PDHonline Course G264 (8 PDH)

Estimating GHG Emissions Using the Local Government Operations Protocol

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International Local Government GHG Emissions Analysis Protocol

Introduction

ICLEI has developed this International Local Government Greenhouse Gas (GHG) Protocol to provide an easily implemented set of guidelines to assist local governments in quantifying the greenhouse gas emissions from both their internal operations and from the whole communities with their geopolitical boundaries. By developing common conventions and a standardized approach, ICLEI seeks to make it easier for local governments to achieve tangible reductions in greenhouse gas emissions. The standardized approach described in this Protocol facilitates comparisons between local governments and the aggregation and reporting of results being achieved by the action of diverse communities.

This Protocol will continue to evolve as new issues are raised and resolved.

Country/Regional Supplements are being developed in order to address some protocol issues in an appropriate local context. The Supplements contain a description of how the principles outlined in this document are to be implemented in each country or region, including appropriate data sources for the specified country or region.

For more information or for clarification of aspects of this Protocol, please contact your local ICLEI office. Contact information is available at http://www.iclei.org.

1.1 Purpose

The purpose of the Local Government Greenhouse Gas Emissions Analysis Protocol is to:

- Promote understanding of a local government's and community's impact on climate change and awareness of changes that can be made to reduce that contribution;
- Enable practitioners to develop complete and accurate emissions analyses to the extent possible and appropriate at the community level;
- Support comparison of different communities in a consistent, detailed, policy-relevant way;
- Enable measurement towards climate goals;
- Provide easily understandable metrics for a wide audience;
- Enable other networks and entities to define custom reporting requirements within the context of the Government Greenhouse Gas Emissions Analysis Protocol; and
- Function in tandem with existing or potential regulatory requirements and emissions certification opportunities.

1.2 Use of the Local Government Greenhouse Gas Protocol

Although this protocol can be applied to a variety of entities, it was written specifically with the unique situation of local governments in mind and has been formulated to address their concerns. Components of this protocol may also be applicable to state and provincial agencies, quasi-governmental agencies and service districts.

The Protocol, together with Country/Regional Supplements, will assist jurisdictions with their local action planning and in quantifying the impact of implemented and proposed measures.

Importantly, this Protocol should be part of a suite of tools that local governments use to help in the completion of a full emissions analysis and strategy. Whereas this document lays out the basic framework for conducting an emissions analysis, users are also referred to additional information available from ICLEI.

1.3 Background on ICLEI

Founded in 1990, ICLEI – Local Governments for Sustainability is an association of city and county governments dedicated to improving global environmental conditions through cumulative local action. Through its campaigns, ICLEI generates political awareness of key environmental issues, provides technical assistance and training to build capacity in local governments to address these issues and evaluates their progress toward sustainable development.

ICLEI assists local governments in their efforts to reduce the greenhouse gas emissions that contribute to both global climate change and declining air quality. To this end, ICLEI provides local governments with analytical tools and methods to measure emissions so that they can set and achieve their emission reduction goals. ICLEI encourages action by focusing on improvement to the quality of life for the entire community by reducing greenhouse gas emissions (i.e. improving air quality, reducing traffic congestion and achieving financial savings for residents and businesses).

1.4 Framework for Greenhouse Gas Management

Local governments should adopt a rigorous project management methodology that progresses from an initial analysis of greenhouse gas emissions, through strategy development and implementation of mitigation measures, to monitoring and reporting.

These elements are expanded on below.

Conduct a Greenhouse Gas Emissions Inventory
An emissions inventory should comprise two parallel analyses for a chosen analysis year, one for local government operations and one for emissions from all sectors of the community, determined by the geopolitical boundary of the jurisdiction. The majority of emissions from local government operations are usually a subset of the community emissions.

Analyzing municipal area emissions presents a number of challenges. Local governments are typically responsible for the governance of sub-national regions and are not able to use the same information sources used by national governments when compiling national inventories for the purpose of reporting under the UNFCCC.

Records of the flow of energy and materials are typically most accurate at the national level, due to national governments having governance over imports and exports. Reducing the spatial area of the analysis from national to region or city often results in a lower level of accuracy in records of material and energy flows due to the constant movement across jurisdictional boundaries.

The need to analyze greenhouse gas emissions at a local government level means that a combination of national and local area information is likely to be required in order to model local community emissions.

Establish a Reduction Target
The emissions reduction target is the quantity of greenhouse gas emissions the jurisdiction is to reduce by the target year. The target is typically expressed as the percentage by which emissions will be reduced relative to a baseline year. Target setting should include consideration of targets adopted by other levels of government, peer communities, feasibility and the urgency of the issue. Separate baseline years, target years and targets may be established in relation to government operations and community-scale emissions. Additional guidance on this matter will be provided in each Country/Regional Supplement.

Develop a Strategy to Reduce Emissions
A strategy and the emission reduction measures included therein should demonstrate how a local government will reduce its greenhouse gas emissions. Most municipal governments will have implemented programs or measures since the baseline year that reduce greenhouse gas emissions – energy conservation, landfill gas recovery, waste reduction, fuel switching, transportation planning, land use planning, etc. The strategy should identify and quantify these existing measures, along with new and proposed measures that will contribute to achieving a reduction in the level of emissions. As with the emissions inventory, a strategy should consist of two parallel analyses – one of greenhouse gas reductions from the community and another of reductions from the local government's operations.

Monitor Progress and Report on Results
Monitoring progress is an important process that provides the city with the opportunity to measure the effectiveness of its greenhouse gas management work. The process also provides an opportunity to highlight achievements, assess key learnings, and provide direction for greenhouse action in the future.

In order to accurately monitor progress, it is important that the analysis conducted in each year is comparable. If the local government has closed a facility or ceased providing a service, this needs to be stated in any progress reports that are produced so that any increase or decrease in emissions is not misleading.

1.5 Reporting in accordance with the ICLEI Local Government Emissions Analysis Protocol Standard

While this Protocol has been developed for use by local governments, other parties needing to compile sub-national inventories will find it useful.

The Protocol has been designed to both provide guidance and establish a standard for local government greenhouse gas management programs. At this stage of the Protocol's development, it is intended that local governments will self-identify compliance with the Local Government GHG Protocol. An accreditation process and associated recognition may be established by ICLEI in the future, for those parties seeking more formal acknowledgment that their greenhouse management is compliant with the Local Government GHG Protocol.

Users of this Protocol, for inventory compilation and reporting purposes, are requested to state that the information presented complies with the requirements of the Local Government GHG Protocol. The term "shall" is used in the chapters containing standards to clarify what is required to prepare and report a GHG inventory in accordance with the LG Protocol Standard. This is intended to improve the consistency with which the standard is applied and the resulting information that is publicly reported.

General Principles

Local governments have unique requirements of greenhouse gas management programs to account for the broad range of operations that typically fall under their jurisdiction. Local government greenhouse gas inventories comprise two parts - the operations of local government itself and the community that they govern.

Local government operations emissions – Emissions resulting from the functions of local government are analogous to those of a relatively complex private sector organization. As such the emissions inventory requirements do not differ significantly from those presented in the GHG Protocol Initiative Corporate Accounting and Reporting Standard developed by the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD);

Community emissions – Emissions measured at the community scale requires a methodology that differs from that used for the compilation of national inventories of greenhouse gas emissions. This is primarily due to the need for such an analysis to reflect the opportunities available to local governments and the challenge of quantifying the local level of activities that lead to the emission of greenhouse gases.

There are certain general principles that need to be adhered to by local governments to ensure that the integrity of the analysis is maximized and that the results are represented in such a way that is useful for policy development.

The development and implementation of this Local Government GHG Protocol follows principles consistent with those used in the finance sector, to ensure accurate accounting and reporting. These principles have previously been adapted by the WRI/WBCSD GHG Protocol Initiative to apply to the accounting and reporting of greenhouse gas emissions and are followed in this Protocol.

Relevance: The greenhouse gas inventory shall appropriately reflect the greenhouse gas emissions of the local government or the community within the local government area and should be organized to reflect the areas over which local governments exert control and hold responsibility in order to serve the decision-making needs of users.

Completeness: All greenhouse gas emission sources and activities within the chosen inventory boundary shall be accounted for. Any specific exclusion should be disclosed.

Consistency: Consistent methodologies to allow for meaningful comparisons of emissions or reductions over time shall be used. Any changes to the data, inventory boundary, methods, or any relevant factors in the time series, shall be disclosed.

Transparency: All relevant issues shall be addressed in a factual and coherent manner to provide a clear audit trail, should auditing be required. Any relevant assumptions shall be disclosed and include appropriate references to the accounting calculation methodologies and data sources used, which may include this Protocol and any relevant Supplements.

Accuracy: The quantification of greenhouse gas emissions or reductions should not be systematically over or under the actual emissions or reductions. Accuracy should be sufficient

to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

Conservativeness: Any assumptions, values and procedures required to calculate either greenhouse gas emissions or reductions should be conservative, such that the level of emissions is not underestimated, nor the benefit of emission reduction measures overestimated.

Inventory Requirements

An emissions inventory should comprise two parallel analyses, one for local government operations and one for all emissions within the community, determined by the geopolitical boundaries of the jurisdiction. Most emissions from local government operations are a subset of the community emissions (limited exceptions occur where local government operations take place outside of the community's geopolitical boundary).

Analyzing community-scale emissions presents a number of challenges. Local governments are typically responsible for the governance of sub-national regions and are not able to use the same information sources used by national governments when compiling national inventories for the purpose of reporting under the UNFCCC. Records of the flow of energy and materials are typically most accurate at the national level, due to national governments having governance over imports and exports. Reducing the spatial area of the analysis from national to sub-national results in a lower level of accuracy in records of material and energy flows. As the spatial area of analysis is reduced to city or municipality, the accuracy of an analysis may be further reduced due to the difficulty of tracking the movement of materials and energy across jurisdictional boundaries. The need to analyze greenhouse gas emissions at a local community level means that a combination of national and local area information is likely to be required in order to model emissions.

This section describes what should be counted, how it should be described and how it should be organized. A common approach to these elements is necessary in order to facilitate results that are comparable over time and across local governments. Separately, guidance on which sectors, sources and scopes of emissions should be included in emissions reporting is provided in Chapter 4.

3.1 Analysis Parameters

An emissions inventory is comprised of separate analyses of the emissions generated by a local government's internal operations and those associated with the community as a whole over the course of a single year. The inventory is conducted by compiling activity data describing energy use and waste generation and multiplying that by emission factors for each type of energy used and each waste disposal site and technology. The government operations and community inventories are each subdivided into sectors that correspond to international standards for classifying greenhouse gas emissions and which reflect government operations and community activities, respectively.

A complete emissions inventory includes careful tracking of location and degree of control over the emissions (scopes) as well as the reliability of, and methodological complexity of, the data sources (tiers).

Local governments should make every effort to include indicator information for each sector. Inclusion of indicators specific to each sector allows emission levels to be normalized and compared based on the energy intensity of each activity through the generation of comparative reports by program administrators (see Section 4.5). Additional guidance on selection of indicators and sources of data will be provided in each Country/Regional Supplement.

3.1.1 Gases

The greenhouse gases that should be quantified and included in a local government greenhouse gas emissions analysis are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), PFCs, HFCs and SF_6 . In most cases the emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) from fossil fuel combustion, electricity generation (the indirect emissions associated with electricity used in the community), waste disposal and wastewater will be the most significant sources of greenhouse gas emissions in community and government operations inventories; see section 3.1.4.1 for guidance of prioritizing emissions.

Biological vs. Fossil Carbon Sources
Appropriate treatment of CO_2 emissions is dependent on the source of carbon embodied in the emissions. The burning of fossil fuels releases carbon into the atmosphere that is not part of the natural carbon cycle. Alternatively, the burning of biologically derived fuels emits carbon dioxide that would have eventually been released in natural processes when the biomass died and decayed. This carbon is considered to be part of the natural carbon cycle. Therefore the burning of biofuels does not have a long term impact on climate change. Local governments should use the convention that burning of wood or biomass is not a source of scope 1 CO_2 in the emissions inventory unless the Land Use Change and Forestry sector is also included in the analysis, but shall include the emission of non-CO_2 greenhouse gases from combustion.

In order to be consistent with reporting requirements of some greenhouse gas management programs and in order to more accurately understand energy consumption patterns and trends, local governments should gather data on biogenic sources of CO_2 and that data should be considered an information item.

It is important to note that when blended fuels are used (e.g. B20, which is 20% biodiesel + 80% mineral diesel), the fossil fraction of the fuel does contribute to the jurisdictions emissions level. Similarly, any non-CO_2 greenhouse gases emitted from the burning of biofuels is not part of the natural carbon cycle and must be included in the emissions analysis.

Note on Lifecycles: in some cases biofuels can be derived from sources that have significant embodied energy or other environmental consequences– for example ethanol derived from a crop that requires significant petrochemical inputs such as fertilizers and pesticides. This can vary widely dependent upon the fuel crop, the region and the growing practices. While this is a distinct issue from the question of how to treat biogenic carbon sources, it is none-the-less an important one. Emissions from these sources, like coal mining and oil refining, could be considered scope 3 within the protocol. Guidance on lifecycle assessments is not provided in this protocol as it is beyond the boundaries of analysis. However, local governments are strongly encouraged to consider the upstream emissions from the specific source of biofuels in making decisions about the use of those fuels.

Electricity Generated from Biological Sources
The use of landfill gas or sewage gas to produce electricity does not contribute to anthropogenic carbon dioxide emissions. Oxidized (burnt, combusted) landfill gas is considered to be the same as burning biomass, as the process of burning landfill gas converts methane to carbon dioxide. Carbon dioxide would have been released through natural decomposition processes, but when organic material decomposes anaerobically it produces methane, which would not have been released as part of the natural carbon cycle. Therefore

preventing the release of this methane by using landfill gas or sewage gas to generate electricity does not contribute to carbon dioxide emissions.

