International Standard for Determining Greenhouse Gas Emissions for Cities

The Intergovernmental Panel on Climate Change (IPCC) advices that, to avoid the worst impacts from climate change, global CO_2 emissions must be cut by at least 50% by 2050. With the majority of the world's population now urbanized, cities will be at the forefront of efforts to reduce greenhouse gas (GHG) emissions.

City mayors, other urban leaders, businesses and civil society all recognize the need to act to reduce the impacts of climate change on cities. While measurement should not delay action, a critical requirement to support policy and access to finances is the establishment of an open, global and harmonized protocol for quantifying the GHG emissions attributable to cities and local regions. Several organizations have established different approaches for inventorying urban GHG emissions[1]. The purpose of this agreement is to establish a common standard by which tools to inventory city emissions should be based.

With the exception of territorial attribution (see paragraph below), GHG inventories for cities should use the principles and methods developed by the IPCC. In particular:

- Inventories should be transparent, consistent, comparable, complete and accurate. They should be sufficiently disaggregated and consistent to enable effective policy development.
- The most recent IPCC guidelines[2] should be used for determining emissions from: energy (stationary and mobile sources); industrial processes and product use (IPPU); agriculture, forestry and other land use (AFOLU; where significant); and waste.
- Annual, calendar year, emissions for all six Kyoto gases[3], and other greenhouse gases as relevant, should be reported.
- Emissions should be reported in terms of carbon dioxide equivalents, using the most recently published IPCC global warming potentials[4].
- Uncertainty assessment and quality assurance are encouraged and should follow IPCC guidelines.

[1] For comparison of methods used by different cities see: Kennedy et al. (2009) Greenhouse Gas Emission Baselines for Global Cities and Metropolitan Regions, paper presented at the World Bank's Fifth Urban Research Symposium, Marseille, France June 28 – 30, 2009. Comparison of software has been undertaken by: Bader, N., and R. Bleischwitz (2009) Comparative Analysis of Local GHG Inventory Tools, study conducted for Institut Veolia Environnement.

[2] In countries that use previous versions of the IPCC guidelines, cities may use these older guidelines so as to be consistent with national inventories.

[3] The six Kyoto greenhouse gases are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

[4] See note 2.

This standard also recognizes that the vitality of cities gives rise to the production of GHG emissions outside of urban boundaries. This standard follows the World Resources Institute / World Business Council for Sustainable Development (WRI/ WBCSD[5]) protocol by including out-of-boundary emissions that are driven by activities in cities (see Appendix I). While it is impractical to quantify all of the emissions associated with the myriad of goods and materials consumed in cities, urban GHG inventories must include:

- Out-of-boundary emissions from the generation of electricity and district heating which are consumed in cities (including transmission and distribution losses);
- Emissions from aviation and marine vessels carrying passengers or freight away from cities[6];
- Out-of-boundary emissions from waste that is generated in cities.

The GHG emissions embodied in the food, water, fuels and building materials consumed in cities should also be reported as additional information items[7]. This is to avoid policies or actions that lower emissions inside of cities, but at the expense of greater emissions outside of cities.

This agreement also includes a standard reporting format for GHG emissions from cities, which includes information on emission factors and activity levels used in the calculation of emissions (see Appendix II). All cities or urban regions with populations over 1 million persons are encouraged to use this reporting standard. Cities with populations below 1 million may use less detailed reporting tables, such as those developed by the European Commission for the Covenant of Mayors.

To be pragmatic, cities may follow the IPCC guidelines[8] for identifying and reporting on *key categories* of emissions, the sum of which represent at least 95% of total emissions. In many cases, AFOLU emissions for cities may be too insignificant to report; IPPU emissions may also be insignificant for some cities.

The determination of urban GHG emissions by this standard does not imply that local governments are responsible for these emissions. Rather the inventory reflects the carbon dependence of the urban economy[9] and highlights the

---

[5] WRI / WBCSD: The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard: Revised Edition. Accessed May 2009 http://www.ghgprotocol.org/.

