
- sulphur hexafluoride (SF_6)
- hydrofluorocarbons (HFCs)

Inventories under the PCP program include only CO_2, N_2O, and CH_4. The three types of fluorinated organic emissions are excluded, because only a few very specific industries emit those GHGs in significant quantities (IPCC 2001).

ii) Direct and indirect emissions

Local government emissions inventories include two types of emissions: direct and indirect. Direct emissions are those produced immediately upon consumption of energy by an end user within the boundaries of the local government. Indirect emissions are those produced by an energy utility upstream of consumption by the end user. These emission types are usually separately managed in processes driven by separate jurisdictional bodies.

A householder who switches on a natural gas–fired furnace or water heater is creating a direct emission: natural gas is burned, and air pollutants are emitted directly into the air. A householder who uses electricity — for example, by switching on a light — is typically creating an indirect emission, because the actual emissions are produced upstream at a power plant, which may be burning fossil fuel to produce the electricity.

Although the energy utility is responsible for emissions associated with the burning of fossil fuels to produce electricity, emissions inventories created by local governments take account of the indirect emissions represented by the electricity consumption of end users within their boundaries. Their emissions reduction plans similarly include actions to reduce the energy consumed by residential, commercial, and industrial end users.

iii) Sources of GHG emissions

Local government emissions inventories track almost all sources of the three main GHGs (i.e. CO_2, N_2O, and CH_4) produced directly or indirectly within local government boundaries. The main sources considered are the burning of fossil fuels (direct emissions), the production of electricity (indirect emissions) from power plants, and the decomposition of biomass in landfills (CH_4 emissions). An exception is made for the emissions from federally or provincially regulated forms of transport (i.e. air, rail, and water); local governments do not track those emissions. Also,

because the CCP protocols do not count GHG emissions from the combustion of biomass, biomass is excluded from PCP emissions inventories.

Direct emissions from fossil fuels

The total direct consumption of all fossil fuels forms one part of the overall calculation of GHG emissions reported to the PCP Secretariat.

Fossil fuels are burned in large quantities to fuel various modes of transportation, to heat buildings, and to power industry. Among the fossil fuels available on the global market, North Americans rely heavily on only three types: natural gas, gasoline, and distillate fuel (fuel oil and diesel fuel). Propane, another fossil fuel, may be included in inventories; however, propane consumption is usually insignificant (often as a barbecue fuel), and actual consumption data are extremely difficult to obtain.

Indirect emissions from electricity generation

The electricity consumed by end users forms the next part of the overall calculation of GHG emissions reported to the PCP Secretariat.

The (typically indirect) emissions resulting from electricity generation by power plants located far from end users are calculated based on consumption of electricity within local government boundaries. The utilities that deliver the electricity can provide the consumption data.

Methane emissions from landfills

Methane from landfills is the only GHG reported in PCP inventories that is emitted directly into the local air without some form of burning occurring. Calculating these emissions accurately can be difficult. The emissions factors used in calculating GHG emissions from solid waste (see "Units of Measure and Emission Factors," next) have a high degree of uncertainty.

iv) Units of measure and emission factors

GHG emissions are measured in equivalent CO_2 (CO_2e) and reported in units of mass. Any unit of mass can be used, depending on the quantity of emissions being reported. For example, a PCP participant might report total emissions of 1,220 tonnes CO_2e for a fleet of vehicles.

Using the CO_2e measure, the relative impact of any GHG on global warming — called its global warming potential (GWP) — can be compared to the GWP of any other GHG. For example, the GWP of CH_4 is 21 times the GWP of CO_2. Therefore, one tonne of CH_4 is equivalent to 21 tonnes of CO_2 (21 CO_2e). Similarly, the GWP of N_2O is 310 times the GWP of CO_2, and therefore one tonne of N_2O measures 310 CO_2e.

An emissions factor is a number that mathematically turns energy consumption data related to a given source of emissions into a measurement of the mass of a pollutant entering the air from that source. Every source unit (e.g. litre of gasoline, cubic metre of natural gas) has multiple related emissions factors — one for each of its constituent GHGs (CO_2, N_2O, CH_4).

The total CO_2e for a quantity of fuel burned is obtained by adding the quantities of the three GHGs released as a result, each multiplied by its associated GWP (IPCC 2001):

$$CO_2e = [(CO_2) + (CH_4 \times 21) + (N_2O \times 310)]$$

Emissions calculators incorporate emissions factors and the GWPs of GHGs to calculate CO_2e.

One exception is electricity. Electrical utilities directly report a CO_2e intensity factor per source unit of energy. In this instance, no calculation for N_2O or CH_4 is required.

4. Earning recognition for Milestone One — requirements

To receive recognition for Milestone One of the PCP program, local governments must complete the requirements of the milestone to the satisfaction of PCP program staff. Milestone One requires completion of two GHG emissions inventories, one for local government operations and one for the community at large, together with forecasts of emissions. The two inventories need not be sent at the same time. Each inventory can be sent as it is completed, and the PCP program will recognize partial completion of Milestone One.

The inventories and forecast information can be sent to the PCP program in one of three forms:

1. A formal report.
2. Summary information, including information for local government operations (see "Municipal Operations Inventory" in Section II) and for the greater community (see "Community Inventory" in Section II). Note: PCP program staff may ask for additional details.
3. GHG software data or a PCP Inventory Quantification Spreadsheet (Microsoft Excel workbook).

Regardless of the form the inventories take, emissions must be reported for each sector listed in Table 1. A subtotal for each sector and the total for each inventory must be given, together with additional information on the source of the data for each sector.

Table 1: Sectors that must be reported in Milestone One inventories for municipal operations and the community

Municipal operations	Community
Buildings	Residential buildings
Fleet	Commercial buildings
Streetlights/traffic signals	Industrial buildings
Water/wastewater	Transportation
Solid waste	Solid waste

The Green Municipal Fund (GMF) gives grants of up to half the cost for developing local action plans and sustainable community plans, to a maximum of $350,000. Grants are available to support the completion of milestones Two and Three. As of January 1, 2008, Milestone One stopped being eligible for GMF funding. Local governments that received GMF financial assistance for Milestone One before that date, and whose GMF contribution agreement specifies delivery of a formal report for Milestone One, must send the report to GMF program staff as well as to the PCP Secretariat. If PCP program staff consider that the local government used highly unconventional methods to develop the inventory or forecast information, they may request additional information to support the method or methods used.

Local governments applying for a GMF grant must apply to complete milestones Two and Three for both their municipal operations and community sectors; however, the milestones for each of these sectors do not need to be completed at the same time. Plans must address all GMF sectors and must include a relevant vision.

