GREENHOUSE GAS PROTOCOL

Global Protocol for Community-Scale Greenhouse Gas Emission Inventories

EXECUTIVE SUMMARY

An Accounting and Reporting Standard for Cities

WORLD RESOURCES INSTITUTE

C40 CITIES CLIMATE LEADERSHIP GROUP

ICLEI Local Governments for Sustainability

"If we want to turn the tide against climate change, cities will need to lead the way. Compact and efficient cities can dramatically reduce emissions and will drive innovation and sustained economic growth. Until recently there has been no consistent way to measure city-level emissions. Now, that has changed. We now have a common international standard to inform strategies to cut emissions and create better, more livable cities."

—***Andrew Steer, President and CEO, WRI***

"As C40 Chair and Mayor of Rio de Janeiro, I know that building a greenhouse gas emissions inventory enables city leaders to manage their emissions reduction efforts, allocate resources and develop comprehensive climate action plans. With the launch of the GPC, cities now have a consistent, transparent and internationally recognized approach to measuring and reporting citywide emissions, allowing for credible comparison and aggregation across timescales and geographies. On behalf of C40, I would like to thank WRI and ICLEI for their partnership in building this powerful standard that will benefit cities across the globe. I strongly encourage other cities around the world to take up this new standard as a key step in the global fight against climate change."

—***Eduardo Paes, C40 Chair and Mayor of Rio de Janeiro***

"With the launch of the GPC, we now have the most comprehensive greenhouse gas accounting and reporting framework for cities worldwide. Drafting and piloting since 2012, the GPC marks a historic international consensus on GHG accounting and reporting emissions, allowing local governments to measure and track their performances in a consistent standard, guided by international best practices. This published version would not have been possible without the excellent cooperation between WRI, C40 and ICLEI, as well as the practical insight and valuable feedback provided by the 35 pilot cities that tested earlier versions in their cities. ICLEI wants to thank these partners and cities for their indispensable contribution to this game-changing Protocol."

—***David Cadman, President, ICLEI***

1. Introduction

Cities are the global centers of communication, commerce and culture. They are also a significant, and growing, source of energy consumption and greenhouse gas (GHG) emissions. A city's ability to take effective action on mitigating climate change, and monitor progress, depends on having access to good quality data on GHG emissions. Planning for climate action begins with developing a GHG inventory. An inventory enables cities to understand the emissions contribution of different activities in the community.

Inventory methods that cities have used to date vary significantly. This inconsistency makes comparisons between cities difficult, raises questions around data quality, and limits the ability to aggregate local, subnational, and national government GHG emissions data. To allow for more credible and meaningful reporting, greater consistency in GHG accounting is required. The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) responds to this challenge and offers a robust and clear framework that builds on existing methodologies for calculating and reporting city-wide GHG emissions.

The GPC requires cities to measure and disclose a comprehensive inventory of GHG emissions and to total these emissions using two distinct but complementary approaches. One captures emissions from both production and consumption activities taking place within the city boundary, including some emissions released outside the city boundary. The other categorizes all emissions into "scopes," depending on where they physically occur. Separate accounting of emissions physically released within the city boundary should be used for aggregation of multiple city inventories in order to avoid double counting.

The GPC is divided into three main parts:

- **Part I** introduces the GPC reporting and accounting principles, sets out how to define the inventory boundary, specifies reporting requirements and offers a sample reporting template
- **Part II** provides overarching and sector-specific accounting and reporting guidance for sourcing data and calculating emissions, including calculation methods and equations
- **Part III** shows how inventories can be used to set mitigation goals and track performance over time, and shows how cities can manage inventory quality

Note, the term "city" is used throughout this document to refer to any geographically discernable subnational entity, such as a community, town, city, or province, and covers all levels of subnational jurisdiction as well as local government as legal entities of public administration.

2. Defining an inventory boundary and emission sources

To use the GPC, cities must first define an inventory boundary. This identifies the geographic area, time span, gases, and emission sources, covered by a GHG inventory. Any geographic boundary may be used for the GHG inventory. Depending on the purpose of the inventory, the boundary can align with the administrative boundary of a local government, a ward or borough within a city, a combination of administrative divisions, a metropolitan area, or another geographically identifiable entity. The GPC is designed to account for GHG emissions in a single reporting year and covers the seven gases covered by the Kyoto Protocol (Section 3.3 in the report).