To illustrate this point, consider an apple growing in the forest. At maturity this apple contains a fixed amount of carbon in its tissue. In a natural system the apple drops from the tree, decomposes, and releases this carbon in the form of CO_2, which was taken up earlier in the year through photosynthesis. This is considered part of the natural carbon cycle so the CO_2 release is not a new emissions source. If humans take this apple and bury it in a landfill, the apple decomposes, but the anaerobic conditions of the landfill cause the carbon in the apple tissue to be released as CH_4 as opposed to CO_2. Since CH_4 is 21 times more effective at trapping heat when released into the atmosphere than is CO_2 and humans were responsible for the release of the CH_4 instead of CO_2, this is considered to be a new source of greenhouse gas emissions. On the other hand, when that methane is captured and combusted, as opposed to being released directly into the atmosphere, the CH_4 is converted back to CO_2. As the total amount of carbon involved in this process has not changed, the amount of CO_2 produced is similar to what would have been released in the initial, natural, case. Therefore the CO_2 emissions from the combustion of landfill gas are not considered as a source of greenhouse gas emissions.

3.1.2 Global Warming Potentials

When counting GHG emissions and reductions, the individual gases must be converted to carbon dioxide equivalent (CO_2e) in order to calculate a single number that represents the total amount of GHG being released (or avoided).

Carbon dioxide equivalent (CO_2e) is the standard unit that allows amounts of greenhouse gases of different strengths to be added together based on that gas's impact on climate change. CO_2e is expressed in terms of the amount of carbon dioxide it would take to have the same impact on global climate change. For example, nitrous oxide is 310 times more potent than carbon dioxide as a global warming gas. Therefore, one unit of N_2O is equivalent to 310 units CO_2e. This conversion factor is the gas's Global Warming Potential. The global warming potential is calculated based on a specific time frame (most commonly 100 years), taking into consideration both the impact and the length of time the gas remains in the atmosphere (i.e. a more potent greenhouse gas that is removed from the atmosphere in 10 years could have a lower global warming potential than a weaker gas that remains in the atmosphere for 50 years).

In general local governments should follow international convention in using the global warming potentials outlined in the IPCC's Second Assessment Report (SAR). This convention may change in the future if international consensus shifts to using more recent values published by the IPCC. In cases where a national government has started using global warming potentials published in a later Assessment Report for reporting to the UNFCCC, a local government within that country should apply these GWPs for inventories of years following the national government's adoption of the new GWPs. Local governments should utilize global warming potentials based on a 100 year time frame unless the national government's inventory is reported using another time frame in which case they should align with the national government.

Common global warming potentials include:

Global Warming Potentials from the IPCC's Second Assessment Report

Gas	SAR
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
HFC-23	11,700
HFC-125	2,800
HFC-134a	1,300
HFC-143a	3,800
HFC-152a	140
HFC-227ea	2,900
HFC-236fa	6,300
HFC-43-10mee	1,300
Perfluoromethane (CF_4)	6,500
Perfluoroethane (C_2F_6)	9,200
C_3F_8	7,000
C_4F_{10}	7,000
C_5F_{12}	7,500
C_6F_{14}	7,400
Sulfur Hexafluoride (SF_6)	23,900

SOFTWARE NOTE: In the vast majority of cases the Global Warming Potentials used to convert to CO_2e will be those in the Second Assessment Report, but flexibility must be allowed for. As described above, in cases where a national government has started using GWPs from a later IPCC Assessment Report those should also be used by local governments in that country. GWPs therefore need to be annual and country-specific, with the choice of GWPs used within a country to be determined by the country administrator of the relevant greenhouse gas management program.

3.1.3 Boundaries

Defining the boundary of an organization that has multiple functions and provides a wide range of services is clearly a challenge. This Protocol uses an extension of the concept of control and influence, which recognizes the broad role of local governments as entities that both provide services and develop policy that affects the local community.

The two boundaries that are applicable to local government are:

Organizational Boundary – consisting of functions directly under local government control, consistent with private sector reporting. In cases where certain functions are shared, a proportional share approach may be needed;

Geopolitical Boundary – consisting of the physical area or region over which a local government has jurisdictional authority.

A complete local government greenhouse gas emissions inventory should separately account for emissions associated with the operations of the government and all activities that occur in the geopolitical area.

3.1.3.1 Organizational Boundary – The Government Operations Analysis

A local government's own organizational greenhouse gas emissions analysis must include emissions arising from the use of all significant assets and services. All emissions that are a consequence of the local government's operations must be included, regardless of where those emissions occur. In some cases, notably electricity use and waste disposal, emissions arising as a consequence of the operations often occur outside the geopolitical boundary of the local government. The physical location of the site where emissions occur is not relevant to the decision regarding what emissions should be included in the analysis.

3.1.3.2 Geopolitical Boundary – The Community Analysis

The community-scale emissions analysis must include all greenhouse gas emissions associated with activity occurring within the local government's geopolitical boundary. Guidance as to what should be reported is included in Chapter 4 and in each Country/Regional Supplement.

Activities that occur within the community boundary can be controlled or influenced by jurisdictional policies, educational programs and establishing a precedent. Although some local governments may have only limited influence over the level of emissions from some activities, it is important that every effort be made to compile a complete analysis of all activities that result in the emission of greenhouse gases.

There may be instances where boundaries overlap such as, for example, when a regional government and a city within its borders conduct separate analyses. In these cases, overlapping jurisdictions are encouraged to collaborate on the data collection and other tasks. It is appropriate that emissions within the geopolitical boundary of a city would also be included in the inventory of emissions within the geopolitical area of another regional government. However, it is important to prevent inappropriate double-counting when reporting more than one jurisdiction in aggregate.

While the first criterion for consideration in community inventories is geopolitical boundaries, in some cases it is important to consider emissions that occur outside of the geopolitical boundaries of the community as a result of decisions or actions taken within the community. A more complete analysis describing how to separately account for these emission sources is described in Section 3.1.6.

3.1.4 Sources

In developing an emissions inventory, all emission sources should be considered in accordance with the principles of relevance, completeness and consistency. Although this should be interpreted within the context of each local government, this section provides guidance regarding an acceptable approach to inventory compilation.

There is no limit to the emission sources and fuel types that local governments may quantify and include in the emissions analysis, although consistency is important. For example, if the

decision is made to include HFCs released from air conditioning systems, then these must be fully included in all analysis sectors. Similarly, if an emissions reduction is to be claimed relative to a baseline emissions inventory, the original emissions source must be included in the inventory. For example, a jurisdiction cannot take credit for installing an emissions capture facility at a closed landfill site unless the baseline emissions inventory includes that site as an emissions source.

SOFTWARE NOTE:
Within each sector, the emissions inventory is built up from discrete sets of activity data (energy use, waste generation, etc.) organized into records. Each record represents an individual emissions source, or group of emission sources. For example, a record can include a single facility, or contain an aggregation of similar facilities (e.g. all pumping stations).

Similarly, the Residential Sector of the Community Inventory may contain only one record for all dwellings or it may contain numerous records that break households into classes, such as single family houses, multi-family units, etc. Ultimately, the level of aggregation of the data will depend on (a) data availability and (b) the level of detail required for the actions planned.

It is important for the users to be able to balance the data requirements of the analysis with the desired outcomes. For example, although it may be easier to combine energy use data for all governmental facilities, local governments would lack the information necessary to target particularly inefficient buildings in their action plans. On the other hand, policies that target residential energy use typically target broad housing groups and so it would be unnecessary to spend time segregating housing into overly fine levels of detail.

3.1.4.1 Prioritizing Measurement of Emissions Sources

Local governments need to make every effort to compile a complete, accurate and consistent inventory of emissions. However, recognizing that the emissions inventory stage is only one element of greenhouse gas management, the desire for completeness needs to be balanced with the need to progress to mitigation action. It is recognized that a local government with limited resources should focus those resources on mitigation in preference to accounting for relatively minor emission sources.

Emission sources that meet the established definition of de minimis emissions may be excluded from measurement and reporting. De minimis emissions refer to one or more emission sources, for one or more gases which, when summed, represent less than 5% of total CO_2e emissions. De minimis sources of emissions are often relatively small, unimportant and difficult to accurately measure and quantify. Further guidance regarding applying the de minimis definition and how to determine whether a particular source is de minimis is provided in Chapter 4 and may be provided in the Country/Regional Supplements to this Protocol.

3.1.5 Base Year

An emissions inventory shall comprise all emissions occurring during a selected calendar year. In cases where government operations records are available only on a fiscal year basis, efforts should be made to categorize emissions sources on a calendar year basis.

Prior to beginning data collection, local governments must examine the range of data sources available and select a year for which accurate records of all emission sources exist in sufficient detail to conduct an accurate inventory. Simultaneously it is often preferable to establish a base (or baseline) year several years in the past so as to be able to account for the emissions benefits of recent actions. It is good practice to compile an emissions inventory for the earliest year for which complete and accurate data can be gathered. The base year for the UNFCCC and subsequent Kyoto Protocol is calendar year 1990. However data from 1990 is often prohibitively difficult or impossible to collect. Given that the priority for a greenhouse gas management program should be on practical results, it is more important that the base year be documented with enough detail to provide a good basis for local action planning than it is that all participants in a program produce an inventory with the same, stipulated base year.

Moreover, it is good practice to aim for a base year analysis that is likely to be representative of the general level of emissions over the surrounding period. Energy use in a year that was particularly hot or particularly cold would usually differ to energy use in an average year, due to the greater level of use of air conditioning or heating respectively. Similarly, cities that have an electricity supply comprising a high proportion of hydroelectricity should avoid abnormally dry years during which the amount of hydroelectricity generation is lower than usual.

It is not required that cities conduct inventories for multiple years for the purpose of adopting a normalizing or averaging approach, due to the additional effort required. Knowledge of local climate variations should be sufficient to ensure that the base year inventory is representative.

When choosing a base year it is important to remember that this is the emissions level against which changes in emissions are measured. Therefore, any emission reduction activities put in place before the base year are considered to be part of the status quo and do not provide the local government with credit towards reaching an emission reduction target that may be adopted. Local governments should also consider regional, state, provincial and national guidelines and precedent in establishing their base years.

In addition to conducting an inventory of base year emissions, it is good practice to complete a comprehensive inventory of emissions at regular intervals following the base year. The best practice is to conduct a re-inventory every year.

3.1.6 Scopes

The emissions inventory includes all important sources of greenhouse gas emissions occurring within the jurisdiction's geopolitical and organizational boundaries. Differentiating between emission scopes helps to avoid the possibility of double counting emissions and misrepresenting emissions when reporting but allows all policy relevant information to be captured. Three classifications are used to categorize emissions sources, differing slightly when applied in the context of government operations and community-scale inventories.

3.1.6.1 Government Operations Emissions Scopes

Government Scopes Definitions

Scope 1 emissions – Direct emission sources owned or operated by the local government.

Scope 2 emissions – Indirect emission sources limited to electricity, district heating, steam and cooling consumption.

Scope 3 emissions – All other indirect and embodied emissions over which the local government exerts significant control or influence.

Information Items – Biogenic emissions and other indicators which may be relevant to a complete understanding of an organization's energy use and climate impact, but which are not conventionally included in greenhouse gas accounting.

Government Scopes Examples

Scope 1: A municipal vehicle powered by gasoline or a municipal generator powered by diesel fuel.

Scope 2: Purchased electricity used by the local government, which is associated with the generation of greenhouse gas emissions at a power plant. These emissions must be included in the government operations analysis, as they are the result of the local government's operations and energy purchasing policies.

Scope 3: Emissions resulting from contracted waste hauling services.

Information item: Biogenic carbon emissions or quantity of electricity generated from solar photovoltaic panels.

Government Operations Emissions Sources

Macro Sector (IPCC)		Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions
Energy	Stationary Combustion	Utility-delivered fuel consumption (e.g., natural gas) Decentralized fuel consumption (e.g., propane, kerosene, fuel oil, stationary diesel, biofuels, coal) Utility-consumed fuel for electricity / heat generation	n/a	Stationary combustion-based emissions from facilities operated by contracted businesses performing essential government services Upstream/downstream emissions (e.g., mining/transport of coal)
	Electricity / Heat Consumption	n/a	Electricity / heat / steam consumption	Electricity/heat/steam consumption-based emissions from facilities operated by contracted businesses performing essential government services Upstream/downstream emissions (e.g., mining/transport of coal)
	Mobile Combustion	Tailpipe emissions from government owned and operated vehicles	n/a	Tailpipe emissions from vehicles operated by contracted businesses performing essential services Upstream/downstream emissions
		n/a	n/a	Tailpipe emissions from vehicles operated by government employees traveling to and from work Upstream/downstream emissions
	Fugitive emissions	Fugitive emissions not already accounted for	n/a	Upstream/downstream emissions
Industrial Processes and Product Use		Fugitive emissions from industrial processes	n/a	Upstream/downstream emissions
Agriculture, Forestry and Other Land Use		Methane from government owned livestock	n/a	n/a
		Net biogenic carbon flux of government owned/operated sources	n/a	n/a
Waste		Government owned/operated landfill, incineration, compost and wastewater facilities	n/a	Analysis-year emissions from government waste disposed to date Embodied future emissions associated with analysis-year waste generation Upstream/downstream emissions (e.g., transport to the landfill)

Emissions from Contracted Services

Emissions from contracted services should be included in an emissions inventory for a local government in some cases. These contractor emissions may be either direct or indirect but will be classified as Scope 3 emissions within the Government Operations inventory regardless. Generally these emissions should be included if they are relevant to an accurate understanding of local government emissions trends, or if they are particularly relevant to developing a comprehensive greenhouse gas management policy.