[6] Domestic and international emissions should be reported separately for both aviation and marine sources. To follow the UNFCCC, international take-off and landing emissions may be included with domestic aviation emissions.

[7] This list of embodied emissions in key urban materials follows from the work of Ramaswami et al. (2008) A demand-centered, hybrid life cycle methodology for city-scale greenhouse gas emissions, Environ. Sci. Technol. 42, 6455-61. The methodology developed by Bilan Carbone (www.ademe.fr/bilan-carbone) could also be used to quantify embodied emissions.

[8] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 1, Chapter 4.

[9] With the deviation from a strict territorial approach through inclusion of out-of-boundary emissions, further principles and guidelines are required to establish which emissions should be included. Some have

extensive experience that local governments already have in monitoring GHG emissions. The standard formatting by local governments would be consistent with national inventories and subject to regional and national compilations as overseen by national directives.

The standard also builds upon the ongoing efforts of local government organizations, at various levels, in establishing different approaches for GHG emissions inventories. It would contribute to stimulating and accelerating ongoing efforts to develop capacities of local governments in measuring GHG emissions attributed to their territories.

Note: City baselines developed using methodology that is generally consistent with this standard are now available for approximately 50 cities, see worldbank.org/urban.

This standard is one of several tools for cities and climate change being developed jointly by UNEP, UN-HABITAT, World Bank and supported by Cities Alliance.

Comments on this draft standard are welcome: Please forward to Soraya Smaoun (UNEP) soraya.smaoun@unep.org, Raf Tuts (UN-HABITAT) Raf.Tuts@unhabitat.org, Daniel Hoornweg (World Bank) dhoornweg@worldbank.org

argued that city GHG inventories should only include components that are under the control or influence of local government, but this is problematic in that major sources of GHGs in cities are sometimes beyond local government control (e.g., power supply, vehicle technology standards). Establishing GHG inventories that reflect the carbon dependence of urban economies is more consistent with the multi-level governance approach that is required to reduce emissions from cities. Under this principle, cities would not, for example, exclude GHG emissions associated with visiting tourists nor emissions from industrial production of exported goods.

Appendix I: A Note on Scopes and Double-counting of Emissions

In adopting the WRI/WBCSD Greenhouse Gas Protocol for corporations, GHG emissions attributed to cities and local regions can be classified as follows:

Scope 1

GHG emissions that occur within the territorial boundary of the city or local region

Scope 2

Indirect emissions that occur outside of the city boundary as a result of activities that occur within the city, limited to only:

electricity consumption *
district heating, steam and cooling*

Scope 3

Other indirect emissions and embodied emissions that occur outside of the city boundary, as a result of activities of the city, including (but not limited to):

electrical transmission and distribution losses*
solid waste disposal*
waste incineration*
wastewater handling*
aviation*
marine*
embodied emissions upstream of power plants
embodied emissions in fuels
embodied emissions in imported construction materials
embodied emissions in imported water
embodied emissions in imported food

Double-counting

All scope 1, scope 2 and scope 3 emissions should be reported such that there is no double-counting in the GHG inventory of a single city.

Scope 2 and some scope 3 emissions (marked by *) should be reported such that no double-counting occurs *between* cities, or local regions. Where a city or local-region produces emissions from the export of electricity, heating, or cooling, or from the import of waste, these emissions should be subtracted from the city's total emissions. Other scope 3 emissions may involve double counting between cities; these are reported as information items (Table 4) and are not included in the city's total emissions.

Appendix II: Standard Tables for Reporting of GHG Emissions for Cities

The purpose of these tables is to provide a consistent ***reporting*** format for GHGs from cities and local regions. Procedures for calculating emissions can be found in the IPCC Guidelines. Further guidance is provided by ICLEI's *International Local Government GHG Emissions Analysis Protocol*, the European Commission's Sustainable Energy Action Plan Guidebook and other urban GHG inventory documentation that is consistent with IPCC Guidelines.

The tables report GHG emissions attributable to the community within the boundaries of a city or local region. Some cities also calculate emissions from local government operations, and may attach these as additional information.