5. Inventories and forecasts — key Milestone One components

Milestone One of the PCP program focuses not only on GHG emissions inventories, but also on forecasts of emissions for both inventories. The inventories for local government operations and for the greater community must account for GHG emissions connected with the infrastructure and activities owned or carried out by the local government or the community. The forecast of emissions for each inventory can be developed using any of several methods. For the PCP program, a simple forecast reflecting a business-as-usual scenario 10 years into the future is all that is required. The business-as-usual forecast becomes important later, when the reduction targets that will qualify the local government to receive credit for Milestone Two of the PCP program are calculated.

To simplify the task of compiling the inventories, infrastructure and activities are assigned to one of the two inventory streams (i.e. local government operations or community) and are grouped into sectors (Table 1) depending on ownership. The assumption is that the owner must be the one to make changes that will reduce emissions. Reduction targets and reduction actions are the responsibility of the entity that controls the given sector or that is assigned to carry out proposed emissions reduction actions (or both). To achieve reductions in the community inventory stream, a local government must implement reduction actions through a GHG emissions reduction plan that is supported by the community and approved by the local government council or board.

Note: Although not required in a PCP inventory, local governments are strongly urged to compile indicator information as they gather inventory data. For example, the number of residential customers that consume natural gas could be used to calculate the average gas consumption per customer, yielding an overall indicator for changes in emissions over time. Indicator information can yield valuable insights into the energy efficiency of homes in the community over time.

6. Selecting the inventory base year and reduction target year

The PCP program suggests that local governments compile their inventories for 2000 or for the year with the best available information. The emissions forecast and period for meeting emissions reduction targets should cover 10 years from the time of joining the program or 10 years from the base year of the emissions inventory.

The emissions inventory for the base year should be developed using the principles presented in this handbook. The method for developing the emissions forecast depends on the particular inventory stream. The forecast for the local government operations inventory can be developed based on projected growth or expenditures in each sector. The forecast for the community inventory can be developed based on projected population growth or any other demographic projection. The method used to derive the forecast should be stated, and the data for the base year and any other inventory years should be shown, together with a calculation of the percentage change in each sector. Projected growth for individual sectors (e.g. residential, commercial, industrial, institutional) could be included if known, together with an estimate of the emissions likely to result from this growth, if a relevant indicator (e.g. square metres) is available.

Gathering the necessary data may be challenging. Local governments are not required to keep financial records for more than seven years; even recent records may be in archive or storage. In selecting a base year for the government operations inventory, local government staff will have to consider how far back in time current or stored datasets go and how accessible and reliable the data for a particular year are. Similar difficulties could be encountered in compiling the data for the community inventory, depending on how the datasets are stored and who must be approached to retrieve them. For example, changes in computer systems and software may prevent the retrieval of older datasets, and changes in ownership and management of community organizations may result in data going missing during the transition. If the needed data are not easily found, then convincing the staff of the community entity to make the necessary search may be either extremely difficult or costly.

Section II: Preparing GHG emissions inventories and forecasts for Milestone One

1. Guiding principles

Many factors must be considered when choosing the datasets and methods to use in preparing GHG emissions inventories. The principles that follow can help local governments make those choices:

- **The inventories must be accurate and must inform all subsequent PCP milestones.** They must reflect actual emissions as closely as possible, and they should set out the quantity of emissions in a way that helps in setting targets, selecting emissions reduction actions, and measuring reductions for reporting purposes.
- **The inventories must be consistent and reproducible.** Consistency makes reproducing the inventory simpler into the future. Staff have an easier learning curve, which becomes more important as the local government starts to monitor and track emissions as part of Milestone Five. Further, if all local governments follow the principles, the validity of comparisons between inventory years and between local governments will be enhanced.
- **The inventories must be cost-efficient.** Inventory development must not consume resources — whether overall costs for consultants or staff time, or a combination — in an unbalanced fashion.
- **The inventories must be verifiable.** They will be reviewed when the local government reports emission reductions for recognition of Milestone Five.

2. Real consumption data, activity estimates and models

The accuracy of an emissions inventory relies entirely on the data inputs used to calculate the emissions. Real consumption data is the preferred starting point. A second, less accurate, method uses activity estimates. As a general rule, real consumption data should be used for the

operations inventory of a local government; estimates of activities can be used when real consumption data are unavailable for a given sector.

A third method, modelling, is often used to calculate emissions — especially in the transportation sector. Local governments should exercise caution when considering emissions models. These models are often difficult to explain, lacking in repeatability, and built with activity data and averages that may have high associated uncertainties (see “Models” later in this subsection).

i) Real consumption data

Real consumption data are obtained from actual energy-consumption datasets compiled through stringent accounting of consumption by a vendor or distributor of energy products. Examples of real consumption data include litres of gasoline and diesel fuel used in fleet vehicles and kilowatt hours of electricity used in street lighting. The vendor or distributor would be expected to be using the best accounting practices under the scrutiny of both the vendor or distributor and the consumer.

Table 2 lists the fuels that energy-consumption datasets would be expected to record. Gasoline, diesel fuel, and natural gas are the main fossil fuels included in PCP program inventories. Less commonly used fuels include propane and fuel oil.

Table 2: Summary of energy sources

Fossil fuels				Fossil-fuel alternative	Biofuels
Liquid	**Gaseous**	**Solid**	**Other**		
Gasoline	Natural gas (dry)	Anthracite	Petroleum coke	Lubricants	Wood and wood waste
Kerosene		Bituminous coal	Coke oven / gas coke	Synfuel	
Jet fuel		Sub-bituminous coal		Chlorinated solvents	
Aviation gasoline		Lignite		Tar	
Diesel fuel and fuel oil		Peat		Sludges	
Heavy fuel oil				Liquid wastes	
Liquefied petroleum gas (LPG)				Pitch	
Propane				Solvents	
				Sawdust, impregnated	
				Distillation residues	
				Plastics	
				Tires and tire-derived fuel	
				Municipal solid waste	

Electricity can be generated by burning any of the fuels listed in Table 2. Natural gas and coal are the most frequent choice; diesel fuel is sometimes chosen in remote communities (e.g. communities that lack a supply of natural gas or whose location makes imports of high-grade coal too costly). Wood and wood waste are also used in communities with abundant supplies of those fuels and a lack of natural gas or other cleaner-burning alternatives.

Real consumption data are the most detailed content held in an emissions inventory; these data are easily audited and unlikely to be disputed. Even so, real consumption data are not always the most appropriate choice.

Generally speaking, if real consumption data can easily be acquired at little or no cost, or at a cost that is justified by the scope of the project, then those real consumption data should be used. If the data can be acquired only for a limited number of years and at considerable cost, an alternative data source should be considered.

In most cases, the entire inventory stream for local government operations should use real consumption data. The only exceptions are personal vehicles used for local government business and solid waste collected at local government facilities.