GHG emissions from city activities shall be classified into six main sectors:

- Stationary energy
- Transportation
- Waste
- Industrial processes and product use (IPPU)
- Agriculture, forestry, and other land use (AFOLU)
- Any other emissions occurring outside the geographic boundary as a result of city activities. These emissions are not covered in this version of the GPC but may be reported separately

Table 1 breaks these six sectors down by sub-sector.

Table 1 **Sectors and sub-sectors of city GHG emissions**

Sectors and sub-sectors
STATIONARY ENERGY
Residential buildings
Commercial and institutional buildings and facilities
Manufacturing industries and construction
Energy industries
Agriculture, forestry, and fishing activities
Non-specified sources
Fugitive emissions from mining, processing, storage, and transportation of coal
Fugitive emissions from oil and natural gas systems
TRANSPORTATION
On-road
Railways
Waterborne navigation
Aviation
Off-road
WASTE
Solid waste disposal
Biological treatment of waste
Incineration and open burning
Wastewater treatment and discharge
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)
Industrial processes
Product use
AGRICULTURE, FORESTRY, AND LAND USE (AFOLU)
Livestock
Land
Other agriculture
OTHER SCOPE 3

3. Categorizing emissions

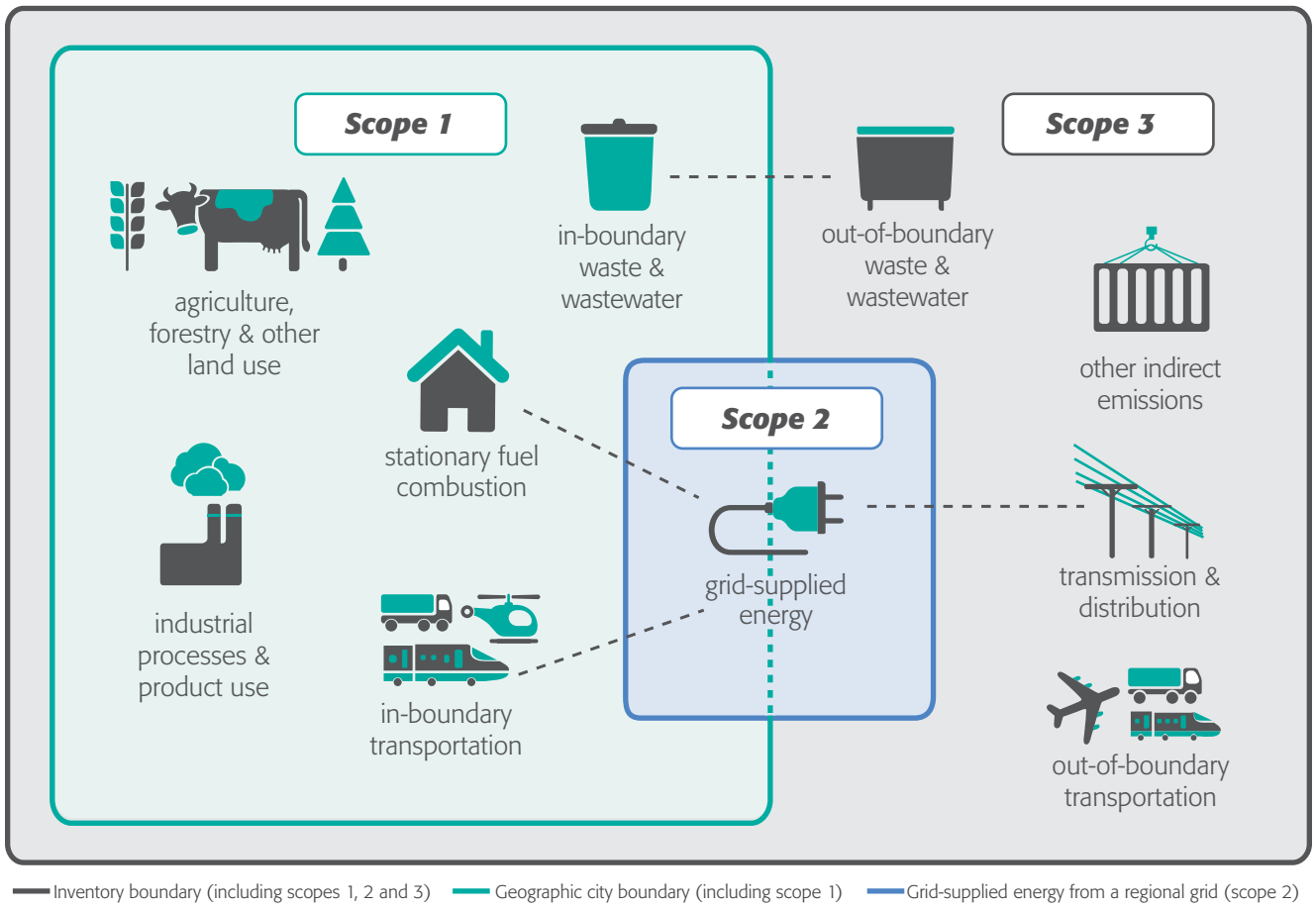
Activities taking place within a city can generate GHG emissions that occur inside the city boundary as well as outside the city boundary. To distinguish among them, the GPC groups emissions into three categories based on where they occur: scope 1, scope 2 or scope 3 emissions. Definitions are provided in Table 2, based on an adapted application of the scopes framework used in the GHG Protocol Corporate Standard.

