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The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) – A New Passage Point on an Old Road?

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A new passage point on an old road?

Retracing the roots of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) in emissions accounting methodologies – a genealogy

Felix Wilmsen and Friederike Gesing***

Abstract

Urban areas and cities have received growing recognition in transnational climate governance as crucial sites of emission sources, and as governmental and administrative actors with significant influence on carbon-intense infrastructures (Bulkeley & Betsill 2013; Schroeder et al. 2013). Since the late 1980s, greenhouse gas emission inventories have been conducted for cities and metropolitan regions as a means of developing reduction measures and monitoring their effects. Early approaches were characterized by great discrepancies between methodologies that were specifically designed for particular local needs. Subsequently, various transnational actors began to develop standardized tools by adapting existing methodologies developed for the national level and for corporations to the needs of cities and municipalities. So far, no municipal emission inventory protocol has been recognized as a globally agreed standard. The field received new momentum in 2014, when the two transnational city networks ICLEI and C40 Cities joined under the newly established Compact of Mayors initiative, and announced the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). This paper provides a genealogy of the GPC by comparing several municipal inventory protocols. The analysis suggest that if understood as a means of strengthening the political claims of transnational actors, the GPC can indeed be expected to have considerable impact on the global climate policy arena. However, despite its considerable effort, the protocol ultimately does not bring much new to the table in technical terms, as it does not solve known issues of geographic-plus emissions accounting. Therefore, the GPC is characterized as a new passage point on an old road.

Keywords: cities and climate change, emissions accounting, emissions reporting, non-state actors, transnational municipal networks, standardization, transnational climate governance

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Acronyms and abbreviations

ADEME	French Environment and Energy Management Agency
AFOLU	Agriculture, forestry and other land use
AR	Assessment Report
ASIF	Activity, Share, Intensity, Fuel model
BEI	Baseline Emission Inventory
BSI	British Standards Institution
CBF	Consumption-based footprints
cCR	carbonn Climate Registry
CCS	CO_2 Capture and Storage
CDP	Carbon Disclosure Project, now CDP
CE	Carbon equivalent
CEMS	Continuous Emissions Monitoring System
CEMR	Council of European Municipalities and Regions
CFC	Chlorofluorocarbon
CH_4	Methane
CHP	Combined Heat and Power
CIF	Transboundary Community-wide Infrastructure Footprint
CIFF	Children's Investment Fund Foundation
CO_2	Carbon dioxide
CO_2e	CO_2-equivalent
CoMO	Covenant of Mayors Office
COP	Conference of the Parties
DOC	Degradable organic carbon
ELCD	European Reference Life Cycle Database
EPIC	Etablissement Public à Caractère Industriel et Commercial (Industrial and Commercial Public Agency)
ESCI	Emerging and Sustainable Cities Initiative
ETS	Emissions Trading System
FLACMA	Latin American Federation of Cities, Municipalities and Municipal Associations
FOD	First Order Decay Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
GRIP	Greenhouse Gas Regional Inventory Project
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GWP	Global Warming Potential
HEAT(+)	Harmonized Emissions Analysis Tool (plus)
HFC	Hydrofluorocarbon
ICLEI	International Council for Environmental Initiatives, now Local Governments for Sustainability
IEA	International Energy Agency
IEAP	International Local Government Emissions Analysis Protocol
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use

ISO	International Organization for Standardization
LAMG	Local Authorities Major Group
LAREA	Local and Regional Energy Agency
LCA	Life Cycle Assessment/Analysis
LGCR	Local Government Climate Roadmap
LGMA	Local Government and Municipal Authority Constituency
LGO	Local Government Operation
MEI	Monitoring Emission Inventory
N_2O	Nitrous oxide
NAZCA	Non-state Actor Zone for Climate Action
NGO	Non-governmental organization
NF_3	Nitrogen trifluoride
OWG	Open Ended Working Group on Sustainable Development Goals
PEMS	Predictive Emissions Monitoring System
PFC	Perfluorocarbon
SDG	Sustainable Development Goal
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
SF_6	Sulfur hexafluoride
SF_5CF_3	Trifluoromethyl sulfur pentafluoride
T&D	Transmission and distribution
TMN	Transnational municipal networks
UCLG	United Cities and Local Governments
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-Habitat	United Nations Human Settlements Programme
UNISDR	United Nations Office for Disaster Risk Reduction
VKT	Vehicle kilometers travelled
WRI	World Resources Institute

1 Introduction

Urban areas and cities have received growing recognition in transnational climate governance as crucial sites of emission sources, and as governmental and administrative actors with significant influence on carbon-intense infrastructures (Bulkeley & Betsill 2013; Schroeder et al. 2013). According to Marcotullio et al. (2013), the urgency for urban climate policy is driven by "increasing concentration of population; growth of urban activities that produce greenhouse gas emissions […]; and the long lasting legacy of urban investment decisions" (Marcotullio et al. 2013: 622).