- **Personal vehicles used for local government business:** Information about personal vehicles driven on local government business is difficult to retrieve. The accounting divisions of most local governments do not track personal vehicles used by staff on local government business. Furthermore, many non-hourly staff receive flat-rate allowances for their use of personal vehicles on the job. The allowance forms part of their pay, and they do not record distance travelled on business.
- **Solid waste collection:** Real data concerning the collection of solid waste from local government facilities are available only if the waste is collected separately from community waste, and such separate collection is rare.

ii) Activity estimates

Activity estimates are indicators, averages, survey results, or national, provincial, or regional data that are spread across units of population or some other measurable unit. The number of kilometres driven in a passenger vehicle by the average resident in a community is an example of an activity estimate.

Activity estimates are less detailed than real consumption data; they are used in inventories when real consumption data are unavailable, too expensive or held in datasets that don't match with the chosen inventory year.

As a general rule, activity estimates should be used only when real consumption data are not available or inappropriate (e.g. too costly).

iii) Models

Models use a combination of real data, indicators, survey results, and averages to calculate emissions. The uncertainties associated with each of a model's parts can limit the usefulness of a model calculation to an inventory. The problem is particularly pressing for models that use survey results. If the survey has not been shown, by comparison with known data, to be valid — that is, to come close to the known data in most cases — or if the model is based on assumptions that increase the uncertainty, then the emissions value calculated by the model may be inaccurate. In addition, models may be unsuitable for calculating the effectiveness or results of actions taken to reduce emissions, because the models may not necessarily account for change in parameters over time or as a result of the emissions control efforts.

Models may also operate inconsistently. Emissions modelling varies with the data and parameters available to the model developer, and identical parameters are rarely available to everyone completing an inventory. Further, the uncertainties in model parameters are often ignored, and data are often accepted at face value without sufficient scrutiny. The method put into effect by the model can also periodically change, further confounding the principle of consistency and preventing reproducibility and comparability. A particular example of that problem is found in software applications that are constantly being updated to reflect new operational methods and previously unavailable data.

Finally, models are complex; they can be difficult to understand and difficult for local government staff to explain to committees, council, and the community. Although this drawback does not preclude a decision to use emissions models, local government staff should carefully consider whether they can dedicate enough time to the model to fully understand it and to pass their knowledge on to others. Some consultants have developed very complex proprietary models whose internal workings they may not want to share. In this case, the consultant should be asked to prepare a brief written explanation of the model, its inputs, and the relative uncertainties of the inputs, if known.

As a general rule, a model should be used only when each part can be fully explained, when its level of uncertainty can be specified, and when an adequate level of consistency is present. Use of the model should be transparently repeatable into the future.

3. Methodology and data sources

Local governments have an emissions calculator available to them that is supported by the PCP Secretariat: the PCP Inventory Quantification Spreadsheet (a Microsoft Excel workbook). PCP members who want to use this tool can request technical support from the PCP Secretariat. (Contact the PCP Secretariat for more information.) PCP members who use other calculators must report the emissions factors and global warming potential (GWP) multipliers used by those calculators.

Emissions calculations involve these steps:

1. For each sector for each inventory year, gather the required data inputs:
   - Consumption data or activity estimate
   - Cost of the fuel or energy
   - Indicator data (if any)

   Scrutinize the data, taking note of uncertainties, if known.
2. Choose the tool or calculator to use.

   To use the PCP Inventory Quantification Spreadsheet:

   a. Contact the PCP Secretariat for instructions on how to enter the data into the spreadsheet tool. Contact your electricity supplier to find out the emissions factors for electricity in your area (or contact the PCP Secretariat to confirm the numbers). Make sure to match the units of fuel or energy consumption in your consumption data or activity estimates with the units of the emissions factors that you obtained. Use the conversions provided in Appendix B if necessary.

To use a different calculator:

b. Follow the instructions given by the developer of the software. Make sure to match the units of fuel or energy consumption in your consumption data or activity estimates with the units of the emissions factors used in the calculator. Review the emissions coefficients for electricity built into the calculator. Make sure that they match the annual emissions coefficients for your inventory year and your region.

To calculate emissions without an off-the-shelf calculator:

c. Make sure to match the units of fuel or energy consumption in your consumption data or activity estimates with the units of the emissions factors that you obtained. Use the conversions provided in Appendix B if necessary. Review the emissions coefficients for electricity that you obtained. Make sure that they match the annual emissions coefficients for your inventory year and your region.

3. Multiply the fuel or energy consumption in each sector by the appropriate emissions factor for each GHG. (Contact the PCP Secretariat for a current list of emissions factors.) Use equation 1 in "Units of Measure and Emission Factors" in Section I to convert and total the component GHGs to reach a final CO_2e value.

i) Gathering the consumption data or activity estimates

Note: Local government staff undertaking this step should first consult tables 3 and 4, which outline the recommended approaches for local government operations and community inventories.

Table 3: Emissions inventories for local government operations — recommended approach and relative uncertainty

Sector	Recommended approach			
	Real consumption data	**Relative uncertainty**	**Estimates**	**Relative uncertainty**
Buildings	Recent-year energy consumption data are easily retrieved	Low	Use as secondary method only when fuel consumption data are unavailable or when backcast or forecast is applied	Moderate to high
Lighting	Recent-year energy consumption data, usually electricity only, are easily retrieved	Low	Use as secondary method only when electricity consumption data are unavailable or when backcast or forecast is applied	Moderate to high
Wastewater and potable water	Recent-year energy consumption data, usually electricity only, are easily retrieved	Low	Use as secondary method only when the related electricity consumption data are unavailable or when backcast or forecast is applied	Moderate to high

Sector	Recommended approach			
	Real consumption data	**Relative uncertainty**	**Estimates**	**Relative uncertainty**
Fleet	Be aware of use of personal vehicles for business	Low	Use as secondary method only when fuel consumption data are unavailable or when backcast or forecast is applied	Moderate to high
			Estimate use of personal vehicles for business	
Solid waste	Real data are uncommon	Low	Default approach when real consumption data are unavailable	High

Table 4: Emissions inventories for the community — recommended approach and relative uncertainty

Sector	Recommended approach			
	Real consumption data	**Relative uncertainty**	**Estimates**	**Relative uncertainty**
Residential buildings	Request data from local fuel vendors and distributors	Low to moderate if community building data not separated	Use as secondary method based on number of houses and average consumption by residences for each fuel type used locally	Low to moderate
Commercial buildings	Request data from local fuel vendors and distributors (source may withhold data considered sensitive by large commercial customers)	Low to moderate if community building data not separated	Use as secondary method based on number of commercial establishments and average consumption by typical establishments for each fuel type used locally	Moderate to high
Industrial buildings	Request data from local fuel vendors and distributors (source may withhold data considered sensitive by large industrial customers)	Low to moderate if community building data not separated	Use as secondary method based on number of industrial establishments and average consumption by typical industry for each fuel type used locally	Moderate to high
Transportation	Local fuel sales data are available, but caution is required in large metropolitan areas or where highways run through municipalities	Low to high	Usually the primary method if local fuel sales data are not appropriate	High