The scopes framework helps to differentiate emissions occurring physically within the city (scope 1), from those occurring outside the city (scope 3) and from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross city boundaries (scope 2). Scope 1 emissions may also be termed "territorial" emissions because they occur discretely within the territory defined by the geographic boundary. Figure 1 illustrates which emission sources occur solely within the geographic boundary established for the inventory, which occur outside the geographic boundary, and which may occur across the geographic boundary.

Table 2 Scopes definitions for city inventories

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking places within the city boundary

Figure 1 Sources and boundaries of city GHG emissions



4. Aggregating city inventories

The GPC has been designed to allow city inventories to be aggregated at subnational and national levels in order to:

- Improve the data quality of a national inventory, particularly where major cities' inventories are reported;
- Measure the contribution of city mitigation actions to regional or national GHG emission reduction targets;
- And identify innovative transboundary and cross-sectorial strategies for GHG mitigation.

Aggregation of multiple city inventories can be accomplished by combining the scope 1 (territorial) emissions of cities whose inventory boundaries do not overlap geographically.

5. Reporting requirements

The GPC requires cities to report their emissions by gas, scope, sector and subsector, and to add up emissions using two distinct but complementary approaches:

- **Scopes framework:** This totals all emissions by scope 1, 2 and 3. Scope 1 (or territorial emissions) allows for the separate accounting of all GHG emissions produced within the geographic boundary of the city, consistent with national-level GHG reporting.
- **City-induced framework:** This totals GHG emissions attributable to activities taking place within the geographic boundary of the city. It covers selected scope 1, 2 and 3 emission sources representing the key emitting sources occurring in almost all cities, and for which standardized methods are generally available.

Chapter 4 of the GPC sets out reporting requirements and explains how to add up emission totals. Cities may also report emissions based on relevant local or program-specific requirements in addition to the requirements of the GPC. GHG inventories should be updated on a regular basis using the most recent data available. The GPC recommends that cities update their inventory on an annual basis, as it provides frequent and timely progress on overall GHG emissions.

Table 3 summarizes the emissions sources and scopes covered by the GPC for both city-level and territorial reporting. These represent the key emitting sources occurring in almost all cities, and for which standardized methods are generally available. Cities should aim to cover all emissions for which reliable data is available. To accommodate limitations in data availability and differences in emission sources between cities, the GPC requires the use of notation keys, as recommended in IPCC Guidelines, and an accompanying explanation to justify exclusion or partial accounting of GHG emission source categories.

The city-induced framework gives cities the option of selecting between two reporting levels: BASIC or BASIC+. The BASIC level covers scope 1 and scope 2 emissions from stationary energy and transportation, as well as scope 1 and scope 3 emissions from waste. BASIC+ involves more challenging data collection and calculation processes, and additionally includes emissions from IPPU and AFOLU and transboundary transportation. Therefore, where these sources are significant and relevant for a city, the city should aim to report according to BASIC+. The sources covered in BASIC+ also align with sources required for national reporting in IPCC guidelines.

Tick marks in Table 3 indicate which emissions sources are covered by the GPC, and cells are colored to indicate their inclusion in city-level BASIC or BASIC+ totals and the territorial total. Rows written in italics represent sub-sector emissions required for territorial emission totals but not BASIC/BASIC+. Gray cells in the scope 2 column indicate emission sources that do not have applicable GHG emissions in that scope category. Emission sources corresponding to the blank boxes in the scope 3 column are not required for reporting, but may be identified and disclosed separately under Other Scope 3.