The determination of whether to include emissions from a contractor in an emissions inventory must be based on three considerations:

1. Is the service provided by the contractor a service which is normally provided by local government? If so, the local government must include these emissions to allow accurate comparison with other local governments.

2. In any previous emissions inventory, was the contracted service provided by the local government and therefore included in the earlier inventory? If so, these emissions must be included to allow an accurate comparison to the historical base year inventory.

3. Are the emissions resulting from the contractor a source over which the local government exerts significant influence? If so, these emissions must be included in order to provide the most policy relevant emissions information.

3.1.6.2 Community-Scale Emissions Scopes

Community Scopes Definitions

Scope 1 emissions – All direct emissions sources located within the geopolitical boundary of the local government.

Scope 2 emissions – Indirect emissions that result as a consequence of activity within the jurisdiction's geopolitical boundary limited to electricity, district heating, steam and cooling consumption.

Scope 3 emissions – All other indirect and embodied emissions that occur as a result of activity within the geopolitical boundary.

Information Items – Biogenic emissions and other indicators which may be relevant to a complete understanding of a community's energy use and climate impact, but which are not conventionally included in greenhouse gas accounting.

Community Scopes Examples

Scope 1: Use of fuels such as heavy fuel oil, natural gas or propane used for heating.

Scope 2: Purchased electricity used within the geopolitical boundaries of the jurisdiction associated with the generation of greenhouse gases at the power plant. These emissions should be included in the community-scale analysis, as they are the result of the community's electricity consumption.

Scope 3: Methane emissions from solid waste generated within the community which decomposes at landfills either inside or outside of the community's geopolitical boundary.

Information item: Biogenic carbon emissions or quantity of electricity generated from solar photovoltaic panels.

Macro Sector (IPCC)		Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions
Energy	Stationary Combustion	Utility-delivered fuel consumption Decentralized fuel consumption Utility-consumed fuel for electricity / heat generation	n/a	Upstream/downstream emissions (e.g., mining/transport of coal)
	Electricity / Heat Consumption	n/a	Utility-delivered electricity / heat /steam consumption Decentralized electricity / heat /steam consumption	Upstream/downstream emissions (e.g., mining/transport of coal)
	Mobile Combustion	Tailpipe emissions from on-road vehicles Tailpipe emissions from rail, sea, airborne and non-road vehicles operating within the community	Electricity consumption associated with vehicle movement within the community (e.g., light rail)	Tailpipe emissions from vehicles used by community residents Upstream/downstream emissions (e.g., mining/transport of oil) Tailpipe emissions from rail, sea, and airborne vehicles departing from or arriving into the community
	Other Energy	Fugitive emissions not already accounted for	n/a	Upstream/downstream emissions
Industrial Processes and Product Use		Decentralized process emissions	n/a	Upstream/downstream emissions
Agriculture, Forestry and Other Land Use		Livestock methane, managed soils	n/a	Upstream/downstream emissions from fertilizer/pesticide manufacture
		Net biogenic carbon flux	n/a	n/a
Waste	Solid Waste Disposal	Direct emissions from landfill, incineration and compost facilities located inside the community	n/a	Landfill, incineration and compost emissions in present-year from waste produced to date inside the community Future emissions from waste disposed Upstream/downstream emissions (e.g., transport to the landfill)
	Wastewater Treatment and Discharge	Direct emissions from wastewater facilities located inside the community	n/a	Present-year emissions from wastewater produced to date inside the community Future emissions from treated wastewater Upstream/downstream emissions (eg, transport to landfill)

Use of Scopes

The Scopes are intended to allow for the inclusion of all policy relevant information in an inventory while preventing double counting and enabling appropriate analysis and representation of data. Reporting requirements will differ dependent upon the management program (see Section 4). However, local governments should always be able to report the total Scope 1 emissions and the total Scope 2 emissions.

Greenhouse gas program administrators need to be aware, when seeking to report the aggregate emissions of local governments participating in their program, that some Scope 1 emissions of one local government may be the Scope 2 emissions of another local government in the same program.

3.1.7 Activity Data

Activity data is the relevant measurement of energy use or other greenhouse gas generating processes. It is used in conjunction with an emission factor (see Section 3.1.8) to determine emissions using the following equation:

Activity data x emission factor = emissions

Guidance as to the appropriate activity data for each source in each sector is provided in Section 3.2 with further guidance provided in each Country/Regional Supplement.

3.1.8 Emission Factors

Emission factors are used to convert energy usage into the associated emissions and so are central to the emissions analysis. They are usually expressed in terms of emissions/energy used (i.e. CO_2/GJ). The energy density of fuels used is also required where the quantity of fuel used is expressed in mass or volume. The conversion to emissions follows the simple approach of:

Fuel consumed (activity data) x emission factor = emissions

There are a variety of emission factors available from numerous sources. The reliability and accuracy of various sources of emission factors is an important consideration. Common sources are listed below. Country specific supplement will provide guidance about the selection of appropriate factors in each country:

- National government agency;
- Sub-national (state, county, etc) government agency;
- International agency (e.g. IPCC Tier 1);
- University or other research institution;
- Non-government organization;
- Corporate/industry reported.

Emission Factors Developed by Local Governments

A sub-national source of emission factors may include the local government that is conducting the analysis. This may be necessary in cases where a local electricity grid is utilized and the generation facilities that supply that grid differ significantly from the larger region in which the local government lies.

It is important that emission factors developed by the city itself are approved by the greenhouse gas program administrator if it is intended to present the resultant inventory as having been conducted in accordance with the program. This approval process is a particularly important stage that must occur before the city's inventory is included in aggregate or comparative reporting.

District Heating/Cooling

In jurisdictions that have district heating systems, purchased heat (usually in the form of steam) shall appear as a fuel type in the individual records of the analysis. This is in line with the "end use" nature of the emissions inventory. It is necessary to know both the amount of steam used locally and the amount of fuel used to generate the steam at the point of production. An emission factor that relates the total amount of steam delivered to each facility to the emissions generated in producing that steam must be computed as follows:

1. Determine the total fuel used by the district heating facility to produce steam.
2. Multiply the fuel used in the district heating facility by the emissions factor for that fuel type to get the total emissions for the heat production. Use a weighted average if more than one fuel type is used.
3. Divide the total emissions by the total amount of steam delivered to the end-users to create an emissions factor for the steam.
4. Apply this emissions factor to the amount of heat purchased by the end user.

Emissions associated with the end-use consumption of steam shall be classified as Scope 2 emissions, while emissions produced by fuel consumption at the facility generating the steam shall be classified as Scope 1 emissions. Local governments must ask their utility provider if the fuel supplied to a district heating facility is included in aggregated Commercial or Industrial Sector fuel consumption data, if that is also provided by the utility. If so, the amount of fuel being delivered to those facilities must be subtracted from the total.

Cogeneration or Combined Heat and Power (CHP)

District heating facilities are often operated as part of a cogeneration system, or combined heat and power (CHP) plant, that produces electricity as well as steam. In these cases, a portion of the emissions from the cogeneration facility are already accounted for in the community's electricity emission factor. Therefore, calculating GHG emissions from heat based on the total fuel consumed and energy produced (as in district heating) would result in double counting. An emission factor is needed that separates heat production from electricity production.

Since the fuel used by the cogeneration facility simultaneously provides both heat and electricity, the following steps must be used to determine emission factors for the electricity and heat produced.

1. Obtain information on the total fuel used by the facility (volume of fuel).
2. Determine the total emissions of greenhouse gases from the fuel used (tonnes of CO_2e).
3. Determine the facility's output of heat and electricity in units of energy (GJ or MMBTU of electricity, GJ or MMBTU of steam).
4. Determine the percentage of the total energy output from the facility that results from electricity and heat (% of total MMBTU or GJ from steam, % of total MMBTU or GJ from electricity)
5. Divide the total emissions by the unit of energy output to determine the "raw" emission factor for the CHP facility (GJ or MMBTU/tonne CO_2e).
6. Multiply the "raw" emission factor by the percentage of the total energy output that is in the form of heat (tonnes CO_2e from heat).
7. Multiply the "raw" emission factor by the percentage of the total energy output that is in the form of electricity (tonnes CO_2e from electricity).

These emission factors can be applied to the steam used in individual facilities. If the electricity produced is being fed into the electrical grid, it must already be accounted for in the average electricity emission factor for the region. If the electricity is being supplied to one or more distinct individual users, then the electricity emission factor calculated above must be applied to the electricity purchased from the cogeneration facility (excluding electricity sold to users outside the jurisdiction).

If the heat and power produced is being used entirely on-site, then the emissions can be calculated simply as a function of the fuel used by that facility without consideration of what it is being used for. In this case emissions resulting from the fuel consumed shall be classified as Scope 1 emissions and included in the Government Analysis if the generation facility is owned or operated by the local government, and as Scope 1 emissions within the Community Analysis so long as the facility is located inside the geopolitically defined community, regardless of its ownership. In either case, regardless of the portion of associated heat and electricity that is consumed on-site, emissions associated with the consumption of the heat and power should be classified as Scope 2 emissions from the perspective of the end-user(s) consuming the heat and power.

Once again, fuels sold to cogeneration facilities may already be included in aggregated Commercial or Industrial Sector fuel consumption data provided by a local utility. Local governments must query their local gas company as to whether all fuels sold to co-generators are included in their analysis and exclude them if the emissions are being attributed to the end user through the above methodology.

Note: If district heating or cogeneration utilizes the waste heat that occurs as a byproduct of another independent process that would already be in operation, such as manufacturing or waste incineration, then the emissions must be attributed to the original process and the heat/power can be considered to be coming from a climate neutral source – as long as the fuel used in the original process is being accounted for elsewhere in the inventory.

3.1.8.1 Electricity

Emissions factors for grid electricity should be determined from the same types of sources as for other emissions factors. However, there are additional complexities resulting from the fact that grid electricity is derived from different sources at different times. Guidance on appropriate sources for average and marginal electricity emission factors will be provided in the Country/Regional Supplements.

Average Electricity Emission Factors
Electricity emission factors convert the amount of electricity used into an equivalent amount of greenhouse gas emissions. Electricity is drawn from an interconnected grid containing many diverse generation facilities (e.g. coal, natural gas, geothermal, hydro, nuclear, etc.), and so the emission factors should reflect this diversity. Therefore, electricity supplied (and associated greenhouse gas emissions) from all electricity providers (private, public, non-utility) supplying the grid must be included in the emission analysis. The electricity emission factors must also reflect changes in generation capacity over time. In this way the emission factors will reflect the average emissions from electricity use in the year and grid region in which the analysis is conducted.

Electricity also experiences transmission and distribution losses, whereby some of the electricity produced at the power plant is lost during delivery to end consumers. Therefore, more electricity is produced than is consumed by the end-user. These transmission and distribution losses are primarily the responsibility of the distribution system. From the perspective of the utility, emissions associated with electricity generation shall be classified as Scope 1. Emissions associated with transmission and distribution losses from electricity not generated by the utility (and therefore not counted in scope 1) shall be classified as Scope 2. From the perspective of the end-user consuming the electricity, while emissions associated with electricity consumption are classified as Scope 2, emissions associated with transmission and distribution losses tied to that consumed electricity should be classified as Scope 3 if reported.

3.1.9 Tiers

A tier represents a level of methodological complexity. Three tiers are described for categorizing both emissions factors and for activity data. Tier 1 is the basic method, frequently utilizing IPCC-recommended country-level defaults, while Tiers 2 and 3 are each more demanding in terms of complexity and data requirements. Although Tiers 2 and 3 are considered to be more accurate, there may be a trade-off between the effort involved in obtaining the information and the benefit of having it. Local governments analyzing greenhouse gas emissions from their municipalities should use the highest practicable Tier.

It is possible that a mixture of tiers will be needed to complete one emissions inventory, reflecting the availability of information in different parts of a country. In some cases calculation of the emissions from a single source will require use of different tiers of activity data or different tiers of activity data and emission factors. Local governments shall apply a "lowest common denominator" approach in these cases and classify the emissions from a specific source as the lowest tier utilized in calculating the emissions.

It is good practice to report tiers for all emission sources included in the inventory. In some cases where aggregate reporting is a significant goal, Country/Regional Supplements may make this a mandatory requirement.

Note: If the emission of air pollutants is included in the greenhouse gas analysis, Tier 3 emissions factors must be used due to the impact of the variables listed in *Tier 3 - emission factors* below.

Tier 1 Emission Factors
Tier 1 standards for all categories are designed to use readily available national or international statistics in combination with the provided default emission factors and additional parameters that are provided, and therefore should be feasible for all countries. The use of a Tier 1 emission estimate requires the following for each source category and fuel:

- data on the amount of fuel combusted in the source category;
- a default emission factor (provided by the IPCC).

Tier 2 Emission Factors
Tier 2 standards require an intermediate level of complexity and locally specific data. Generally the use of a Tier 2 approach requires:

- data on the amount of fuel combusted in the source category;
- a country-specific emission factor for the source category and fuel for each gas.

Country-specific emission factors are developed by taking into account country-specific data, such as carbon content of the fuels used, carbon oxidation factors, fuel quality and (for non-CO_2 gases in particular) the state of technological development.

Tier 3 Emission Factors
Tier 3 standards are the most complex and require the most specific data. A Tier 3 approach splits the fuel combustion statistics according to the following variables and uses emission factors that are dependent upon various combinations of each:

- data on the amount of fuel combusted in the source category;
- a country-specific emission factor for the source category and fuel for each gas;
- combustion technology;
- operating conditions;
- control technology;
- quality of maintenance;
- age of the equipment used to burn the fuel.