The categories in the tables represent an ideal level of reporting for urban inventories. Where availability of data hinders the detailed reporting in some categories, then it is reasonable to combine categories together, e.g.: stationary combustion in residential, commercial and industrial sectors; or domestic and international aviation.

List of Tables

Table 1. Community Information

Name of city or local region	
Country	
Inventory year	
Reporting date	
Population (year round residents)	
Land area (sq. kilometers)	
Urbanized area (sq. kilometers)*	
Heating degree days (18°C base)*	
Building gross floor areas (m^2)* Residential Commercial / Institutional Industrial	
Name, status and address of reporter	
Name, status and address of third party verifier (if applicable)	
Other information, e.g., websites of fuller inventory report or emissions reduction program .	

* Optional reporting data that helps with interpretation of GHG sources.

Table 2. Greenhouse Gas Emissions by Sector

	SCOPE	CO_2	CH_4	N_2O	Other[i]	**TOTAL**
GWP		(1)	( )	( )		
Units		kt CO_2 e.	kt CO_2 e.	kt CO_2 e.	kt CO_2 e.	kt CO_2 e.
ENERGY						
a) Stationary Combustion						
Electricity (incl. T&D losses)[ii]	1,2,3[iii]					
District energy, CHP, and energy from waste[iv]	1,2,3					
Commercial & Institutional	1					
Residential	1					
Manufacturing Industries & Construction	1					
Other	1					
b) Mobile Combustion						
Road transportation: LDVs	1					
Road transportation: trucks	1					
Road transportation: other	1					
Railways	1					
Domestic aviation[v]	3					
International aviation[vi]	3					
Domestic marine[vii]	3					
International marine[viii]	3					
Other	1					
c) Fugitive Sources						
INDUSTRIAL PROCESSES	1					
AFOLU	1					
WASTE						
Solid waste disposal on land[ix]	1,3					
Wastewater handling[x]	1,3					
Waste incineration[xi]	1,3					
TOTAL						

Notes on Table 2

[i] Includes HFCs, PFCs, SF6s and potentially other GHGs; please specify

[ii] This category is for emissions from the generation of electricity consumed in the city, regardless of whether the generation occurs inside or outside of the city boundaries; it includes emissions associated with transmission and distribution losses, but excludes electricity generated by combined heat and power (CHP).

[iii] The only scope 3 emissions included here are those from the transmission and distribution losses associated with electricity consumed in the city. Other scope 3 emissions that are upstream of power generating facilities are not included here; these may be recorded in Table 4.

[iv] May include district energy systems or heat pipes for which emissions occur outside of the city boundaries.

[v] Aviation emissions may be determined from fuel loaded onto planes within the boundaries of the city. The method of Ramaswami et al. (Environ. Sci. Technol. 42, 6455-61, 2008) may be used to allocate emissions between different cities served by an airport..

[vi] See above. To follow the UNFCCC, international take-off and landing emissions may be included with domestic aviation emissions

[vii] Marine emissions may be determined from fuel loaded onto vessels within the boundaries of the city.

[viii] See above

[ix] This includes emissions from residential, commercial and industrial waste that are emitted inside or outside of the city boundaries.

[x] May include emissions from wastewater handling that occur outside of the city boundaries

[xi] Excludes emission from energy generation

Table 3 Greenhouse Gas Emissions by Fuel or Activity Type

	Activity Data			Emissions Factor[i, ii]			Total GHGs
	Value	**Units**	**Tier[iii]**	**Value**	**Units**	**Tier**	**t CO_2 e**
ENERGY							
Electricity (on-site renewable)[iv]		GWh	N/A	0	t CO_2 e / GWh	N/A	0
Electricity (grid)[v]		GWh			t CO_2 e / GWh		
Natural gas		TJ			t CO_2 e / TJ		
Fuel oil		TJ			t CO_2 e / TJ		
Coal		TJ			t CO_2 e / TJ		
Gasoline		TJ			t CO_2 e / TJ		
Diesel		TJ			t CO_2 e / TJ		
Jet Fuel		TJ			t CO_2 e / TJ		
Marine Fuel		TJ			t CO_2 e / TJ		
<add fuels as appropriate[vi]>		TJ			t CO_2 e / TJ		
INDUSTRIAL PROCESSES							
<add industrial products as appropriate>		kt			t CO_2 e / kt		
WASTE							
Solid waste disposal on land		kt			t CO_2 e / kt		
Wastewater handling		kt BOD			t CO_2 e / kt BOD		
Waste incineration		kt			t CO_2 e / kt		
AFOLU							
<add AFOLU activity data as appropriate>							