Sector	Recommended approach			
	Real consumption data	Relative uncertainty	Estimates	Relative uncertainty
	Calculations of vehicle kilometres travelled (VKT) with low uncertainties are difficult to obtain		GHGs can be estimated based on number of vehicles, average VKT per year, and average vehicle fuel efficiency	
Solid waste	Data are easily obtained in most municipalities	Low	Use as secondary method based on number of residential, commercial, and industrial establishments and average waste generated by each	High
			Factors for the various types of establishments are another possibility	

Whether consumption data, activity estimate, or a combination is chosen for the various sectors in the two inventory streams, gathering the data is likely to be the most resource-intensive task in preparing the inventories. “Municipal operations inventory” and “Community inventory” later in this section outline the datasets and estimates available for each sector of each inventory.

As mentioned earlier, the highest level of detail is achieved with real consumption data; estimates, which rely on assumptions, indicators and averages, achieve a lower level of detail. Tables 3 and 4 list the relative uncertainty of the data inputs; absolute uncertainties can be assigned to specific datasets. In general, the level of detail of the data input has a reverse relationship with the relative uncertainty of the dataset: a high level of detail corresponds with a low level of uncertainty.

During collection of real consumption data, local government staff should strongly consider also gathering the costs of fuel or energy. Cost information is essential in identifying the savings that can be achieved through energy conservation measures.

Backcasts and forecasts are valid if they are developed in relation to indicator data for each sector. The costs of fuel or energy for backcast data must be researched; the costs for forecast data must be predicted. The “Municipal operations inventory” and “Community inventory” subsections suggest indicator data for each sector of each inventory.

ii) Converting consumption data or activity estimates to common units

Energy consumption data and emissions factors can be reported using a variety of units. Before emissions are calculated, energy consumption data (or activity estimates) and emissions factors must both be shown in the same units. The simplest way to ensure that all input parameters are in the same units is to convert the energy consumption data into the units used for the emissions factors.

Many converters are available on the World Wide Web. You can locate them by entering “energy unit converter” into a Web search engine. One such converter can be found at <www.chemie.fu-berlin.de/chemistry/general/units_en.html>. For convenience, Appendix B shows some energy conversion factors.

iii) Multiplying the energy consumption data or activity estimate by the emissions coefficient

In this last step, the matched-unit input parameters are multiplied to show the mass of the emissions. Emissions should be reported in CO_2e or any unit of mass (e.g. megatonnes, kilotonnes) that is appropriate for the size of the emissions values. Once the subtotal for each sector has been calculated, add the sector values together to find the total inventory value. Details for each sector are provided in the "Municipal operations inventory" and "Community inventory" subsections, next.

4. Municipal operations inventory

The local government operations inventory considers five sectors:

- buildings
- outdoor lighting (e.g. streetlights, playing field lighting, traffic signals, etc.)
- wastewater and potable water
- vehicle fleet
- solid waste collected at facilities owned and operated by the local government

Table 5 lists energy sources typically used in each sector.

Table 5: Energy sources typically used in local government operations sectors

Local government operations	Fuel/energy source					
	Natural gas	Electricity[a]	Fuel oil	Gasoline	Diesel fuel	Other fuels[B]
Buildings	☑	☑	☑		☑	☑
Lighting		☑				☑
Wastewater and potable water		☑				☑
Fleet[C]				☑	☑	☑
Solid waste[D]	N/A	N/A	N/A	N/A	N/A	N/A

[a] One or many fuels may be used to produce electricity; combinations are reflected in the emissions factor provided by the electricity supplier.

[b] In rare cases, other fuels (see Table 2) are possible in all categories.

[c] Natural gas, propane and electricity consumption by fleets is insignificant relative to gasoline and diesel fuel.

[d] Solid waste creates a direct emission (methane) from landfills. No energy sources are implied.

Local government operations inventories that have been reported to the PCP program are kept confidential unless the municipality gives permission to the PCP Secretariat for limited, conditional use. The combined anonymous data from many local government inventories may be used at any time to develop national program reports.

i) Buildings

The buildings sector should receive particular attention. It accounts for a significant proportion of any inventory of local government operations emissions, and it offers significant potential for emission reduction actions.

Inclusion protocols: Include all buildings owned by the local government, plus buildings leased or rented to others. Include any diesel fuel that is consumed by backup electrical generators.

Exclusion protocols: Do not include wood burned for space heating.

Real consumption data: The fuel or energy sources most commonly used for buildings are electricity, natural gas, fuel oil, and propane. Data are available from the provider of the fuel or energy, or from local government records.

Costs: Request that the datasets include consumption costs. Reporting any federal taxes added to the purchase of fuel is optional; the local government can claim reimbursement for federal taxes paid. Other taxes included in the cost of the fuel are reported. Delivery charges for natural gas, diesel fuel, and fuel oil are also reported.

Indicators: All indicators are important; however, at a minimum, data on the floor area of individual buildings should be gathered. This information is used to develop energy intensity data (energy use for a given area), which may be useful if an emissions backcast or forecast is necessary.

Estimates: Use estimates only if the buildings dataset is large (at least 25 buildings) and spans several years (up to five). Buildings used in calculating average emissions intensity should have used the same fuel for the entire period over which the average is being calculated. Buildings known to have high fuel or energy consumption (e.g. pools, ice arenas, potable water and liquid waste treatment plants) do not form part of such a calculation.

Even if the datasets as described are available, data are unlikely to be available for many of the factors that influence energy consumption (e.g. climate and occupancy) for the inventory year being developed.

General instructions: Include the names of individual buildings. Never group buildings that consume large quantities of energy. If groupings are desirable, limit them to park washrooms, park fieldhouses, storage facilities, and so on.

In simplifying an inventory that covers many buildings (e.g. more than 50), group similar buildings together (e.g. all the park fieldhouses), but retain the original consumption data for each building. Those data will be needed in the future. When grouping buildings, record the number of buildings (insert a column into the calculator) and the total of the indicators for each group. Table 6 shows the buildings sector module in the PCP Inventory Quantification Spreadsheet tool.