Because of the challenges inherent in collecting activity data for a local government emissions inventory, local governments may need to rely on diverse data sets. While in some cases it will be necessary to rely on national averages or other generalized data, it is important to distinguish it as such. Because of the myriad of possible sources of information, this Protocol adopts an outcome based methodology for tiering activity data, with common examples given. Local governments must strive to utilize the highest tier of data which is available.

Tier 1 Activity Data
Tier 1 activity data is defined as activity data which is sufficient to approximate the scale of

emissions from a particular source, but which will not accurately respond to local changes in use or behavior. Tier 1 activity data shall be used only in cases where more accurate data is unavailable and where the source is secondary. Examples of Tier 1 data are:

- national average fuel use per capita
- national average solid waste generation per employee
- methane recovery system effectiveness estimates based on the assumption that the system meets regulatory guidelines

Tier 2 Activity Data
Tier 2 activity data is defined as activity data which is sufficient to approximate the scale of emissions from a particular source and which will accurately respond to local changes in use or behavior. While Tier 2 data is often based on estimates or models, it is important that the sources of data adhere to a professional standard for conducting such estimates. It is also important that, wherever possible, estimation methods comply with methods used elsewhere in the local government's planning efforts. Examples of Tier 2 data are:

- engineering estimates of energy use based on system use and design
- estimates of heating fuel use based on known historical use modified based on population changes and variations in annual temperatures (heating degree days)
- fuel use estimated from distance traveled times average fuel efficiencies
- methane recovery system effectiveness estimates based on system design
- total community distance traveled estimates based on systematic traffic counts and road segment lengths
- local population change forecasts by an approved census body
- quantity of fuel used in a year based on known price paid times average fuel cost in that year

Tier 3 Activity Data
Tier 3 activity data is defined as activity data which is sufficient for regulatory or billing purposes and which will precisely respond to local changes in use or behavior. Examples of Tier 3 data are:

- metered energy use
- metered methane recovery
- quantity of solid waste as weighed at a transfer station

STANDARDS NOTE - Local governments seeking to comply with ISO14064-1 should note the requirement in that standard for an uncertainty assessment to be included in an analysis of emissions. The uncertainty of an emissions analysis will clearly be affected by the Tier selection as described in this section. See Appendix A.2 for more detail.

SOFTWARE NOTE - Software developers shall provide capacity for local governments to record in each Sector of the analysis the tier of activity data that has been used in the analysis. The emission factor tier must be recorded, for each fuel type, on the emission factor software interface together with the source of the emission factor, or the source of the data that has been used to develop the emission factor.

3.2 Sectors

The sectors used in local government greenhouse gas management need to reflect the operations of local governments and the way in which they interact with their communities. Simultaneously it is important that a local government analysis conforms to the international standards for national and corporate reporting to ensure consistency and comparability.

3.2.1 Government Operations Emissions

In all cases, local governments shall retain the ability to categorize their organizational emissions in the following sectors as outlined by the IPCC:

- Stationary Combustion
- Mobile Combustion
- Fugitive and other Energy Emissions
- Industrial Processes and Product Use
- Agriculture, Forestry and Other Land Use
- Waste

It is also important that local governments classify their organizational emissions as belonging to one of the following sectors:

- Buildings and Facilities
- Electricity or district heating/cooling generation
- Vehicle Fleet
- Streetlighting and Traffic Signals
- Water and Wastewater Treatment, Collection and Distribution
- Waste
- Employee Commute
- Other

Not all local governments provide the same functions and consequently some governments will not have any emissions from some sectors. The “other” sector recognizes the diversity of local government functions and allows for consideration of any sources of emissions not included elsewhere. Additional guidance on categorization of individual sources by sector is provided in sections 3.2.1.1 through 3.2.1.6.

Macro Sector (IPCC)		Government Sector (ICLEI)
Energy	Stationary Combustion	Buildings and Facilities
		Street Lights and Traffic Signals
		Water/Sewer (energy only)
	Mobile Combustion	Vehicle Fleet
		Employee Commute
	Fugitive emissions	Other
Industrial Processes and Product Use		Other
Agriculture, Forestry and Other Land Use		Other
Waste	Solid Waste Disposal	Waste
	Biological Treatment of Solid Waste	
	Incineration and Open Burning of Waste	
	Wastewater Treatment and Discharge	

3.2.1.1 Stationary Combustion

Fuel Consumed in Heating and Cooling Government Owned or Operated Facilities

Fossil fuels, either utility delivered or decentralized, used in buildings or facilities owned or operated by local governments must be quantified. Emissions resulting from this source must be counted as Scope 1. Wherever possible this data must be determined based on verifiable metered records used for billing.

Local governments should calculate this fuel use in three sectors: buildings, streetlights and traffic signals, and water/wastewater treatment and distribution. The Buildings Sector must include all stationary combustion sources in any facilities owned or operated by the local government which are not included in streetlights or water/wastewater. Streetlights must include any fuel used in any road lighting, park lighting, specialty or accent lighting (e.g. lights used in shopping areas), traffic signals, and other lights operated by the local government that are not associated with a particular facility – lighting associated with a specific facility should be included in the Buildings Sector. In most cases there will be no fuel consumption in the Streetlight Sector as all lighting is electric. The Water/Wastewater Sector must include emissions associated with stationary fuel use in water and sewage treatment facilities, pumps and lift stations and other facilities used to deliver drinking water to, and dispose of sewage from, the community. For each sector, it is good practice to gather and track this data on a facility by facility basis to enable the most complete analysis of operating efficiency.

It is important that all fuel supplied for purposes of producing electricity or centralized heating or cooling (e.g. steam) that will be supplied to the grid (and could subsequently be reported as a Scope 2 emissions source) be tracked and reported separately as utility consumed fuel used for electricity/district heating generation. Note that this does not apply to

situations in which fuel is used to generate electricity or steam which is used on site and not supplied to the grid. See Municipal Utilities below for more information.

Electricity and Utility Delivered Heating/Cooling Consumption

Local governments must quantify all electricity or centralized heat or cooling (e.g. steam) used in facilities which they own or operate as Scope 2. Wherever possible this data must be based on verifiable metered records used for billing.

Utility-delivered electricity and heat consumption must be converted into greenhouse gas emissions using emission factors. These emission factors convert the amount of electricity or heat used into an equivalent amount of greenhouse gas and air pollutants created at generation plants. These sources of energy can be produced at many diverse facilities (e.g. coal, hydro, nuclear, etc.), and so the emission factors must reflect this diversity. In many cases a supply of energy cannot be traced to a specific facility. Local governments shall strive to adopt emission factors that most accurately model the impacts of the decisions that are made locally about the consumption of electricity or central heating/cooling (See section 3.1.8.1). In some cases this will mean the use of regional emission factors and in some cases it will mean use of emission factors developed for a specific utility. Additional guidance on this matter will be provided in each Country/Regional Supplement. In most cases the emission factors used for electricity and district heating/cooling in local government operations should be the same as that used for calculations in the community inventory.

Local governments should track this electricity or centralized heating or cooling use in three sectors: Buildings, Streetlights and Traffic Signals, and Water/Wastewater. The Building Sector must include all electricity or centralized heat or cooling in any structures or facilities owned or operated by the local government which are not included in the Streetlight or Water/wastewater Sectors. Streetlights must include any electricity used in any road lighting, park lighting, specialty or accent lighting (e.g. lights used in shopping areas), traffic signals, and other lights operated by the local government that are not associated with a particular facility – lighting associated with a specific facility should be included in the Buildings Sector. The Water/Wastewater Sector includes emissions associated with electricity or centralized heat or cooling used in water and sewage treatment facilities, pumps and lift stations and other facilities used to deliver drinking water to, and dispose of sewage from, the community. It is good practice to gather and report this data on a facility by facility basis to enable the most complete analysis of operating efficiency.

Municipal Utilities

Local governments that own or operate utilities must include the emissions from all fuel used to generate electricity, heat or cooling as a Scope 1 emission source. All emissions associated with energy purchased (or wheeled) by the utility should be regarded as a Scope 2 source, including emissions associated with transmission and distribution losses.

3.2.1.2 Mobile Combustion

Fuel Used by Vehicles Owned or Operated by the Local Government

The Vehicle Fleet Sector includes emissions from all vehicles owned or operated by the local government and vehicles used in the service of the local government (such as employees' personal vehicles and contractors' vehicles used on government business). It is good practice to calculate CO_2 emissions in this sector directly from fuel consumption. In cases where fuel consumption records are unavailable, CO_2 emissions can be estimated from the distance traveled by fleet vehicles.

To calculate actual fuel usage during the inventory year:
1. Subtract the amount of fuel in storage tanks at the local government's fueling facilities at the beginning of the inventory year from the amount in storage tanks at the end of the inventory year;
2. Subtract this residual fuel from the amount of fuel purchased over the course of the year; and
3. Add the amount of fuel purchased by individual vehicle operators at private fueling stations.

An alternative to using fuel purchase information is to estimate fuel usage from distance traveled. Fuel usage can be estimated from distance traveled using the fuel efficiencies for each vehicle type.

Although the above methods will calculate CO_2 emissions from vehicle fuel usage, quantifying non-CO_2 greenhouse gases and air pollutants also requires information on vehicle type. Best practice is for fuel usage data or distance traveled to be sourced by vehicle classification and the percent of the total fuel consumed used by each class of vehicle applied. This is possible if the local government fuel provider keeps good records on which vehicles refuel at government stations and how much fuel they purchase. Where distance traveled by vehicle class is not known, an estimation variable must be used.

It is good practice to gather and report this data disaggregated by vehicle class and by division of the government responsible for the use of the vehicles so as to enable the most complete analysis of operating efficiency.

All emissions produced by vehicles owned by the local government are classified as Scope 1 emissions, with the exception of electric vehicles. Where electricity that is used to power electric vehicles can be distinguished from electricity used in the Building Sector is must be classified as vehicle fleet Scope 2. Emissions produced by employee-owned vehicles and vehicles used by contractors performing government services shall be classified as Scope 3 emissions.

Employee Commute

Local governments can calculate energy use and emissions associated with local government employees' travel to and from work. All emissions in this sector must be classified as Scope 3 emissions, as the government can influence the commute patterns of their employees but is not directly responsible for those emissions.

The Employee Commute Sector is very similar to the Vehicle Fleet Sector. Most local governments will use data on either vehicle or passenger distance traveled. Collection of this information will generally depend upon a survey of employee commuting behavior (distance employees travel to work, the transportation mode they use, and the number of days a week they come to work). This activity data shall then be multiplied by average fuel efficiencies for passenger vehicles.

Employee Air Travel

In some cases local governments may determine that employee air travel while on government business constitutes a significant source of local government emissions and should be included. Local governments which expect to count reduction of a source of emissions as a measure must include those emissions in the base year inventory.

Emissions that occur in the base year within the organizational boundaries of the local government must be classified as Scope 3. The methodology for quantification of emissions from these sources should comply with international standards.

3.2.1.3 Fugitive Emissions

In some cases local governments may determine that fugitive emissions constitute a significant local source of local government emissions and should be counted. Local governments that expect to count the reduction of a source of emissions as a measure must include those emissions in the base year inventory.

Emissions that occur in the base year within the organizational boundaries of the local government must be classified as Scope 1. The methodology for quantification of emissions from these sources shall comply with international standards. The method for collection of activity data shall be as complete as possible.

3.2.1.4 Industrial Processes and Product Use

In some cases local governments may determine that emissions from industrial processes and product use constitute a significant local source of local government emissions and should be counted. Local governments that expect to count the reduction of a source of emissions as a measure must include those emissions in the base year inventory.

Emissions that occur in the base year within the organizational boundaries of the local government must be classified as Scope 1. The methodology for quantification of emissions from these sources should comply with international standards. The method for collection of activity data shall be as complete as possible.

3.2.1.5 Agriculture, Forestry and Other Land Use

Agricultural Emissions

In some cases local governments may determine that agricultural emissions constitute a significant source of local government emissions and should be counted. Local governments that expect to count reduction of a source of emissions as a measure must include those emissions in the base year inventory.

Emissions that occur in the base year within the organizational boundaries of the local government must be classified as Scope 1. The method for quantification of emissions from these sources should comply with international standards. The method for collection of activity data shall be as complete as possible.

Net Biogenic Carbon Flux on Government Owned or Operated lands

Net biogenic carbon flux refers to total change, from one year to the next, in the total carbon stored in a variety of states in all lands owned or under the management of the local government. In some cases local governments may determine that net biogenic carbon flux constitutes a significant source of local government emissions and should be counted. Local governments that expect to count reduction of a source of emissions as a measure must include those emissions in the base year inventory.

Emissions that occur in the base year within the organizational boundaries of the local government must be classified as Scope 1. The method for quantification of emissions from these sources should comply with international standards. The method for collection of activity data shall be as complete as possible. Additional guidance will be provided in the Country/Regional Supplements.

3.2.1.6 Waste

Methane Emissions from Waste Generated Through Government Operations
This sector must consist of all employee-generated solid waste, plus all other solid waste generated at government facilities, such as parks, recreation buildings etc. As this waste is a consequence of operating public facilities, it is the local government's responsibility to provide waste collection and/or recycling services at these facilities.

This waste is a subset of the total waste stream generated by the community and must be calculated using the same method as used in the community waste sector, including the first order decay model in cases where the waste is landfilled. See the "Waste Sector" in the Community Analysis (Section 3.2.2.6) for a complete discussion of the waste sector method and how to use it to calculate emissions.

Emissions from the waste produced by the local government must be classified as Scope 3 emissions.

Operation of Solid Waste Disposal Sites

In cases where the local government operates or has substantial control over a solid waste disposal facility, the emissions resulting from waste generated by all parties except the local government (and therefore accounted for in waste generated through government operations above) at that facility must be classified as a Scope 1 emission source.