Notes on Table 3

[i] Where the emissions factor for a fuel depends on the application or sector, then the fuel may be entered multiple times in this table. For example the emissions factor for stationary combustion vary for energy industries, manufacturing industries, the commercial sector and the residential sector (see Tables 2.2 to 2.5 of Volume 2 of the 2006 IPCC Guidelines)

[ii] The calculation of emissions from combustion of some fuels may not be as straightforward as multiplying a single activity level by a single emissions factor. For example, with road transportation, emissions of CO_2 depend on the quantity of fuel consumed, while emissions of CH_4 and N_2O also depend on driving characteristics, vehicle type and emissions control technology. In such cases, a weighted averaged emission factor should be reported in the table.

[iii] The IPCC's Tiers (1, 2, or 3) provides an indication of the accuracy and complexity of approach used to determine activity levels or emissions factors. In some cases there may only be one Tier. When a city is unable to use an IPCC tier approach, e.g., due to lack of data, then any alternate method used should be recorded in a footnote to the table.

[iv] Electricity consumption from on-site renewable sources may be reported on this line (and excluded on the line below), or alternatively renewable sources may be incorporated into a local emissions factor for electricity, used in the line below. For further details on calculating local emissions factors for electricity see section 3.4.4 in Part II of the European Commission's Covenant of Mayors handbook.

[v] The emissions factor for electricity may be based on local, regional, state/province or national grids, or some weighted average of these, as appropriate to local conditions.

[vi] Other fuels such as CNG/LPG, biofuels, etc. should be added here where they are used in significant quantities. Emissions factors are available in the IPCC guidelines or national inventories.

CNG: Compressed Natural Gas

LPG: Liquefied Petroleum Gas

Table 4 Upstream (Embodied) Greenhouse Gas Emissions[i]

	Activity Data		Emissions Factor		Total GHGs
	Value	**Units**	**Value**	**Units**	**t CO_2 e.**
ENERGY					
Electricity (on-site renewable)		GWh		t CO_2 e / GWh	
Electricity (grid)		GWh		t CO_2 e / GWh	
Natural gas		TJ		t CO_2 e / TJ	
Fuel oil		TJ		t CO_2 e / TJ	
Coal		TJ		t CO_2 e / TJ	
Gasoline		TJ		t CO_2 e / TJ	
Diesel		TJ		t CO_2 e / TJ	
Jet Fuel		TJ		t CO_2 e / TJ	
Marine Fuel		TJ		t CO_2 e / TJ	
<add fuels as appropriate>		TJ		t CO_2 e / TJ	
WATER		ML		t CO_2 e/ ML	
BUILDING MATERIALS					
Cement		Kt		t CO_2 e / kt	
Steel		Kt		t CO_2 e / kt	
Bricks		Kt		t CO_2 e / kt	
<add building materials as appropriate>					
FOOD					
Cereals		Kt		t CO_2 e / kt	
Fruits		Kt		t CO_2 e / kt	
Meat		Kt		t CO_2 e / kt	
Seafood		Kt		t CO_2 e / kt	
Dairy		Kt		t CO_2 e / kt	
Other		Kt		t CO_2 e / kt	

Notes on Table 4

[i] While the use of physical units (e.g., TJ or kt) rather than monetary units is encouraged for this table, some of the emissions factors may be derived from Environmental Input Output (EIO) models. Multiregional EIO tables are available for many parts of the world, see for example: http://www.feem-project.net/exiopol/ and https://www.gtap.agecon.purdue.edu/databases/v7/default.asp. The source of emissions factors should be reported as a footnote to the table.