Table 6: Buildings emissions worksheet in the Partners for Climate Protection (PCP) Inventory Quantification Spreadsheet tool (less common energy types are not shown but are available in the spreadsheet in hidden columns)

Buildings																												
Corporate inventory																												
Description:																												
	Electricity (kWh)			Natural gas (cum)			District energy (GJ)			Fuel oil (L)			Diesel (L)		Indicators					Total							
Building or building group name	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Operating hours	Occupants	Floor area (1,000 m^2)	Building or building group name	Total cost ($)	Total CO_2e (t)	Total cost ($)/ operating hour	Total cost ($)/occupant	Cost ($)/$m^2$	CO_2e (t)/ operating hours	CO_2e (t)/ occupant	CO_2e (t)/ m^2

ii) Lighting

The lighting sector includes outdoor lighting such as overhead street lights, playing field lights, parking lot lights, and traffic signals. Generally, lighting accounts for less than 10 per cent of the total emissions of the local government operations inventory. Nevertheless, significant cost savings can be realized.

Inclusion protocols: Include street lights or traffic signals or both that are leased to a private management company or utility.

Exclusion protocols: Do not include street light grids that are owned and operated by a private company or leased to the municipality; these are included in the community inventory.

Real consumption data: The conventional energy source for the lighting sector is electricity. Data are available from the electricity supplier or from local government records. Some accounts may not be metered (i.e. the account is billed at a flat rate); therefore, be aware that the data from these accounts is an estimate of the actual consumption.

Costs: Request that the datasets include the costs for consumption.

Indicators: The number of lights and their bulb numbers and wattages are important indicators.

Estimates: Use estimates only if the number and wattage of bulbs are known.

General instructions: Separate the data by lighting type. Include defined street light grids, if available. Alternatively, group the data, but retain the original consumption information. Table 7 shows the calculator for the lighting sector in the PCP Inventory Quantification Spreadsheet tool.

Table 7: Lighting emissions worksheet in the Partners for Climate Protection (PCP) Inventory Quantification Spreadsheet tool

Streetlights						
Corporate inventory						
Description:						
	Electricity (kWh)			Indicator		
Streetlight group name	Total use	Total cost ($)	Total CO_2e (t)	# of streetlights	Total cost ($)/ streetlight	Total CO_2e (t)/ streetlight

iii) Wastewater and potable water

Emissions related to wastewater and potable water are highly variable in local government operations inventories. They are influenced by many factors, including any sanitary sewer and potable water treatment plants present in the system and the local topography, which may require the use of pump stations for sanitary sewers, storm water, and potable water.

Inclusion protocols: Include all infrastructure for sanitary sewers, storm water, and potable water that is owned by the local government. Also include infrastructure that is leased to a utility or private management company. For potable water and sanitary sewer treatment plants, electricity, natural gas or fuel oil may be in use for space heating. Buildings that house stations

containing pressure-reducing valve usually have associated lights and sometimes have space heating for winter conditions. The emissions related to the lights and space heating, if any, are included in the wastewater and potable water sector, and not the buildings sector.

Exclusion protocols: Do not include infrastructure that is owned and operated by a private utility. Such infrastructure is included in the community emissions inventory. Emissions from biomass are not included in the inventory to conform with the CCP protocol.

Real consumption data: The conventional energy source for wastewater and potable water infrastructure is electricity, although other energy types (e.g. natural gas, fuel oil, and propane) may be used at some facilities for space heating. Data are available from the electricity supplier or from local government records.

Costs: Request that the datasets include the costs for consumption.

Indicators: Include the volume of treated wastewater and potable water, and the volume of pumped wastewater, potable water, and storm water, if tracked. **Note:** Tracking the total volume of wastewater and potable water pumped is unusual.

Estimates: Estimates can be used if the indicators are known.

General instructions: Separate the data for sanitary sewer, storm water, and potable water infrastructure. Group pump stations within each category and retain the original dataset.

Table 8: Water and wastewater emissions worksheet in the Partners for Climate Protection (PCP) Inventory Quantification Spreadsheet tool

Water and sewage

Corporate inventory

Description:

	Electricity (kWh)			Natural gas (cum)			District energy (GJ)			Fuel oil (L)			Diesel (L)			Indicator	Total			
Facility or facility group name	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Total use	Total cost ($)	Total CO_2e (t)	Output (1,000 L)	Total cost ($)	Total CO_2e (t)	Total cost ($)/output (L)	Total CO_2e (t)/output (L)

iv) Vehicle fleet

Like the buildings sector, the vehicle fleet sector needs particular attention. It accounts for a large portion of the total emissions of the local government operations inventory, and it offers the potential for many emissions reductions.

Inclusion protocols: Include all vehicles owned and operated by the local government. Include personal vehicles used for local government business. **Note:** Only kilometres are usually tracked for personal vehicles used for local government business; the fuel efficiency of such vehicles is not usually tracked. In the absence of fuel efficiency data, an estimate may be required.

Exclusion protocols: The inclusion of portable motorized equipment (e.g. leaf blowers and lawnmowers) is optional, but taking the time to track all fuels consumed during local government operations is highly recommended.

Real consumption data: The fuels most commonly used for vehicle fleets are gasoline and diesel fuel. Natural gas, propane, and electricity may also be in use, but are likely to be insignificant. Data from fuel-tracking systems or card-access systems that record expenditures and vehicle mileage are often available. Every effort should be made to extract these data, even if contained in an outdated system, archived on microfiche, or otherwise stored. At a minimum, the finance department should be able to provide the total volumes of gasoline and diesel fuel consumed in a particular year. If records list costs only, approximate volumes can be calculated based on the average price per unit of fuel.

Costs: Request that the datasets include the costs for consumption. Include the tax surcharges on gasoline and diesel fuel that are included in the price of the fuel. If the costs for fuels are not available, average prices for gasoline and diesel fuel for the inventory year can be found at the Statistics Canada website (<www.statscan.ca>).

Indicators: Record the number of vehicles in each group and the total kilometres travelled in each identified group.

Estimates: Avoid the use of estimates in this sector. Data for the most recent complete year should be available, and an accurate backcast can be developed if the number and types of vehicles are known for the backcast year. It is better to backcast from a real number and make an assumption, than to backcast the number based on inaccurate information. A forecast can be developed by predicting the size of the fleet in the future.

General instructions: Various levels of detail can be used. At the highest level, vehicles could be distinguished by local government department, fuel type, and on-road or off-road use. At a minimum, vehicles should be grouped into fuel types.