Emissions from these facilities must be calculated using the same method as used in the community waste sector, including the first order decay model in cases where the waste is landfilled. See the "Waste Sector" in the Community Analysis (Section 3.2.2.6) for a complete discussion of the waste sector method and how to use it to calculate emissions.

Methane Emissions from Wastewater Treated at a Facility Operated by the Local Government

Local governments should count methane emissions resulting from wastewater/sewage/industrial wastewater in cases where the local government owns, operates or otherwise exerts significant control over the wastewater collection and treatment system. Determination of the scope which these emissions will be reported as will depend upon the location of the treatment facility and upon the extent to which the local government exerts control over the treatment facility's operations.

In all cases where the treatment facility is owned or operated by the local government, those emissions should be classified as Scope 1. In cases where the treatment facility is owned or operated by another organization, but where provision of sewage treatment services is a typical responsibility of local governments and where the local government in question has a contractual relationship with the owner or operator of the facility, then the emissions must be classified as Scope 3..Emissions from wastewater should be determined based on the First Order Decay model developed by the IPCC and described in the 2006 Guidelines for National Greenhouse Gas Inventories.

3.2.2 Community-Scale Emissions

The community-scale analysis encompasses all greenhouse gas emissions released within the geopolitical boundary governed by the local government. The community inventory must also account for the results of actions and decisions taken within the community regardless of where the emissions occur geographically. Collecting information on every individual emission source in the community is not always possible or practical, so a variety of approaches are likely to be needed to develop a useful estimate of community-scale emissions. Utility companies may be able to provide information on total electricity used by residential, commercial and industrial customers, but not be willing to reveal more detailed information that would be useful for policy and strategy development.

It is frequently also the case that one entity does not deliver all the stationary or transportation energy consumed within the community. Collating a complete data set of actual consumption may not be possible for even a small local government area, so it is often necessary to estimate some fuel and electricity use from proxy data. For example, total transportation fuel usage may need to be calculated from total distance traveled.

These approaches to data collation are reflected in the tiers concept (see Section 3.1.9 of this Protocol, as well as the Country/Regional Supplement.)

In all cases local governments shall retain the ability to report their community's emissions in the following sectors as outlined by the IPCC:

- Stationary Combustion
- Mobile Combustion
- Fugitive and other Energy Emissions
- Industrial Processes and Product Use
- Agriculture, Forestry and Other Land Use
- Waste

In many cases, it will greatly facilitate decision making to further subdivide these sectors in a manner consistent with the way local governments are accustomed to considering their policy setting roles. Historically, ICLEI has encouraged local governments to report stationary combustion sources in the residential, commercial and industrial sectors. While this division is not mandatory under this Protocol it is considered good practice. Some governments have also considered an institutional sector which is an acceptable practice. Additional guidance on categorization of individual sources by sector is provided in sections 3.2.2.1 through 3.2.2.6.

<table>
<tr><th colspan="2">Macro Sector (IPCC)</th><th>Community Sector (ICLEI)</th></tr>
<tr><td rowspan="4">Energy</td><td rowspan="3">Stationary Combustion</td><td>Residential</td></tr>
<tr><td>Commercial</td></tr>
<tr><td>Industrial</td></tr>
<tr><td>Mobile Combustion</td><td>Transportation</td></tr>
<tr><td>Fugitive Emissions</td><td>Other</td></tr>
<tr><td colspan="2">Industrial Processes and Product Use</td><td>Other</td></tr>
<tr><td colspan="2" rowspan="2">Agriculture, Forestry and Other Land Use</td><td>Agricultural Emissions/Other</td></tr>
<tr><td>Other</td></tr>
<tr><td rowspan="4">Waste</td><td>Solid Waste Disposal</td><td rowspan="4">Waste</td></tr>
<tr><td>Biological Treatment of Solid Waste</td></tr>
<tr><td>Incineration and Open Burning of Waste</td></tr>
<tr><td>Wastewater Treatment and Discharge</td></tr>
</table>

3.2.2.1 Stationary Combustion

Utility-Delivered Fuel Consumption

In cases where a central utility, or small number of utilities, provides fuel that is used within a community's Geopolitical boundaries, that source is classified as scope 1. Data on total community use should be gathered from the primary energy providers. Wherever possible this data should be segregated by the energy provider into sectors of the economy (residential, commercial and industrial).

Occasionally the primary energy providers are not able to provide energy use data broken out by individual sector (i.e. for instance commercial and industrial data are often reported jointly). In this situation, all energy use data, and associated emissions data, can be classified together as combined Residential/Commercial/Industrial emissions. Users should be sure to document this occurrence, so as to avoid comparisons being made between the combined totals and the emissions from any one sector in another jurisdiction.

It is important that all fuel supplied for purposes of producing electricity or centralized heat or cooling (e.g. steam) that will be supplied to the grid (and could subsequently be reported as a Scope 2 emissions source) be tracked and reported separately. See also *Utility-consumed fuel for electricity / heat generation* below. Note that this does not apply to situations in

which fuel is used to generate electricity or steam which is used on site and not supplied to the grid.

Utility-Delivered Electricity / Heat Consumption

In cases where a central utility, or small number of utilities, provides electricity or centralized heat or cooling (e.g. steam) that is used within a community's geopolitical boundaries, that source is classified as Scope 2. Note that all such emissions must be counted as Scope 2 regardless of where the generation occurred; in some cases this will include an accounting of emissions once as a Scope 1 source and again as a Scope 2 source; reporting requirements (see Chapter 4) will appropriately distinguish these emissions so as to prevent double counting.

Data on total community use shall be gathered from the primary energy providers. Wherever possible this data should be segregated by the energy provider into sectors of the economy (residential, commercial and industrial). Occasionally the primary energy providers are not able to provide energy use data broken out by individual sector (e.g. commercial and industrial data are often reported jointly). In this situation, all energy use data, and associated emissions data, can be classified together as a combined Residential/Commercial/Industrial. Local governments shall be sure to document this occurrence, so as to avoid comparisons being made between the combined totals and the emissions from any one sector in another jurisdiction.

Utility-delivered electricity and heat consumption must be converted into greenhouse gas emissions using electricity emission factors. Electricity emission factors convert the amount of electricity used into an equivalent amount of greenhouse gas and air pollutants created at power stations. These sources of energy can be produced at many diverse facilities (e.g. coal, thermal, hydro, nuclear, etc.), so the emission factors should reflect this diversity, but in many cases a supply of energy cannot be traced to a specific facility.

Local governments shall strive to adopt emission factors that most accurately models the impacts of the decisions that are made locally about the consumption of electricity or central heating/cooling. In some cases this will mean the use of a regional emission factor and in some cases it will mean use of an emission factor developed for a specific utility. Additional guidance on this matter will be provided in each Country/Regional Supplement. Also see section 3.1.9.1.

Decentralized Fuel Consumption (e.g., propane, kerosene, fuel oil, stationary diesel, biofuels, coal)

In cases where fuel is provided to a community by a large number of suppliers and consumed within the community's geopolitical boundaries, that source must be classified as Scope 1. Wherever possible this data shall be segregated into sectors of the economy (residential, commercial and industrial).

Accurate sources of this information may be difficult to find. Where possible, data on total community use should be gathered from the primary energy providers. Lower tiered activity data sources may be require for this source.

It is important that all fuel supplied for purposes of producing electricity or centralized heat or cooling (e.g. steam) that will be supplied to the grid (and could subsequently be classified

as a Scope 2 emissions source) be tracked and reported separately. Note that this does not apply to situations in which fuel is used to generate electricity or steam which is used on site and not supplied to the grid.

Utility-Consumed Fuel for Electricity / Heat Generation

In cases where fuel is used within the geopolitical boundaries of the community to generate electricity for the grid or else for central heating/cooling systems, the emissions must be included in a local emissions inventory. These emissions should be classified as Scope 1. Because these emissions may also accounted for at the point of energy consumption as a Scope 2 source, it is important that they be tracked separately from other Scope 1 fuel use.

Decentralized Electricity / Heat Consumption Not Accounted for Under Stationary Combustion (e.g., solar, geothermal)

In cases where energy is used in a community but where that energy use is both decentralized and emissions free, information about the use of that energy can still be collected and considered as an Information Item. The value in doing so is predominantly to create a more complete picture of the community's energy use pattern. In order to qualify for reporting under this category an energy source must be metered and must be reported in a standardized unit such as BTU or kWh.

3.2.2.2 Mobile Combustion

Tailpipe Emissions from On-Road Vehicles within the Geopolitical Boundary (Scope 1 on-road)

Energy used for transportation by on-road vehicles within a community should be classified as Scope 1. Ideally these emissions could be calculated directly from data on fuel consumed within the geopolitical boundaries of the community. This data is generally not available, in most cases it will be estimated base on regional vehicle distance traveled data. Each Country/Regional Supplement will provide guidance on the appropriate activity data and applicable emission factors that should be employed.

Local governments may choose to calculate either or both types of the following scope 3 on-road emission methods in order to augment their understanding of potentially policy relevant emissions reduction opportunities. Some Country/Regional Supplements may specify the use of one of the scope 3 on-road emission methods in lieu of scope 1 on road emissions. Local governments are encouraged to calculate and consider both scope 1 and scope 3 on road emissions, but should consider the specific reporting guidelines that they will be adhering to (See chapter 4 and the Country/Regional Supplements). In no case should both scope 1 and scope 3 or both types of scope 3 on-road transportation emissions be included in the same report.

Tailpipe Emissions from On-Road Vehicles used by community residents (scope 3 on-road)

Energy used for transportation by on-road vehicles by residents of the community should be classified as scope 3. These emissions may be calculated based on transportation modeling or else by determining the annual distance traveled by vehicles owned by citizens of the community.

Tailpipe Emissions from Transportation Demand Generated by Local Residences and Businesses (scope 3 on-road)

Energy used for transportation by on-road vehicles resulting from transportation demand created by residences, businesses and amenities within the community should be classified as scope 3. These emissions may be calculated based on transportation modeling of vehicle distance traveled and trip demand generation estimates. These calculations should adhere to the prevailing transportation modeling practices.

Tailpipe Emissions from Non-Road Vehicles

Emissions from fuel used by vehicles and engines operated primarily off road (construction equipment, landscaping equipment, etc), but used within the geopolitical boundaries of the community may be included in the inventory and counted as a Scope 1 source. In practice, tier 3 or even tier 2 quality data for these sources will be difficult to acquire in most cases.

Emissions from Local Transit Systems

Emissions from energy used for transportation by transit systems within a community should be included in the inventory. These emissions should be classified as Scope 2 in cases where the transit system is powered by electricity and classified as Scope 1 in all other cases.

In many cases local transit systems will be operated as part of a larger regional transit system. In these cases, the local government must count the emissions that result from the movement of the transit system within the geopolitical boundaries of the community apportioned on a distance traveled basis.

Rail Traffic

Energy used for transportation by freight and long-distance passenger rail systems within a community should be classified as Scope 2 in cases where the train is powered by electricity and classified as Scope 1 in all other cases.

These systems are generally operated as part of a larger regional system. The local government should count the emissions that resulted from the movement of the trains within the geopolitical boundaries of the community apportioned on a distance traveled basis.

Air Travel

Air travel can be a significant source of emissions but is unique for several reasons. First, the emissions from international air travel are not reported as part of national inventories under the UNFCCC guidelines. Second, a significant portion of the emissions associated with air travel occur outside of the geopolitical boundaries of the community, and it is nearly impossible to determine which portion occurred on one side of the boundary or the other. Third, it can be argued that in many cases airports serve a region rather than an individual community, so while the airport's emissions might be attributed to the community in which it happens to reside, it is likely that a large proportion of the passengers are neither residents of, nor traveling to that community.

As these factors will significantly affect the comparability of communities with and without airports, most greenhouse gas management programs will establish specific guidance for the

reporting of these emissions (See chapter 4). In order to achieve the greatest level of policy relevance, this protocol offers two alternative ways of accounting for community emissions for air travel: Air Travel Originating within the Community and Air Travel Serving the Needs of the Community's Residents. These two methods offer alternative lenses through which to consider the appropriateness and effectiveness of emissions reduction policies. These two methods should be considered mutually exclusive within reporting.

Air Travel Originating within the Community: Local government emissions inventories for airports located within their geopolitical boundaries should determine the total amount of fuel used by planes on all flights originating at the airport. In many cases this information will be difficult to acquire and a common substitute will be fuel loaded onto planes at the airport. These emissions should be classified as Scope 3.

Energy densities and greenhouse gas emissions from these fuels used must be based on guidance provided in each Country/Regional Supplement to this Protocol. The global warming potentials of these emissions shall be based on the GWP of the fuel at ground level; no attempt should be made to account for varying impacts of greenhouse gases at varying altitudes until sufficient scientific consensus is formed around the best way to account for this effect. For this same reason, global warming potentials used should not be multiplied by the potential impacts of radiative forcing from high altitude emissions.

Air Travel Serving the Needs of the Community's Residents: Local governments may also consider the air travel footprint of their citizens and classify such emissions as a Scope 3 source. To determine these emissions, local governments should identify all airports in their region which support the local demand (including any within the community's geopolitical boundary) and determine the total amount of fuel used by planes on all flights originating at each airports. As above, fuel loaded onto planes at each airport will be a common surrogate data set. This fuel should then be apportioned to the community inventory based on the portion of travelers at the airport who are residents of the community. The methodology for making this calculation will necessarily vary dependent upon a large number of regional factors. Additional guidance may be provided in each Country/Regional Supplement. These emissions should be classified as Scope 3.

Emissions associated with the operation of the airport (e.g. the electricity used in the terminals, the fuel used by vehicles servicing the airplanes, etc) should not be counted in this category. These should be aggregated with other sectors (commercial electricity use, non-road vehicles, etc.). In cases where a government operates the airport these organizational portions of the inventory shall be reported as part of the government emissions analysis, but the emissions from the planes themselves shall not be counted unless the government owns or operates the planes.