The GPC provides a sample reporting template that covers all reporting requirements. Cities may report GHG emissions in a variety of additional formats depending on purpose and audience, and may also disaggregate emissions by fuel type, municipal operations within each sector or sub-sector, etc.

Figure 2 Sources and scopes covered by the GPC

Sectors and sub-sectors	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY			
Residential buildings	✓	✓	✓
Commercial and Institutional buildings and facilities	✓	✓	✓
Manufacturing industries and construction	✓	✓	✓
Energy industries	✓	✓	✓
Energy generation supplied to the grid	✓		
Agriculture, forestry, and fishing activities	✓	✓	✓
Non-specified sources	✓	✓	✓
Fugitive emissions from mining, processing, storage, and transportation of coal	✓		
Fugitive emissions from oil and natural gas systems	✓		
TRANSPORTATION			
On-road	✓	✓	✓
Railways	✓	✓	✓
Waterborne navigation	✓	✓	✓
Aviation	✓	✓	✓
Off-road	✓	✓	
WASTE			
Disposal of solid waste generated in the city	✓		✓
Disposal of solid waste generated outside the city	✓		
Biological treatment of waste generated in the city	✓		✓
Biological treatment of waste generated outside the city	✓		
Incineration and open burning of waste generated in the city	✓		✓
Incineration and open burning of waste generated outside the city	✓		
Wastewater generated in the city	✓		✓
Wastewater generated outside the city	✓		
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)			
Industrial processes	✓		
Product use	✓		
AGRICULTURE, FORESTRY, AND LAND USE (AFOLU)			
Livestock	✓		
Land	✓		
Other agriculture	✓		
OTHER SCOPE 3			
Other Scope 3			

✓ Sources covered by the GPC

+ Sources required for BASIC+ reporting

Sources included in Other Scope 3

Sources required for BASIC reporting

Sources required for territorial total but not for BASIC/BASIC+ reporting *(italics)*

Non-applicable emissions

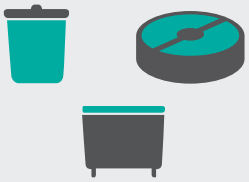
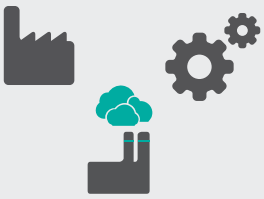
6. Calculating GHG emissions

Part II of the GPC provides overarching and sector-specific reporting guidance for sourcing data and calculating emissions. Cities should select the most appropriate methodologies based on the purpose of their inventory, availability of data, and consistency with their country's national inventory and/or other measurement and reporting programs in which they participate. The GPC does not require specific methodologies to be used to produce emissions data; rather it specifies the principles and rules for compiling a city-wide GHG emissions inventory. Where relevant, the GPC recommends using methodologies aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

For most emission sources, cities will need to estimate GHG emissions by multiplying activity data by an emission factor associated with the activity being measured. Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time (e.g., volume of gas used, kilometers driven, tonnes of waste sent to landfill, etc.). An emission factor is a measure of the mass of GHG emissions relative to a unit of activity. For example, estimating CO_2 emissions from the use of electricity involves multiplying data on kilowatt-hours (kWh) of electricity used by the emission factor ($kgCO_2/kWh$) for electricity, which will depend on the technology and type of fuel used to generate the electricity. GHG emissions data shall be reported as metric tonnes of each GHG as well as CO_2 equivalents (CO_2e).

Data can be gathered from a variety of sources, including government departments and statistics agencies, a country's national GHG inventory report, universities and research institutes, scientific and technical articles in environmental books, journals and reports, and sector experts/stakeholder organizations. In general, it is preferable to use local and national data over international data, and data from publicly-available, peer-reviewed and reputable sources, often available through government publications. Where the best available activity data do not align with the geographical boundary of the city or the time period of the assessment, the data can be adapted to meet the inventory boundary by adjusting for changes in activity using a scaling factor. Emission factors should be relevant to the inventory boundary and specific to the activity being measured.