Table 9: Vehicle fleet emissions worksheet in the Partners for Climate Protection (PCP) Inventory Quantification Spreadsheet tool

	Gasoline (L)			Diesel (L)			Propane (L)			Compressed Natural Gas (L)			Ethanol Blend (L)			Indicators			Total					
Vehicle or Vehicle Group Name	**Total Use**	**Total Cost ($)**	**Total eCO_2**	**Total Use**	**Total Cost ($)**	**Total eCO_2 (t)**	**Total Use**	**Total Cost ($)**	**Total eCO_2 (t)**	**Total Use**	**Total Cost ($)**	**Total eCO_2 (t)**	**Total Use**	**Total Cost ($)**	**Total eCO_2 (t)**	**Vehicle Kilometers**	**# of Vehicles**	**Vehicle or Vehicle Group Name**	**Total Cost ($)**	**Total eCO_2 (t)**	**Total Cost ($)/km**	**Total Cost ($)/# of Vehicles**	**Total eCO_2 (t)/km**	**Total eCO_2 (t)/# of Vehicles**
Total																		**Total**						

v) Solid waste

Emissions from solid waste, mainly CH_4, enter the air directly as the waste decomposes. The solid waste sector is the only sector in the inventory in which emissions are not calculated based on burning fuel directly or indirectly in the generation of electricity. The information required is the mass of solid waste generated by all local government operations.

If mass data are not available, the mass can be estimated. The estimate is based on the total volume of solid waste either known or derived in a separate estimation technique. Because solid waste from municipal facilities is a small fraction of the total local government operations inventory, the absence of data for the actual mass of solid waste deposited at the landfill is not a serious problem. An estimation of the mass can be used. The sample calculation in Table 10 shows how to estimate mass when the total volume of the available disposal bins is known.

Table 10: A technique for estimating the mass of solid waste from municipal operations when the volume of all disposal bins is known[a]

Number of bins	Size of bins (yard^3)	Frequency of pickup/week	Total annual volume (yards^3)	Annual mass (kg)	Conversion to tonnes
9	3	1	1,404	210,600	211

[a] Assumes that bins are full and that 1 cubic yard = 150 kg. Other assumptions can be used if better data are available.

Inclusion protocols: Include all solid waste generated at local government facilities (e.g. buildings and parks).

Exclusion protocols: Do not include any solid waste generated in the community.
Note: All waste deposited by the community at public facilities is included.

Real data: These data are available only if solid waste from local government facilities is collected separately from community waste. When data are not available, estimate the mass as shown in Table 10.

Costs: Waste collection and disposal costs can be gathered only if solid waste from local government operations is collected separately from community waste. If an average cost per tonne for community waste is known, and the mass of local government waste in tonnes is known, then the cost for local government solid waste can be calculated.

Indicators: Record the number of employees working in the municipal office buildings and any usage statistics for waste generated at public recreation facilities and parks.

Estimates: Estimates of solid waste from local government operations are acceptable and can be developed using the number of bins, the volume of bins, and the frequency of pickup. The volume of bins is commonly measured in cubic yards, and 1 cubic yard of uncompacted waste is assumed to weigh 150 kg (see Table 10).

General instructions: The assumption that 1 cubic yard of solid waste weighs 150 kg can be changed if more accurate data are available. The resulting CO_2e can be calculated using the PCP Inventory Quantification Spreadsheet tool or the Landfill Gas Emissions Model (LandGEM), which, at the time of writing, could be found on the U.S. Environmental Protection Agency website at <www.epa.gov/ttn/catc/products.html>. Because websites are frequently reorganized, enter the key word “landgem” into a Web search engine if the foregoing URL stops working.

Emissions related to solid waste from local government operations are not significant. Given the difficulty of accurately tracking them when real tipping data are not collected, the use of LandGEM for calculating such emissions calculations is recommended only if LandGEM is also being used to calculate emissions related to community solid waste. Alternatively, the total mass of solid waste can be multiplied by 0.5, a factor that comes close to reproducing the result of a more complicated calculation in LandGEM. PCP program members who use LandGEM can find user manuals for the system at the U.S. Environmental Protection Agency website mentioned earlier.

5. Community inventory

The community inventory considers five sectors:

- residential buildings
- commercial buildings
- industrial buildings
- transportation
- solid waste

Table 11 lists energy sources typically used in each sector.

Table 11: Energy sources typically used in community sectors

Community	Fuel/energy source					
	Natural gas	Electricity[a]	Fuel oil	Gasoline	Diesel fuel	Other fuels[b]
Residential buildings	☑	☑	☑		☑	☑
Commercial buildings	☑	☑	☑		☑	☑
Industrial buildings	☑	☑	☑		☑	☑
Transportation[c]				☑	☑	☑
Solid waste[d]	N/A	N/A	N/A	N/A	N/A	N/A

[a] One or many fuels may be used to produce electricity; combinations are reflected in the emissions factor provided by the electricity supplier.

[b] In rare cases, other fuels (see Table 2) are possible in all categories.

[c] Natural gas, propane and electricity consumption in the transportation sector is insignificant relative to gasoline and diesel fuel.

[d] Solid waste creates a direct emission (methane) from landfills. No energy sources are implied.

For simplicity, the three buildings sectors are combined because the treatment of emissions from these sectors vary very little. The relevant differences are noted where appropriate.

Community inventories that have been reported to the PCP program may be published in PCP publications if the local government grants permission. The combined anonymous data from many community inventories may be used at any time to develop national program reports.

i) Residential, commercial, and industrial buildings

As is the case for the buildings sector in a local government operations inventory, all the buildings sectors in the community inventory should receive particular attention. The potential for emissions reduction actions in these sectors is large.

Inclusion protocols: Include all buildings in the community (i.e. residential dwellings, institutions, commercial establishments, and industrial facilities), but note the exclusion protocols for the industrial sector.

Exclusion protocols: Do not include wood burned for space heating. In the industrial buildings sector, local governments have the option to exclude large, energy-intensive operations (e.g. pulp and paper mills, cement manufacturers, steel mills, etc.).

The question of whether a local government should be able to choose to exclude large industrial operations from its community emissions inventory is currently under debate. As a general rule, all emissions sources should be included in the community inventory, even though the local government may have little opportunity to implement reduction measures at large industrial facilities. Further, in a community in which industry is largely absent, with the exception of one or more large operations, data providers may be reluctant to offer detailed datasets, because the data may come close the revealing the operations' actual consumption. The decision by the local government to include or exclude large industrial emitters should be recorded in the inventory and reported to the PCP Secretariat.

Real consumption data: The fuel or energy sources most commonly used for buildings are electricity and natural gas. Data for both of these sources are available from the provider of the fuel or energy. Ask the data provider to group the data by building sector (residential, commercial, industrial). If large industrial operations have been excluded from the inventory, ask the data provider to subtract the energy consumption data relating to those operations from the total energy use within community buildings.

Costs: Request that the datasets include the average costs for consumption by sector. Include delivery charges for natural gas, diesel, and fuel oil.