Marine Transportation

Seaports and marinas can be a significant source of emissions but are unique for several reasons. Firstly, the emissions from international shipping are not reported as part of national inventories under the UNFCCC guidelines. Secondly, a significant portion of the emissions associated with ships occur while outside of the geopolitical boundaries of the community, and it is often impractical to determine which portion occurred on one side of the boundary or the other. Thirdly, it can be argued that in many cases seaports and marinas serve a region rather than an individual community, so while the emissions might be attributed to the community in which it happens to reside, it is likely that a large proportion of the passengers

and goods transported are neither residents of, nor traveling to that community. As these factors will significantly affect the comparability of communities with and without sizable ports, most greenhouse gas management programs will establish specific guidance for the reporting of these emissions (See chapter 4).

Intra-Community Marine Transportation: Emissions from sea travel occurring entirely within the local government's geopolitical boundary should be included in the inventory and classified as a Scope 1 source (or Scope 2 if powered by electricity).

Marine Transportation Originating within the Community: Additionally, local governments should attempt to determine the total amount of fuel used by journeys originating within the jurisdiction. In many cases this information will be difficult to acquire and a common substitute will be fuel loaded or sold at the marina or seaport. These emissions shall be classified as a Scope 3 source.

In-Port Fuel Consumption: It is also good practice for local governments to determine what portion of the total emissions occurred while ships were in port. While in some cases this data may be challenging to gather, it is of particular policy relevance as local governments often have the option of providing electricity to ships in port to preclude the need for them to generate electricity on-board using fossil fuels. These emissions shall be subtracted from the totals reported above as Scope 3 and classified independently as Scope 2.

Scope 2 emissions from providing electricity to ships in port should be counted in the community inventory as utility provided electricity. Wherever possible these emissions must be tracked separately to enable juxtaposition with Scope 1 in-harbor fuel consumption.

Emissions associated with the operation of ports and marinas (e.g. the electricity used in the port's facilities, the fuel used by vehicles loading or unloading ships, etc) should not be counted in this category. These must be aggregated with other sectors (commercial electricity use, non-road vehicles, etc.). In cases where a government operates the port these organizational portions of the inventory must be counted as part of the government emissions analysis, but the emissions from the boats themselves should not be counted unless the government owns or operates them.

3.2.2.3 Fugitive Emissions

In some cases local governments may determine that fugitive emissions constitute a significant local source of community emissions and should be included in the analysis. Local governments that expect to count the reduction of a source of emissions as a measure must include those emissions in the base year inventory.

Emissions that occur in the base year within the geopolitical boundaries of the local government must be classified as Scope 1. The method for quantification of emissions from these sources shall comply with international standards. The method for collection of activity data shall be as complete as possible.

3.2.2.4 Industrial Processes and Product Use

In some cases local governments may determine that greenhouse gas emissions from industrial processes and product use constitute a significant local source of emissions and

should be included. Local governments that expect to count the reduction of a source of emissions as measure must include those emissions in the base year inventory.

Emissions that occur in the base year inside of the geopolitical boundaries of the local government must be classified as Scope 1. The method for quantification of emissions from these sources shall comply with international standards. The method for collection of activity data shall be as complete as possible.

3.2.2.5 Agriculture, Forestry and Other Land Use

Agricultural Emissions

In some cases local governments may determine that agricultural emissions constitute a significant local source of community emissions and should be included. Local governments that expect to count the reduction of a source of emissions as a measure must include those emissions in the base year inventory.

Emissions that occur in the base year within the geopolitical boundaries of the local government must be reported as Scope 1. The method for quantification of emissions from these sources shall comply with international standards. The method for collection of activity data shall be as complete as possible.

Net Biogenic Carbon Flux

Net biogenic carbon flux refers to total change, from one year to the next, in the total carbon stored in a variety of states in all lands community's geopolitical boundary. In some cases local governments may determine that net biogenic carbon flux constitutes a significant local source of community emissions and should be included.

Emissions that occur within the geopolitical boundaries of the local government must be reported as Scope 1. The method for quantification of emissions from these sources shall comply with international standards. The method for collection of activity data shall be as complete as possible. In cases where information gathered may systematically exclude significant portions of this sector, the included emissions from this sector shall not be counted as Scope 1; systematically incomplete emissions must be counted as information items.

3.2.2.6 Waste

The waste sector is unique among emission sources typically quantified by local governments and presents unique challenges in attempting to be both complete and relevant. There are a variety of disposal options that local governments may employ. More over it is important that communities attempt to account for emissions that are a result of waste generated in the community even in cases where that waste is disposed of somewhere else. Governments shall strive for complete, accurate and relevant accounting of emissions resulting from the waste sector.

Emissions from solid waste in some disposal methods are released slowly over a period of years. Therefore, a relatively small portion of the total emissions produced by waste generated in the inventory year is actually released during the inventory year. Conversely,

significant emissions may be released in the inventory year that are the result of disposal practices in earlier years.

In general local governments will need to know:
• disposal method(s) of waste generated within the community;
• quantity of waste disposed by or in the community;
• composition of the waste stream generated by the community;
• location of the disposal facilities for all waste originating in the community; and
• operational details of the disposal facilities including total waste disposed, existence and effectiveness of any methane recovery systems and historic use.

Disposal Method - The waste disposal technology or technologies employed should be included in the analysis for all waste that originates within the community regardless of the geographic location of the disposal site.

Waste Quantity - The total quantity of waste disposed by the community should be determined based on the most accurate method available. This quantity must be included in the analysis in weight of waste and on a dry weight basis, if possible. Where a community's waste is sent to more than one disposal site, the quantity of waste disposed should be subdivided and tracked separately for each waste disposal site if possible. If it is not possible to track the quantity of waste separately for each waste disposal site then it must be tracked separately for each technology employed.

SOFTWARE NOTE: The IPCC waste sector equations are designed to be on a dry weight basis but available data is generally wet weight. Software products should allow the mass to be entered on a wet weight basis and provide an input cell for each waste type asking for moisture content. The adjusted weight is then to be used in all software calculations.

Waste Composition - Local governments should include in the analysis the constituent components of the waste stream. Different types of organic matter have different methane generation potentials based on carbon content, and different methane generation rates based on several factors. Moreover, the carbon embodied in plastics is non-biogenic, so where a disposal technology is employed that releases that carbon, the resulting CO_2 should be counted in the inventory.

It is important to distinguish between waste generated and waste disposed. Waste generated is generally the gross amount of waste produced in the community. Waste disposed is the net amount of waste following the effects of any diversion (e.g. recycling or reuse) efforts and must be the quantity used for inventory calculations. Additional guidance on the most appropriate sources of data regarding waste quantity will be provided in each Country/Regional Supplement.

Where different subdivisions of the total waste stream are known to have different compositions (e.g. composted portions of the waste stream will comprise almost exclusively of organic material), it is important to include specific waste stream compositions in the analysis. In estimating waste stream composition it is important that the composition corresponds to the waste disposed and not the waste generated. Guidance on determining waste stream categories and composition will be provided in each Country/Regional Supplement.

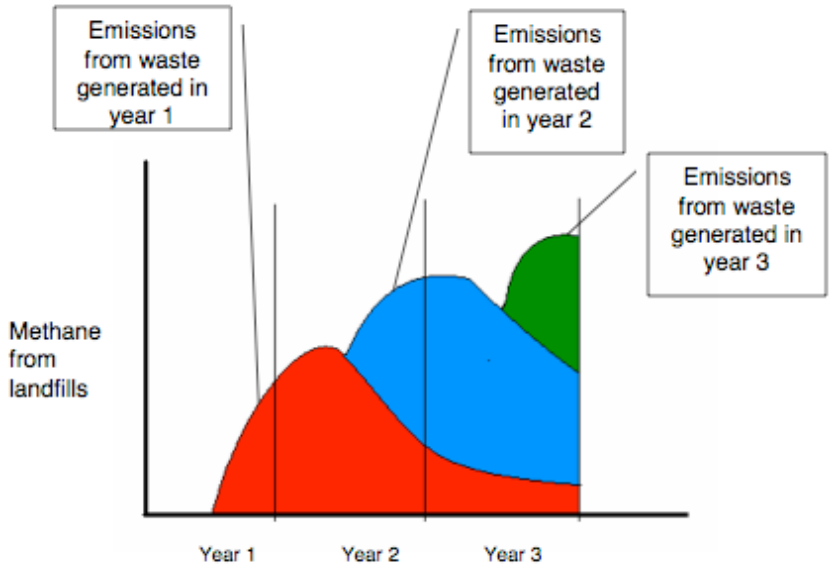
Disposal Location - There are four sources of emissions that a local government must include in the analysis (although sources 1 and 2 may not exist in every community):

1. Emissions from solid waste disposal landfills/open dumps inside of the community's geopolitical borders (Scope 1)
2. Emissions from incineration/open burning and composting/biological treatment inside of the community's geopolitical borders (Scope 1)
3. Emissions from solid waste generated by the community and disposed of at landfills/open dumps regardless of the location of the facility (Scope 3)
4. Emissions from solid waste generated by the community and disposed of by incineration/open burning and composting/biological treatment regardless of the location of the facility (Scope 3)

Disposal Facility Operational Details

Emissions from landfills/dumps – All emissions occurring at landfill sites used by the community or located in the community must be classified as Scope 1 or Scope 3 emissions. Emissions from landfills located within the community and used for disposal of waste by the community should be classified as both Scope 1 and Scope 3 emissions sources under separate methodological analyses. Where a landfill (regardless of geopolitical location) is used to dispose of waste from the community conducting the analysis and from other communities, the emissions from the landfill should be apportioned on a proportional basis determined from the community's historical contribution of waste to the landfill.

The mechanism for calculating landfill emissions must be the same for landfills inside of the community and outside of the community. Local governments must determine the quantity of methane using a first order decay (FOD) model. To the greatest extent possible the model should be specific to the waste stream composition and actual conditions at the landfill. Where actual data does not exist, local governments may rely on IPCC or national default assumptions to populate the model. Specific guidance on the use of the model and appropriate data tiers will be provided in each Country/Regional Supplement.



Reported emissions in year three are a result of waste deposited in the landfill in that year and prior years.

An adaptation of the standard IPCC method should be used to determine methane generated. The calculation estimates the methane generation potential (Lo) which is based on the mass of decomposable degradable organic carbon (DDOCm). DDOCm is dependent on the mass of the waste sent to landfill, the type of waste and the fraction of DOC in each waste type that can decompose (DDOCf). Guidance on appropriate sources of data to populate this model, application of default values and delineation of tiers will be provided in each Country/Regional Supplement.

Methane emissions in a given year for a given type of waste should be derived from the methane generated that year less methane recovered, less methane that is oxidized.

CH_4 EMISSION FROM Solid Waste Disposal Site (SWDS)

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T\right] \bullet (1-OX_T)$$

Where:

CH_4 Emissions = CH_4 emitted in year T, Gg
T = inventory year
x = waste category or type/material
R_T = recovered CH_4 in year T, Gg
OX_T = oxidation factor in year T, (fraction)

To determine methane generated, the calculation estimates the methane generation potential (L_o) which is based on the mass of decomposable degradable organic carbon ($DDOC_m$). $DDOC_m$ is dependent on the mass of the waste in the landfill, the type of waste and the variable DOC_f, the fraction of DOC that can decompose.

CH_4 GENERATED FROM DECAYED DDOCm

$$CH_4\ generated_T = DDOCm\ decomp_T \bullet F \bullet 16/12$$

Where:

CH_4 $generated_T$ = amount of CH_4 generated from decomposable material
$DDOCm\ decomp_T$ = DDOCm decomposed in year T, Gg
F = fraction of CH_4, by volume, in generated landfill gas (fraction)
16/12 = molecular weight ratio CH_4/C (ratio)

Determining $DDOC_m$ requires information about the amount of reactive material present in the landfill as a result of waste contributed by the community. The following two equations model the amount of carbon in a given year that is available to decompose.

DDOCm ACCUMULATED IN THE SWDS AT THE END OF YEAR T

$$DDOCma_T = DDOCmd_T + (DDOCma_{T-1} \bullet e^{-k})$$

DDOCm DECOMPOSED AT THE END OF YEAR T

$$DDOCm\ decomp_T = DDOCma_{T-1} \bullet (1 - e^{-k})$$

Where:

T = inventory year
$DDOCma_T$ = DDOCm accumulated in the SWDS at the end of year T, Gg
$DDOCma_{T-1}$ = DDOCm accumulated in the SWDS at the end of year (T-1), Gg
$DDOCmd_T$ = DDOCm deposited into the SWDS in year T, Gg
DDOCm decompT = DDOCm decomposed in the SWDS in year T, Gg
k = reaction constant, $k = \ln(2)/t_{1/2}$ (y^{-1})
$t_{1/2}$ = half-life time (y)

LONG-TERM STORED DOCm FROM WASTE DISPOSAL DATA

$$DOC_m\ long\text{-}term\ stored_T = W_T \bullet DOC \bullet (1 - DOC_f) \bullet MCF$$

W_T = Mass of waste disposed of in year T, Gg
DOC_f = fraction of DOC that can decompose in the anaerobic conditions in the SWDS (fraction)
MCF = CH_4 correction factor for year of disposal (fraction)

The reaction constant, k, is related to the time that it takes degradable organic carbon to decay to half of its initial mass, the half life ($t_{1/2}$). The value for k will depend upon a number of factors, most significantly the relative moisture at the solid waste disposal site and speed at which the materials tend to decay (i.e. the type of materials). A number of studies in developed countries under temperate conditions have indicated values for k corresponding to half-lives of between 3 and 35 years (cited in IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Chapter 3 Solid Waste Disposal). In general higher k values (and shorter half-lives) correspond to more moisture and rapidly degradable waste such as food.