Since the late 1980s, greenhouse gas (GHG) emissions from urban areas have been counted and reported in order to develop reduction measures and to inform local climate policies (Kennedy et al. 2011: 24). While critics from the social science argue that this focus on quantifiable emission reductions is only one possible way of urban climate action (Hoffmann 2011; Bulkeley & Broto 2013), that the capacity of cities to deliver mitigation outcomes needs to take their multifaceted roles in multilevel governance structures into account (Bulkeley & Betsill 2013), and that there remains a lack of evidence that such actions contribute significantly to the reduction of global GHG emissions (Bansard et al. 2016), urban emissions accounting is attracting increasing attention.

As defined by Bader and Bleischwitz (2009), the basic function of emission inventories and their underlying methodologies is to provide a comprehensive overview of the emissions in total and by sector (Bader & Bleischwitz 2009: 13). Most importantly, "[t]he inventory never aims to be an end in itself but rather a tool for emission monitoring and a basis for developing carbon reduction strategies, implement action plans and guarantee GHG emission reductions" (Bader & Bleischwitz 2009: 29). However, as pointed out by Dhakal (2010), knowledge of urban GHG emissions is still sparse and total emissions differ significantly between urban areas. This makes it difficult to devise criteria to compare the performance of cities in terms of total and per capita emissions and emissions reductions (Dhakal 2010: 278). The use of different methodologies for accounting urban emissions leads to great discrepancies when aggregated at the global scale. This makes it even more difficult to estimate the contribution of emissions from urban areas to the global total.

According to the International Energy Agency (IEA), cities were responsible for 71% of total energy-related CO2 in 2006 (IEA 2008). Marcotullio et al. estimate a global total of energy-related GHG emissions from urban areas of 41.5% to 66.3%, using a top-down approach (Marcotullio et al. 2013: 632). As a consequence of the variations in estimates at the global scale as well as in total and per capita emissions from cities, both local authorities and academia have been calling for a standardization of urban emissions accounting. Ideally, such a global standard should provide global comparability between urban inventories in accordance with the requirements of the United Nations Framework Convention on Climate Change (UNFCCC) for national GHG greenhouse gas emission inventories (Bader & Bleischwitz 2009: 4, 28f; Kennedy et al. 2011: 48; Dhakal 2010: 279; Marcotullio et al. 2013: 631).

The first global effort of this kind was the International Local Government Greenhouse Gas Emission Analysis Protocol (IEAP) developed by ICLEI (see Box 1), a transnational network of local governments advocating for climate actions at the municipal scale, in 2009.[1] In the following years, several protocols resulted from the collaborative efforts of international organizations and initiatives such as the World Bank, UNEP, UN-Habitat, and the Covenant of Mayors. However, none of the protocols published so far has emerged as a globally agreed standard.

This debate received new momentum in 2014, when a new player was introduced to the field: the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) – a joint effort by the transnational networks United Cities and Local Governments (UCLG), ICLEI and C40 Cities, and primarily developed by the World Resources Institute (WRI). The GPC is being advertised as "the most comprehensive greenhouse gas […] accounting and reporting framework for cities around the globe" (ICLEI 2015b: 3) by its proponents. This paper asks what the GPC can contribute to the field of municipal emissions accounting. It develops a genealogy of the GPC and discusses possible implications of the attempt to further standardize urban emissions accounting on the field of transnational climate governance.

2 From the national to the corporate to the municipal – basic inventory concepts and their roots

Most methodologies for standardized emission inventories can be traced back to the efforts of the International Panel on Climate Change (IPCC) to streamline emissions accounting and reporting. With its Guidelines for National Greenhouse Gas Inventories, the IPCC provides an internationally agreed standard for national emissions accounting and reporting under the UNFCCC (IPCC 1994; 1996; 2006). These guidelines informed all municipal inventory protocols covered in this paper, including the GPC.