Indicators: Indicators are slightly different in each buildings sector. The residential sector should indicate the population and number of dwellings. More detailed data can show the number of single- and multi-family residences. The commercial and industrial sectors should indicate the floor space and number of establishments. More detailed data can show the numbers of commercial buildings, institutions, and warehouse operations in the commercial sector and the numbers of light and heavy industrial operations in the industrial sector.

Estimates: Estimates can be used if the number of establishments and the average energy consumption for buildings in each sector are known. Residential sector estimates should use local (not national or provincial) average consumption data, because these data vary greatly because of differences in climate and the energy efficiency of construction practices in the locality. If the data provider cannot supply real consumption data because of problems defining local government boundaries, ask for average consumption data for each sector.

Estimates start to create problems in densely populated metropolitan areas. The average consumption for a low- to medium-density urban area will fail to reflect the lower per capita energy consumption of a high-density urban area. Care should be taken to separate areas by density in the estimate. For the commercial and industrial sectors, estimates can be used if data for large institutions, warehouses, and large industrial operations can be separated.

General instructions: Report the energy consumption values provided by the energy utilities or the values calculated from any real consumption data or estimates allocated per relevant unit. If separate estimates have been made for different types of buildings within sectors, prepare individual worksheets that reflect those estimates.

ii) Transportation

Transportation is another important sector in the community inventory. Emissions in this sector account for a significant portion of the total emissions in the inventory.

Transportation emissions can be estimated using any of three methods. The first method bases the estimate on fuel sales; the second, on vehicle kilometres travelled (VKT); and the third, on the number of registered vehicles in the community and averages for fuel efficiency and VKT in each vehicle class. **Note:** Data to support even one of these methods may not be available. If data are not available, consult with transportation specialists to determine how community transportation could otherwise be modelled for the community in question.

Inclusion protocols: Include all vehicles in the community (i.e. cars; vans; trucks; motorcycles; buses, including transit; and heavy trucks).

Exclusion protocols: Do not include marine, rail, and air traffic. Those transportation sectors fall under provincial or federal jurisdiction, or both. Do not include traffic from large highways or freeways that cross local government boundaries. **Note:** Excluding highway traffic is particularly important if the model in use generates VKT from road length within the local government boundaries.

The question of whether a community inventory should include off-road vehicles in its transportation sector (e.g. tractors, graders, loaders, etc.) is currently under debate. Inclusion requires a decision on the method that will be used to calculate community transportation and vehicle classes to be included in the data. For instance, fuel sales data will not capture off-road vehicles, although vehicle registration data may. In the vehicle registration scenario, off-road vehicles could easily be identified in the dataset and then included or excluded.

Real consumption data: The fuel or energy sources most commonly used for vehicles in the transportation sector are gasoline and diesel fuel. Natural gas, propane, and electricity are also used, but in insignificant amounts. Real consumption data can be gathered only from fuel sales data.

Fuel sales data are not necessarily more accurate than either of the other methods described. Commercial card locks and fuel delivered to commercial and industrial operations with fleet-fueling stations, are not included in fuel sales data. Tiny, remote fueling stations may not be included in the dataset. Further, fuel allocated to fueling stations on highways that pass through the local government's boundaries may not reflect fuel used within those boundaries. Further, fuel sales may include fuel volumes used by vehicles travelling through the community on major roads that cross local government boundaries. In this scenario, emissions from fuel sales will be greatly overestimated. And many other assumptions can be made once the volumes and locations of fueling stations are analyzed with respect to the local government boundaries.

If propane data are gathered, ask the data provider to distinguish between automobile propane and propane used for other activities (e.g. barbecues, space heaters, etc.).

Costs: Costs can be accurately calculated only if the fuel sales method is used. Otherwise, fuel consumption and associated costs are only as accurate at the model that is used to create the data.

Indicators: For the fuel sales method, try to use vehicle registration data to track the number of vehicles in each vehicle class. The indicators in this sector are typically those used in the two estimation methods: VKT and vehicle registration estimates. For either estimation method, avoid reporting the indicators separately; they are incorporated in the emissions calculation.

Estimates: The VKT method, which was developed by traffic engineers, estimates VKT from vehicle counts on collector and arterial roads. Do not include the VKT from highways and freeways in the calculation. The VKT method is essentially a model, and local government staff must understand it well enough to explain it to others (e.g. council, committees, community groups, etc.).

The vehicle registration method relies on the availability of vehicle registration data from licensing bodies. Even when such data are available, they may be problematic, because registrations for companies with large fleets that do not necessarily operate in the community will be included in the dataset. The method registration also involves accepting assumptions about national averages for fuel efficiency and VKT for each vehicle class.

General instructions: Assess the layout of the community with respect to highways and freeways. If many vehicles travel through the community, but have few opportunities to refuel within community boundaries, use the fuel sales method. When pass-through traffic has easy access to numerous fueling stations, use an alternative method.

iii) Solid waste

Solid waste is another important sector in the community inventory, because CH_4 from solid waste is an energy opportunity for local governments. The data required is the mass of solid waste generated in the community, or a quantitative measure of the CH_4 being produced by landfills.

Inclusion protocols: Include all solid waste generated in the community regardless of whether the landfill is located outside local government boundaries.

Exclusion protocols: Do not include industrial wastes or demolition and construction wastes.

Real data: Data are usually easily obtained from the waste management coordinator.

Costs: Waste collection and disposal costs can be obtained from the waste collection company.

Indicators: Include the population of the municipality.

Estimates: The local government, waste disposal contractor, or landfill operations personnel usually track these data. If the data are not tracked (e.g. in an unmanaged landfill), the volume may be estimated based on an estimate of the number of trips by garbage trucks to the landfill in a given year. If the trips estimate is unreliable, explore other methods (e.g. estimate volume from aerial photographs or on-site measurements, or ask for the disposal rate per resident from an adjacent community).

General instructions: Although the PCP Inventory Quantification Spreadsheet can calculate emissions related to solid waste, the Landfill Gas Emissions Model (LandGEM) is a possible alternative. (At the time of writing, LandGEM could be found at <www.epa.gov/ttn/catc/products.html>. Because websites are frequently reorganized, enter the key word “landgem” into a Web search engine if the foregoing URL stops working.) The LandGEM model is widely used throughout North America by local governments and consultants working on behalf of local governments. It is the best tool available to calculate emissions from solid waste. If LandGEM is used for the calculation, the result can be entered directly into the PCP Inventory Quantification Spreadsheet.

Section III: Recalculating dated inventories and Milestone Two

1. Recalculating dated emissions inventories

Local governments have been participating in the PCP program for more than 10 years. Many have completed inventories dating 10 or more years into the past. If the methods used to prepare a past inventory differ from those used to prepare a recent inventory, and if more detailed data have become available, the local government should consider refining and recalculating the older inventory.