The value k shall be aligned as closely as possible with the value relevant to the landfill site, while DDOCm shall be based on the composition and mass of waste generated by the community and sent to the landfill site. In this way the calculation uses information on both the place of generation and the place of disposal, regardless of whether they are both in the same local government area or not.

The value Rt is the absolute amount of methane that is recovered and destroyed by the landfill in year t. The default value must be 0 and this shall only be changed where there is certainty that methane is being recovered and destroyed. In many cases local governments will only contribute a portion of the waste sent to a given solid waste disposal site (scope 2 solid waste emissions). In these cases, the local governments can determine the Rt value for use in the formula by determining the total quantity of recovered methane at the landfill divided by the total emissions from the landfill using a first order decay model. This percentage of methane recovered can be multiplied by the emissions that result from waste generated by the community to yield the appropriate Rt.

Not all the carbon in waste deposited in a landfill site decomposes, even over a long period of time. The long-term storage of carbon must not be reported in the waste sector, however. This item is calculated using the same equation and so is included here for ease of use, but shall be reported in the Agriculture, Forestry and Other Land Use sector as a component of the net-biogenic flux in cases where the local government is doing a complete inventory of carbon stocks. In cases where the local government is not doing such an inventory this data must not be reported in isolation as a scope 1 sink, it must be counted as an information only item and not included in any total emissions reported.

In summary, base year methane emissions that occur at landfills within the geopolitical boundary of the community must be counted and should be classified as Scope 1 regardless of where the waste was generated or when the waste was disposed (in cases where waste generated by another community is present in a landfill within the analysis community's geopolitical boundary, emissions from that waste shall be included in the analysis community's Scope 1 emissions). Additionally, all methane emissions that result from the waste generated within the geopolitical boundary of the community must be counted regardless of where those emissions occur or when the waste was disposed, and these emissions should be classified as Scope 3.

Emissions from burning, incineration and composting by the community - All emissions occurring in the base year within the local government geopolitical boundaries, resulting from burning, incineration and composting must be counted and classified as Scope 1. Local governments must count emissions of CH_4 and N_2O that result from open burning and incineration of organic materials. CO_2 from these materials should not be considered Scope 1 because it is of biogenic origin but should be classified as an information item. Open burning or incineration resulting in emissions of non-biogenic CO_2 (e.g. plastics) must also be counted. Emissions of CH_4 and N_2O that result from composting must be counted. Emissions of CO_2 from composting shall not be classified as Scope 1, as such emissions are biogenic in origin. Sources for appropriate emissions factors for various waste stream components for open burning, incineration and composting will be provided in each Country/Regional Supplement.

Emissions from burning, incineration and composting outside of the community – All emissions occurring from burning, incineration and composting of waste that originated in the community must be included and classified as Scope 3. Local governments must count

emissions of CH_4 and N_2O that result from open burning and incineration of organic materials. CO_2 from these materials should not be considered Scope 3 because it is of biogenic origin but should be classified as an information item. Open burning or incineration resulting in emissions of non-biogenic CO_2 (e.g. plastics) must also be counted. Emissions of CH_4 and N_2O that result from composting must be accounted for. Emissions of CO_2 from composting should not be counted as Scope 3, as such emissions are biogenic in origin. Sources for appropriate emissions factors for various waste stream components for open burning, incineration and composting will be provided in each Country/Regional Supplement.

Wastewater Methane

Local governments should count methane emissions from wastewater/sewage/industrial wastewater. In cases where the treatment facility is located within the geopolitical boundaries of the local government, those emissions must be classified as Scope 1. In cases where the treatment facility is outside of the local government boundary but the control of the treatment facility rests in whole or in part with the local government, the emissions from that treatment facility should be classified as Scope 3. Scope 3 wastewater emissions can be apportioned using a proportional share method where a facility treats waste from multiple communities. It is important to note that the guidelines for determining the scope of emissions from wastewater differ for reporting of local government operations which are more heavily dependent upon the organizational control than on the geopolitical location of the facility.

Calculation of emissions from wastewater treatment systems should be consistent with international standards, employing the first order decay (FOD) model utilized by the IPCC.

4. Reporting

Reporting Local Government greenhouse gas emissions can be complex, due to shared functions and potentially overlapping geopolitical boundaries of city and regional governments. For a report to be considered in compliance with the Local Government GHG Protocol, it is important to adhere to the General Principles (see Section 2). This provides report users with confidence that the information is an accurate reflection of a local government's or community's greenhouse gas emissions, and that the information presented is complete, accurate and consistent over time. In general:

- All reports generated must specify the year and the organizational entity or geopolitical area that the data relates to.
- At a minimum, cities must separately account for and report Scope 1 and Scope 2 emissions.
- Scope 3 emissions and information items may be reported separately in recognition of the policy relevance of those emissions (see exception for the Global Standard Report).
- Report preparers should include all GHG source information and documentation used to construct the inventory reports.
- Report preparers should include a statement to specify the tier of activity data and emissions factors used to quantify each source of emissions.
- Non-CO_2 emissions from biomass combustion should be included in Scope 1 and the CO_2 emissions reported as an information item.
- Scope 1 emissions shall be reported by GHG gas separately, and aggregated to CO_2e
- Scope 2 and 3 emissions shall be reported as CO_2e

4.1 Global Reporting Standard

The Local Government GHG Protocol defines a Global Reporting Standard specifically designed to enable comparison of local governments internationally. There are two:

1. **Comparative Community Emissions Responsibility Standard**: representing the portion of community-scale emissions that can be estimated and reported on a comparative basis by all geopolitically defined communities. This includes:

    a. All Scope 1 analysis-year emissions except for direct emissions from power plants and landfills located within the geopolitical boundary
    b. All Scope 2 analysis-year emissions from the consumption of electricity, heat and steam within the geopolitical boundary
    c. All Scope 3 analysis-year emissions associated with the decomposition of solid waste and sewage waste-water produced to date within the geopolitical boundary.

2. **Comparative Government Operations Emissions Standard**: representing the emissions responsibility from local government operations. This includes:

    a. All Scope 1 analysis-year emissions except for direct emissions from power plants and landfills owned and operated by the local government

b. All Scope 2 analysis-year emissions from the consumption of electricity, heat and steam by local government operations

The emissions within each standard shall be reported separately by scope and *cumulatively*. The cumulative total shall be considered the single inventory roll-up number for local government operations and community-scale reporting, respectively. The cumulative local government and community inventory numbers themselves do not add together. The local government inventory is (with the exception of certain sources occurring outside the geopolitical boundary) a subset of the community inventory total.

The Global Reporting Standard defines only what should be included in a GHG inventory report for a particular year for local governments. Requirements for verification and reporting frequency are left to programs and registries that require reporting by the Global Reporting Standard.

4.2 National Reporting Standards

Each Country/Regional Supplement may include a recommended **National Reporting Standard**, which includes sources judged by the review committee to be consistent and valuable enough to be included for reporting. These reports vary by country and are adopted only on review.

4.3 Guidelines for Custom Local Government Reporting

The Global Reporting Standard is not adequate as a policy tool for many local governments. Unlike private sector entities, many local governments may wish to report a wide variety of indirect Scope 3 emissions to inspire policy making aimed at reducing the community or local government's overall footprint. These kinds of attributed emissions sources are theoretical and it is often impractical to define and apply the theory consistently internationally. Hence, most Scope 3 emissions are not required in the Global Reporting Standard. Some examples local governments commonly wish to report include:

- Upstream emissions from materials and fuel consumption, to frame measures that reduce consumption.
- Attributed transport demand emissions generated in neighboring communities over which they feel they have an influence, in order to backstop policies that reduce this travel demand.
- Inventory numbers for Agriculture, Forestry and Other Land Use sectors (not required in the Global Reporting Standards) in order to frame an urban forestry programs.
- Optional co-benefit indicators, such as air pollution emissions, as a means to demonstrate and quantify the co-benefits of local climate action.

This Local Government GHG Emissions Analysis Protocol encourages cities, networks, governments, and others to create custom reporting standards. Custom reporting standards (wishing to be compliant with this Protocol) must adhere to the General Principles and are typically expanded to include:

- Scope 3 sources to include in an inventory and how to compute them.
- Requirements on reporting frequency and verification.

- A recommendation to simultaneously report by the Global Standard Report requirements to ensure their efforts can be compared with local governments worldwide.

Users creating custom reporting standards are encouraged to identify sources that permit evaluation of a full range of mitigation opportunities. They are discouraged from including Scope 3 sources that are academic and have no obvious policy relevance so the local government does not waste its time collecting irrelevant information.

Although the intention of this Protocol is to provide a framework for local government greenhouse gas management, users should be aware that methods may not have been developed to allow the inclusion of non-key sectors or other gaseous emissions.

4.4 Guidelines for Aggregated Reporting

Aggregate reporting refers to greenhouse gas program administrators reporting the summed result of individual local government inventories, within the constraints of any confidentiality agreements or privacy legislation. Reporting typically involves the administrators reporting aggregated results of local governments within one country to program funders or other levels of government.

It is important that reports generated by administrators include only information that the city has reported for its own purposes, and can therefore be regarded as complete and accurate. A local government may choose not to compile a complete inventory every year, so care should be taken by program administrators to report aggregate emissions only for those years for which every participant has completed an inventory.

It is recommended that aggregate reporting use the standard unit carbon dioxide equivalent (CO_2e) and express quantities in metric tonnes to facilitate international comparisons. However, recognizing that there are countries in which metric units are not widely used, it is acceptable that aggregate reports produced for use within a single country use the units that are standard in that country. Please refer to your Country/Regional Supplement for further guidance on units that are preferred in particular countries and that may be used for aggregate reporting in those countries.

When aggregating local government emissions it is imperative to avoid double counting between scopes and geopolitical boundaries. The best way to achieve this is to ensure that all reporting local governments are following a consistent reporting standard that defines the mix of Scope 1, 2, and 3 emissions that should be included (i.e., the Global Reporting Standard). If reporting local governments have not followed the same reporting standard, the best way to avoid double counting is to count only Scope 1 emissions.

4.5 Indicators

Due to the differing size and nature of cities, many comparisons between them are not valid. The use of reports generated using sector-specific indicators will ensure that the different population and level of business activity in local governments does not distort the comparison. Appropriate indicators will be specified for each sector in the Country/Regional Supplements.

A comparison that is made between local governments will be influenced by both the energy used in each and the emission factors that are relevant to each.

Boundaries note: When comparing local governments, it is important to delineate between the types of jurisdiction in question. A direct comparison between cities and regions may not be appropriate if they include different types of activities (e.g., rural versus urban) and have different organizational and geopolitical boundaries. These situations are handled on a case by case basis to ensure adjustments are made for overlapping boundaries.

Glossary

Action Plan – see "Local Action Plan"

Analysis – see "Emissions Analysis"

Baseline - A hypothetical scenario for what GHG emissions, removals or storage would have been in the absence of the GHG project or project activity.

Base Year – The emissions level against which to measure change over time, comprised of the annual emissions by activities within the boundaries of the analysis for a selected year.

Biofuel – A fuel derived from a biological (as opposed to fossil) source (i.e. vegetable oil, wood, straw, etc).

Blended fuels – Any fuel made from a mix of different fuels. Most often refers to a mix of a fossil fuel with a renewable bio-fuel. For example:

- Ethanol blend – Ethanol, or ethyl alcohol, combined with regular gasoline
- Biodiesel (B20) – A mix of 80% petroleum diesel with 20% diesel derived from vegetable oil
- Methanol Diesel – A combination of methanol blended with petroleum diesel fuel

British Thermal Unit (Btu) – A measure of energy content defined as the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit at about 39.2 degrees Fahrenheit.

Carbon Dioxide (CO_2) – The most common GHG, consisting of a single carbon atom and two oxygen atoms. CO_2 is released by respiration the burning of fossil fuels, and is removed from the atmosphere by photosynthesis in green plants.

Carbon Dioxide Concentration - The atmospheric carbon dioxide concentration, at 379 ppmv in 2005, is about 35% greater than the pre-industrial (1750-1800) value of about 280 ppmv, and higher than at any time in at least the last 160,000 years. Carbon dioxide is currently rising at about 1.8 ppmv (0.5%) per year due to anthropogenic emissions.

Carbon Dioxide equivalents – See "CO_2e"

Carbon Intensity – The amount of carbon emitted per unit of energy or fuels consumed.

Chlorofluorocarbons (CFCs) - Compounds of carbon containing both chlorine and fluorine. They are non-poisonous and inert at ordinary temperatures and easily liquifiable under pressure, which make them excellent refrigerants, solvents, foam-makers and for use in aerosol sprays. Chlorofluorocarbons (CFCs) do not occur naturally. The use of CFCs is strictly regulated.

CO_2e (Carbon Dioxide Equivalents) – A common unit for combining emissions of greenhouse gases with different levels of impact on climate change. It is a measure of the impact that each gas has on climate change and is expressed in terms of the potency of carbon dioxide. For carbon dioxide itself, emissions in tonnes of CO_2 and tonnes of CO_2e are the

same, whereas for nitrous oxide and methane, stronger greenhouse gases, one tonne of emissions is equal to 310 tonnes and 21 tonnes of CO_2e respectively.

Coefficient Set – A set of all emission factors of a particular type. For example, the electricity emissions for a specific grid region for all years in the analysis would comprise a Coefficient Set.

Coefficients – See "Emission Factors"

Cogeneration – The generation of two forms of energy such as heat and electricity from the same process with the purpose of utilizing or selling both simultaneously.

Decentralized Fuel - Fuels that are not distributed to the end user through pipelines. For example, light fuel oil is distributed to residential consumers via fuel truck.