A second source of inspiration for municipal inventories came from the wide range of methodologies designed for accounting corporate GHG emissions and removals in the private sector, developed to demonstrate private sector self-commitments, including emissions reporting via platforms such as the former Carbon Disclosure project, now CDP (see Box 2). One such initiative is the Greenhouse Gas Protocol and the associated Corporate Accounting and Reporting Standard, developed by the World Resources Institute (WRI), a US non-profit think-tank, and the World Business Council for Sustainable Development (WBCSD), advocating for sustainability efforts and green growth in the corporate sector. The protocol, first published in 2001 and revised in 2004, adapts the IPCC's basic quantification methods and reporting requirements to the particular needs of private corporations. It has been influential especially due to the introduction of a unique framework of emissions "Scopes" that allow to estimate direct and indirect GHG emissions separately while avoiding double-counting of emissions from different companies.

In hindsight, the introduction of the Scopes framework can be seen as key to bridging the gap between the national and the local level. Municipal communities and local governments have more

[1] To avoid ambiguities, the term "municipal" will be used to include cities and the surrounding areas under the jurisdiction of the local authority. Deviations from this rule will be indicated if necessary. Some inventory protocols reviewed in this paper, such as the IEAP, apply separate accounting for emissions from Local Government Operations (LGO) and those from activities of the community. In such cases, it will be referred to these separate inventories as LGO inventories and community-inventories. The municipal inventory would in this case be the total of both.

in common with corporations than with nation states in terms of their operations (ICLEI 2009: 7). The Scopes framework allowed for the development of methodologies exclusively for the municipal scale without letting go of the basic inventory principles set out in the IPCC Guidelines for national accounting.

This section provides a more detailed account of the IPCC Guidelines, the Greenhouse Gas Protocol Corporate Standard, and their respective key concepts and features. Drawing from this, it offers an overview of basic emission quantification methods and approaches.

2.1 The IPCC Guidelines for National Greenhouse Gas Inventories

The IPCC Guidelines provide "methodologies for estimating national inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases" (IPCC 2006a: 4). Emissions and removals are estimated within the national territory and offshore areas under a country's jurisdiction and for the calendar year during which they occur. Such inventories comprise a set of standard reporting tables for gases included, emission sources, categories, and years, supplemented by a documentation of methods and data sources used (IPCC 2006b: 1.4).

Generally, emissions are estimated by combining data on the extent of human activities, called activity data (AD), with the quantified emissions or removals per activity unit, called **emission factors** (EF) (IPCC 2006b: 1.6):

$$emissions = AD \cdot EF$$

However, some situations do not allow for the application of this concept. One example is the decomposing of waste (IPCC 2006b: 1.6). Unlike emissions from the combustion of fuel in a car engine that occur almost immediately *during* the use of the vehicle, emissions from waste are released over a certain period of time *after* the initial disposal. In the first example, emissions are estimated by multiplying the amount of fuel used (activity data) with the potential emissions occurring from combustion of the particular fuel used (emission factor). In the second example, the time-lag resulting from the decomposing process makes this impossible and calls for an alternative accounting method, such as the mass balance method (see 1.3).

In the IPCC Guidelines, emissions are estimated within **five sectors**, further divided into sub-sectors, categories and sub-categories. For example, the Energy sector is sub-divided into the sub-sectors of fuel combustion activities, fugitive emissions from fuels, and carbon dioxide transport and storage. Within these sub-sectors, fuel combustion activities include the following categories: energy industries, manufacturing industries and construction, transport, other sectors, and non-specific. The transport category, for example, is then further divided into the sub-categories of civil aviation, road transportation, railways, water-borne navigation, and other transportation (IPCC 2006a: 6).

The **Energy sector** includes emissions from the exploration and exploitation of primary energy sources, the conversion of primary energy sources in refineries and power plants, the transmission and distribution of fuels, and the use of fuels in stationary and mobile applications. Emissions from these activities are released during combustion and as fugitive emissions that escape without combustion (IPCC 2006c: 1.5). Emissions and removals from CO_2 capture and storage (CCS) are covered here as well (IPCC 2006c: 1.11).

Included in the **Industrial Processes and Product Use (IPPU) sector** are emissions from industrial processes, e.g., emissions from the chemical or physical transformation of materials, from the use of GHGs in products (such as in refrigerators, foams or aerosol cans), and emissions from non-energy uses of fossil fuels (IPCC 2006d: 1.5).

The **Agriculture, Forestry and Other Land Use (AFOLU) sector** includes emissions and removals occurring on "managed land" (IPCC 2006e: 1.5), which is defined as land "where human interventions and practices have been applied to perform production, ecological or social functions" [2] (IPCC 2006e: 1.5). In practice, AFOLU emissions and removals cover carbon stock changes in biomass, dead organic matter, mineral soils, and harvested wood products, as well as emissions and removals from fire, liming and urea application, rice cultivation and cultivated organic soils, managed wetlands and flooded land, livestock, and manure management systems (IPCC 2006e: 1.5).