For example, older transportation data might be recalculated if a better method has become available. As older inventories are updated, comparisons between the older and newer inventories increase in validity and credibility. Calculating the actual emissions is not difficult; the difficult part is gathering accurate data for inventories that will meet the “Guiding Principles” in Section II.

2. Milestone Two: setting a GHG reduction target

PCP recommends the following targets:

- a 20 per cent reduction below base year GHG emissions for local government operations within 10 years; and
- a six per cent reduction below base year GHG emissions for the community within 10 years.

Note that targets are set in absolute terms, but reductions are expressed a percentage of the base year inventory quantity. Participation in the PCP program is voluntary, and so a municipality can revise its target as its emissions reduction plan develops.

An emissions reduction target can be established at any time; however, the target is normally set after the emissions inventories and forecast have been developed, or after the results of existing emissions reduction measures have been calculated.

In developing a reduction target for the community, the local government usually seeks input from residents, non-governmental organizations, and the private sector. The reduction target and the timeline for achieving it must then be endorsed by the council or board. Recognition for PCP Milestone Two is earned when the local government submits the council or board endorsement of the emissions reduction targets to the PCP program.

Reduction targets can be set using one of two strategies:

- Adopt the PCP program’s recommended percentage targets and amend those targets at a later date if necessary; or
- Develop numeric targets based on inventory information and the reductions that can typically be achieved by implementing various reduction initiatives.

Thought must also be given to the timing of council or board adoption of the targets. Staff must consider existing council or board endorsements, if any, and must choose the stage in the PCP process at which to approach the council or board.

Here are some insights into how to time the adoption of targets:

1. If the council or board has endorsed completing milestones One, Two, and Three together:
    - Staff may choose to approach council or the board about target adoption as soon as the targets have been developed — that is, after completion of Milestone One and before completion of Milestone Three. In this scenario, targets are set before anything is known about the reduction actions to be implemented. Targets may later need to be amended, a step that is easily taken at the completion of Milestone Three, when staff must also report to council or the board.
    - Alternatively, staff may choose to wait until Milestone Three is complete. In this scenario, council or the board will set the target based on its willingness to endorse implementation of the reduction actions set out in Milestone Three.
2. If no council or board resolution to proceed with the PCP program has been passed and the emissions inventory and forecast have been completed (either in the past or recently):
    - Staff may send the inventory to council or the board as information, with a request that it endorse recommendations to (a) join the PCP program and adopt the recommended PCP targets and (b) proceed with Milestone Three.
    - Alternatively, staff may send the inventory to council or the board as information, with a request that it endorse a recommendation to join the PCP program and proceed with milestones Two and Three together. In this scenario, Milestone Two can be met in light of the results from Milestone Three.

The PCP Secretariat recommends that local governments complete milestones One, Two, and Three in combination. Local governments may choose to complete the milestones in combination first for corporate operations and later for the community.

As of January 1, 2008, local governments are eligible to receive funding from GMF for the development of GHG reduction targets only if target development is conducted as part of an application to complete a local action plan. The milestones do not have to be completed simultaneously, but they must be combined in one application. GMF can provide a grant of up to a 50 per cent toward the completion of milestones Two and Three.

3. Tracking emissions over time and replication

PCP members should try to develop emissions inventories annually or, at minimum, at three- to five-year intervals. However, unless the local government is aiming for recognition for Milestone Five, there is no requirement for periodic inventory development.

Periodic inventory development becomes easier if local government staff make an effort to establish relationships with data providers and to design ways of acquiring data internally and externally that feed into a replication of the GHG inventory development process. The internal and external data providers should all be listed in the emissions inventory. Notes about job titles and departments are more important than individual names, because the positions are less likely than the position-holders to change over time.

Any emissions report should mention the methods used to develop the GHG inventory. During future inventories, staff can review and reuse the methods, or at least understand how methods have changed over time. If no formal report is prepared, relevant notes should be entered into the spreadsheets or calculators so that others can repeat the inventory process.

Selected reading

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Appendix A — List of acronyms

CCP	Cities for Climate Protection
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
FCM	Federation of Canadian Municipalities
GHG	greenhouse gas
GMF	Green Municipal Fund
GWP	global warming potential
HFC	hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
LandGEM	landfill gas emissions model
N_2O	nitrous oxide
PCP	Partners for Climate Protection
PFC	perfluorocarbon
SF_6	sulphur hexafluoride
VKT	vehicle kilometres travelled

Appendix B — Useful conversions

Mass

1 pound (lb)	453.6 grams (g)	0.4536 kilograms (kg)	0.0004536 metric tons (tonnes)
1 kilogram (kg)	2.205 pounds (lb)		
1 short ton (ton)	2,000 pounds (lb)	907.2 kilograms (kg)	
1 metric ton (tonne)	2,205 pounds (lb)	1,000 kilograms (kg)	1.1205 short tons (tons)

Volume

1 cubic foot (ft3)	7.4805 U.S. gallons (gal)	0.1781 barrel (bbl)	
1 cubic foot (ft3)	28.32 litres (L)	0.02832 cubic metres (m^3)	
1 U.S. gallon (gal)	0.0238 barrel (bbl)	3.785 litres (L)	0.003785 cubic metres (m^3)
1 barrel (bbl)	42 U.S. gallons (gal)	158.99 litres (L)	0.1589 cubic metres (m^3)
1 litre (L)	0.001 cubic metres (m^3)	0.2642 U.S. gallons (gal)	
1 cubic metre (m^3)	6.2897 barrels (bbl)	264.2 U.S. gallons (gal)	1,000 litres (L)

Energy

1 kilowatt hour (kWh)	3,412 btu (btu)	3,600 kilojoules (kJ)	
1 megajoule (MJ)	0.001 gigajoules (GJ)		
1 gigajoule (GJ)	0.9478 million btu (million btu)	277.8 kilowatt hours (kWh)	
1 btu (btu)	1,055 joules (J)		
1 million btu (million btu)	1.055 gigajoules (GJ)	293 kilowatt hours (kWh)	
1 therm (therm)	100,000 btu	0.1055 gigajoules (GJ)	29.3 kilowatt hours (kWh)

Other

Kilo	1,000		
Mega	1,000,000		
Giga	1,000,000,000		
Tera	1,000,000,000,000		
1 psi	14.5037 bar		
1 atmosphere (atm)	0.9869 bar	101.325 kilopascals	14.696 pounds per square inch (psia)
1 mile (statute)	1.609 kilometres		
1 metric ton CH_4	21 metric tons equivalent CO_2		
1 metric ton N_2O	310 metric tons equivalent CO_2		
1 metric ton carbon	3.664 metric tons CO_2		