De Minimis – For the purposes of this Protocol, the GHG emissions from one or more emissions, for one or more gases which, when summed, represent less than 5% of an organization's total CO_2e emissions.

Direct Emissions – Emissions from that are owned or controlled by the reporting organization.

Emissions Analysis – A comprehensive / quantitative look at the affect a jurisdiction is having on GHG emissions. The analysis includes the base year emissions inventory, the emissions forecasts and quantification of the impacts of measures from municipal operations and the community as a whole.

Emission Coefficients – See "Emission Factors."

Emission Factors / Coefficients – A unique value for determining the amount of a GHG emitted for a given quantity of fossil fuel consumed. These factors are expressed in terms of the ratio of emissions of a particular pollutant (e.g. carbon dioxide) to the quantity of the fuel used (e.g. kilograms of coal). For example, when burned, 1 tonne of coal = 2.071 tonnes of CO_2.

Emissions Inventory – (see Inventory)

First Order Decay (FOD) model - A methodology for estimating CH_4 emissions from organic waste undergoing biological decomposition. This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed. If conditions are constant, the rate of CH_4 production depends solely on the amount of carbon remaining in the waste.

Forecast Year – Any future year in which predictions are made about emission levels based on growth multipliers applied to the base year.

Fugitive Emissions – The unintended emissions of GHGs from the transmission, processing, or transportation of fossil fuels or other materials (e.g. coolant leaks in HVAC systems or natural gas line leaks).

Geopolitical Boundary – the physical area or region over which a local government has jurisdictional authority.

Global Warming Potential (GWP) – The ratio of radiative forcing that would result from the emission of one kilogram of a GHG to that from the emission of one kilogram of carbon dioxide over a fixed period of time.

Greenhouse Effect - The effect of heat retention in the lower atmosphere as a result of absorption and re-radiation by clouds and various greenhouse gases of long-wave terrestrial radiation. Incoming, short-wave radiation, including visible light and heat, is absorbed by materials which then behave as black bodies re-radiating at longer wavelengths. Certain substances (e.g. carbon dioxide) absorb long-wave radiation, are heated by it, and then begin to radiate it, still as long-wave radiation, in all directions, some of it downwards. Despite its name, the actual heating in a real greenhouse is caused mainly by the physical obstruction of the glass, which prevents warm air from leaving and cooler air from entering.

Greenhouse Gases (GHG) – Gases which are transparent to solar (short-wave or light) radiation but opaque to long-wave (infrared or heat) radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. Thereby reducing the amount of earth's radiation that escapes to space, with consequent warming of the lower atmosphere and the earth's surface (see Greenhouse Effect). For the purposes of this standard, GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydroflurocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF_6).

Hydrofluorocarbons (HFCs) – GHGs used primarily as a refrigerant, comprising a class of gases containing hydrogen, fluorine, and carbon.

Indirect Emissions – Emissions that occur because of a local government's actions, but are produced by sources owned or controlled by another entity. For example, the purchase of electricity that was generated by emission-producing fuel outside of the jurisdiction's boundaries.

Intergovernmental Panel on Climate Change (IPCC) – An organization established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988 to assess information in the scientific and technical literature related to all significant components of the issue of climate change, and providing technical analysis of the science of climate change as well as guidance on the quantification of GHG emissions.

Interim Year – Any year for which an emissions inventory is completed that falls between the base year and the target year. Completing an emissions inventory for an interim year is useful in determining a jurisdiction's progress towards meeting their emission reduction goals.

Inventory – The quantification of all emissions within the jurisdiction's boundaries during a particular year.

Kilowatt Hour (kWh) – The electrical energy unit of measure equal to one thousand watts of power supplied to, or taken from, an electric circuit steadily for one hour. (A Watt is the unit of electrical power equal to one ampere under a pressure of one volt, or 1/746 horsepower.)

Local Action Plan – includes the emissions analysis, Emissions Reduction Target, Emissions Reduction Strategy, and Emissions Reduction Implementation Strategy.

Measures – For the purposes of this standard, measures are any action taken to reduce GHG emissions.

Methane (CH_4) – A GHG resulting from the anaerobic decomposition of vegetative materials in wetlands, urban landfills, and rice paddies, the production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The principle constituent of natural gas, methane is a single carbon atom linked to four hydrogen atoms.

Methane Recovery Factor – A measurement of the percentage of methane produced that is being captured at a landfill. For example, a landfill that is capped, lined, and has a methane extraction system may prevent the escape of 90% of the methane emitted by the waste disposed at the landfill; in this case the methane recovery factor would be 90.

Tonne – Standard international metric measurement for the quantity of GHG emissions, equivalent to 1000 kilograms, about 2,204.6 pounds or 1.1 short tons.

National Communication – All parties to the UNFCCC should report on the steps they are taking to implement the convention and an annual inventory of their GHG emissions to the UNFCCC secretariat. These are included in the country's "National Communication" to the secretariat.

Net Biogenic Carbon Flux – The change in the total amount of carbon stored in a defined area, from one year to the next. Carbon stored in live organic matter, soils and harvested products are summed so that a shift from one category to another or regrowth of harvested products is not counted as a change in the total stored carbon.

Nitrous Oxide (N_2O) – A potent greenhouse gas produced in relatively small quantities. It is composed of a two nitrogen atoms and a single oxygen atom and is typically generated as a result of soil cultivation practices, particularly the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Perfluorocarbons (PFCs) – A GHG consisting of a class of gases containing carbon and fluorine. Originally introduced as alternatives to ozone depleting substances they are typically emitted as by-products of industrial and manufacturing processes.

Person (Passenger) Miles Traveled (PMT) – A unit of measurement used in transportation related fields that measures the level of personal mobility in a community. A person mile of travel equals one person traveling one mile, by any mode, including walking, cycling, automobile, van pool, transit, etc. PMT should not be confused with vehicle miles traveled (VMT). For example, if a car has five people in it and travels 10 miles. The VMT for that trip is 10 but the PMT is 50. The total PMT associated with a particular vehicle trip equals the VMT multiplied by the occupancy of the vehicle.

Proxy Data / Proxy Energy Use Data – A related piece of data that can be used to estimate energy usage. For example, average annual electricity costs in a region can be used to create an estimate of actual electricity costs in a jurisdiction's inventory of emissions from government operations.

Sectors – Within each module, records are organized into sectors that contain similar activities or emissions sources. The sectors for the community module includes: Residential, Commercial, Industrial, Transportation, Waste, and other. The sectors in the government module include: Buildings, Vehicle Fleet, Employee Commute, Streetlights, Waster and Sewage, Waste, and Other.

Sulfur Hexafluoride (SF_6) – a GHG consisting of a single sulfur atom and six fluoride atoms. Primarily used in electrical transmission and distribution systems.

Target Year – The year by which the emissions reduction target should be achieved. See also "Forecast Year."

United Nations Framework Convention on Climate Change (UNFCCC) – An international environmental treaty produced at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. The UNFCCC provides an overall framework for international efforts to mitigate climate change. The Kyoto Protocol is an update to the UNFCCC.

Verification – A process through which a third party confirms that a GHG emissions analysis has met a recognized minimum quality standard and complied with the appropriate procedures and protocols for calculating and submitting the emissions information.

Appendices

Summary of Standards

A.1 The UN Framework Convention on Climate Change

The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention entered into force on 21 March 1994 and enjoys near universal membership, with 191 countries having ratified.

Under the Convention, governments:
• gather and share information on greenhouse gas emissions, national policies and best practices;
• launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries;
• cooperate in preparing for adaptation to the impacts of climate change.

The UNFCCC requires signatory nations to report emissions of the following greenhouse gases:

• CO_2 - Carbon dioxide
• CH_4 - Methane
• N_2O - Nitrous oxide
• PFCs - Perfluorocarbons
• HFCs - Hydrofluorocarbons
• SF_6 - Sulphur hexafluoride

ICLEI recognizes that activities leading to the emission of some gases are beyond the influence of local government and are more appropriately accounted for by national governments.

At a national level, emissions of greenhouse gases are reported using the UNFCCC emission source categories described below, with methodological guidance provided by the Intergovernmental Panel on Climate Change (IPCC):

Fuel combustion (Sectoral Approach)
Emissions of all greenhouse gases from fuel combustion activities. CO_2 emissions from the combustion of biomass fuels are not included but other greenhouse gases from biomass fuel combustion are included. Incineration of waste for waste-to-energy facilities are considered to result in fuel combustion emissions and not Waste Sector emissions.

Energy Industries
Comprises emissions from fuels combusted by the fuel extraction or energy producing industries.

Transport
Emissions from the combustion and evaporation of fuel for all transport activity, regardless of the sector of the economy in which they are used.

Agriculture
All anthropogenic emissions from agriculture except for fuel combustion and sewage emissions.

Land-use Change and Forestry
Total emissions and removals from forest and land use change activities. These activities may impact on three different carbon sources/sinks: above-ground biomass, below-ground biomass and soil carbon.

Waste
Total emissions from solid waste disposal on land, wastewater, waste incineration and any other waste management activity. Any CO_2 emissions from fossil-based products (incineration or decomposition) are not included here nor are CO_2 emissions from organic waste handling and decay, which is considered to be biogenic in origin.

Industrial Processes
Emissions that are not related to the use of energy or solvents, such as by-products from the manufacture of materials. Other industrial emissions are accounted for in the relevant source category (e.g. Fuel Combustion)

Solvent and Other Product Use
Emissions resulting from the use of solvents and other products containing volatile compounds.

International Bunkers, Aviation and Marine
Emissions resulting from fuel use in ships or aircraft engaged in international transport.

Other
Emissions that do not fit under any other emission source/sink categories of the main categories described elsewhere.

The alignment between these sectors and those typically used by local government is indicated at the end of section A.4.1.2.

A.2 The International Organization for Standardization (ISO) 14064
It is important to note that, where ISO 14064 is used to inform a greenhouse gas management program, the requirements of that program are additional to the requirements of ISO 14064. Further, if a requirement of ISO 14064 prevents an organization from complying with a requirement of the greenhouse management program, the requirement of the program takes precedence.

ISO 14064 imposes a number of requirements that are additional to those of current local government greenhouse gas management programs. Many of these requirements are also used by the WRI/WBCSD GHG Protocol which guided the development of the Standard.

In order to satisfy the ISO requirements at least three additional elements should be incorporated by cities wishing to demonstrate compliance:

Reporting by individual greenhouse gas
For simplicity and communication purposes, emissions are usually expressed in carbon dioxide equivalent (CO_2e). The ISO requirement is that reports document the emissions of

each of the six greenhouse gases listed in the UNFCCC and Kyoto Protocol (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Local governments have traditionally reported total emissions of 'tonnes CO_2e' but should also report by individual greenhouse gas in order to satisfy the requirements of ISO 14064.

Where a local government does not intend to seek compliance with ISO 14064, it may report total emissions using the unit 'tonnes CO_2e'. The global warming potentials used to convert from an amount of greenhouse gas to the carbon dioxide equivalent (CO_2e) must be calculated based on a 100 year time frame. Consistent with reporting under the Kyoto Protocol, local governments should follow international convention in using the global warming potentials outlined in the IPCC's Second Assessment Report.

Uncertainty assessment
An analysis of greenhouse gas emissions is subject to a degree of uncertainty that may arise from the accuracy of available activity data, the degree of alignment with annual or monthly time periods or variation in the quality of fuel sources. To facilitate accreditation to the ISO 14064 series of standards, a local government should assess the uncertainty associated with an inventory/analysis of any given year.

Local governments wishing to include an uncertainty estimate in their analysis of greenhouse gas emissions should refer to the 2006 IPCC Guidance Chapter 3 Uncertainties for detailed methods.

Local governments that are not seeking compliance of their analysis with ISO 14064 are not required to conduct an uncertainty assessment.

Document retention
An initial analysis of greenhouse gas emissions is usually conducted for an historical year, in order to generate baseline data. A subsequent analysis may be done up to five years after that initial exercise, during which time important documents may be misplaced.

To enable auditing, all original documents that are relevant to the analysis must be retained by the local government.

A.3 Global Reporting Initiative
The Global Reporting Initiative is a partner organization of ICLEI – Local Governments for Sustainability. GRI has developed a Public Sector Agency Supplement to the G3 Guidelines, which may be used to assist local governments identify the extent of their responsibility for greenhouse gas emissions from their municipality.

Boundary analysis
Defining the boundary of an organization that has multiple functions and provides a wide range of services is clearly a challenge. In order to provide guidance, GRI uses an extension of the concept of control and influence, based on company financial reporting. The following definition of control is provided (GRI, 2005):

The power to govern the financial and operating policies of an enterprise so as to obtain benefits from its activities.

In recognition that the GRI Guidelines are not only used by organizations seeking economic benefit, the definition of control includes the ability to derive benefits other than solely economic ones.

The boundary of an organization can also include elements of another organization's operations, if it has the power to subject significant influence over those operations. The definition of significant influence is (GRI, 2005):

The power to participate in the financial and operating policy decisions of the entity but…not control over those policies.

The boundary approach used in the GRI Guidelines Public Sector Agency Supplement uses the control and significant influence boundary guidance in the following way, recognizing the broad reach of public agencies:

Organizational Performance – consisting of functions directly under the agency's control, consistent with the private sector reporting approach;
Public Policies and Implementation Measures – activities that occur as a result of the agency implementing public policy.

A boundary defined by the sphere of influence of public policy is potentially very large and will inevitably intersect with another public agency's boundary to some extent. A public agency that is an elected public authority can be considered to have a sphere of significant influence that extends to the reaches of the geopolitical boundary that contains those responsible for electing it.

Local governments intending to seek compliance with the GRI Framework should adopt the boundary approach outlined above, but refer to the GRI for detailed guidance.

Local governments that are not seeking compliance of their analysis with the GRI Framework will also find the principles above to be useful guidance.