Figure 3 **Emission source sectors**

Sectors in the GPC	
STATIONARY ENERGY	
	Stationary energy sources are one of the largest contributors to a city's GHG emissions. These emissions come from the combustion of fuel in residential, commercial and institutional buildings and facilities and manufacturing industries and construction, as well as power plants to generate grid-supplied energy. This sector also includes fugitive emissions, which typically occur during extraction, transformation, and transportation of primary fossil fuels.
TRANSPORTATION	
	Transportation covers all journeys by road, rail, water and air, including inter-city and international travel. GHG emissions are produced directly by the combustion of fuel or indirectly by the use of grid-supplied electricity. Collecting accurate data for transportation activities, calculating emissions and allocating these emissions to cities can be a particularly challenging process. To accommodate variations in data availability, existing transportation models, and inventory purposes, the GPC offers additional flexibility in calculating emissions from transportation.
WASTE	
	Waste disposal and treatment produces GHG emissions through aerobic or anaerobic decomposition, or incineration. GHG emissions from solid waste shall be calculated by disposal route, namely landfill, biological treatment and incineration and open burning. If methane is recovered from solid waste or wastewater treatment facilities as an energy source, it shall be reported under Stationary Energy. Similarly, emissions from incineration with energy recovery are reported under Stationary Energy.
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	
	GHG emissions are produced from a wide variety of non-energy related industrial activities. The main emission sources are releases from industrial processes that chemically or physically transform materials (e.g., the blast furnace in the iron and steel industry, and ammonia and other chemical products manufactured from fossil fuels and used as chemical feedstock). During these processes many different GHGs can be produced. In addition, certain products used by industry and end-consumers, such as refrigerants, foams or aerosol cans, also contain GHGs which can be released during use and disposal.
AGRICULTURE, FORESTRY AND OTHER LAND USE (AFOLU)	
	Emissions from the Agriculture, Forestry and Other Land Use (AFOLU) sector are produced through a variety of pathways, including livestock (enteric fermentation and manure management), land use and land use change (e.g., forested land being cleared for cropland or settlements), and aggregate sources and non-CO_2 emission sources on land (e.g., fertilizer application and rice cultivation). Given the highly variable nature of land-use and agricultural activity across geographies, GHG emissions from AFOLU are amongst the most complex categories for GHG accounting.

7. Tracking progress and setting goals

Inventories can be used as the basis for setting mitigation goals and tracking performance over time. For many cities with existing climate action plans and targets, the mitigation goal boundary used will be different to the inventory boundary outlined above or will apply to a subset of the GHGs, scopes, or emission sources set out in the GPC. Cities are encouraged to align their mitigation goal boundary to the GPC inventory boundary, but where the mitigation goal boundary remains different from the GPC inventory boundary, cities should explain the differences, and reason for the differences, to avoid any confusion.

8. Managing inventory quality and verification

The GPC does not require that cities verify their inventory results, but recommends that cities choose the level and type of verification that meets their needs and capacity. To manage inventory quality over time, cities should establish a management plan for the inventory process. The design of an inventory management plan should provide for the selection, application, and updating of inventory methodologies as new data and research become available.

Verification involves an assessment of the completeness and accuracy of reported data. Cities may choose to verify their data to demonstrate that their calculations are in accordance with the requirements of the GPC and provide confidence to users that the reported GHG emissions are a fair reflection of a city's activities. This can be used to increase credibility of publicly reported emissions information with external audiences and increase confidence in the data used to develop climate action plans, set GHG targets and track progress. Verification can be performed by the same organization that conducted the GPC assessment (self-verification), or by an independent organization (third-party verification).

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A list of funders is available at www.ghgprotocol.org/city-accounting

World Resources Institute

WRI is a global research organization that works closely with leaders to turn big ideas into action to sustain a healthy environment—the foundation of economic opportunity and human well-being.

C40 Cities Climate Leadership Group

C40 is a network of the world's megacities committed to addressing climate change. Established in 2005, C40 offers cities an effective forum where they can collaborate, share knowledge and drive meaningful, measurable and sustainable action on climate change.

ICLEI - Local Governments for Sustainability

ICLEI is a leading association of cities and local governments dedicated to sustainable development. ICLEI represents a movement of over 1,000 cities and towns in 88 countries. ICLEI promotes local action for global sustainability and supports cities to become sustainable, resilient, resource-efficient, biodiverse, and low-carbon.

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GREENHOUSE GAS PROTOCOL

The Greenhouse Gas Protocol provides the foundation for sustainable climate strategies. GHG Protocol standards are the most widely used accounting tools to measure, manage and report greenhouse gas emissions.

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