The **Waste sector** covers emissions from solid waste disposal, biological treatment of solid waste, incineration and open burning of waste, and wastewater treatment and discharge, including septic tanks and latrines and the discharge of wastewater into waterways (IPCC 2006f: 1.4f).

Lastly, very specific cases, such as indirect emissions from nitrogen deposition from non-agriculture sources, are included in the **Other sector** (IPCC 2006b: 1.5).

The IPCC Guidelines provide complete coverage of "all greenhouse gases not covered by the Montreal Protocol, for which the IPCC, at the time of writing, provided a global warming potential" (IPCC 2006b: 1.5). This includes the following compounds: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3), trifluoromethyl sulphur pentafluoride (SF_5CF_3), halogenated ethers (e.g., $C_4F_9OC_2H_5$, $CHF_2OCF_2OC_2F_4OCHF_2$, and $CHF_2OCF_2OCHF_2$), and other halocarbons not regulated under the Montreal Protocol, such as CF_3I, CH_2Br_2, $CHCl_3$, CH_3Cl and CH_2Cl_2 (IPCC 2006b: 1.5).

The methodologies set out in the IPCC Guidelines require emission inventories to be compiled from the **sub-category** level. Emissions and removals are then summed up for each gas to calculate a national total. Fuel use in international transport, such as aviation and marine transport, is reported separately (IPCC 2006b: 1.5). Within emission sectors and categories, **key categories** of emission sources and sinks with significant influence on absolute emissions and removals covered are identified for the inventory (IPCC 2006b: 1.6).

Three **levels of data precision** and methodological complexity are distinguished, called "**Tiers**". Tier 1 methods allow the use of easily accessible national and international statistics, such as national or international averages, combined with default emission factors (IPCC 2006b: 1.6). They come at the cost of large uncertainties. Tier 2 methods demand country- or region-specific emission factors, such as locally specific factors for each GHG compound, and disaggregated activity data and are therefore more reliable. Tier 3 demands high-resolution data, e.g., activity data that is directly metered, and provides the lowest degree of uncertainty (Srivastava n.d.: 20).

Tier methods are selected according to the particular situation of the country, reflected by the key categories identified. Decision trees for each category help selecting the appropriate Tier, whereas "[i]n general, it is good practice to use higher Tier methods for key categories, unless the resource

[2] Emissions from unmanaged land can be included in the inventory on an optional basis.

requirements to do so are prohibitive" (IPCC 2006b: 1.6). As will be shown below, the Tier concept is used in most corporate and municipal inventories as well.

The concept of good practice can be understood as a general principle by which the inventorying process should be guided. The estimates on which the inventory is based should be as precise as possible, avoiding over- and under-estimates. Also, uncertainties should be reduced where practical (IPCC 2006b: 1.6), and the IPCC Guidelines dedicate an entire chapter to uncertainty assessment and quality assurance and control and verification, respectively (IPCC 2006b: 1.8, 3.1ff, 6.3ff).

The IPCC Guidelines define **five accounting principles**. *Transparency* requires "sufficient and clear documentation such that individuals or groups other than the inventory compilers can understand how the inventory was compiled and can assure themselves it meets the good practice requirements for national greenhouse gas emissions inventories" (IPCC 2006b: 1.7). Under the principle of *completeness*, elements missing from the inventory should be documented and their exclusion should be justified (IPPC 2006b: 1.8). *Consistency* requires that if possible, emissions should be calculated with the same method and data sources each year to reflect real annual fluctuations and not methodological differences (IPCC 2006b: 1.8). Furthermore, inventories are required to be *comparable* to inventories of other countries and *accuracy* of estimates should be pursued. Once completed, the inventory is reported to the UNFCCC in a way that enables users to understand the data and methods used, including additional background information, e.g., on the country's particular circumstances (IPCC 2006b: 1.10).

2.2 The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard

The Corporate Standard is the result of an NGO-business partnership between WRI and WBCSD to develop a standardized methodology for emission inventories for corporations. With over 1000 businesses and organizations that have developed emission inventories using the Corporate Standard (Greenhouse Gas Protocol 2016), the protocol has "arguably become the best practice for reporting GHGs by corporations (and other institutions)" (Kennedy et al. 2011: 26). It adapts the basic methodology set out in the IPCC Guidelines to the corporate sector.[3] As will become clear in the following sections of this paper, the Corporate Standard together with the IPCC Guidelines is at the core of most municipal emission inventory methodologies.

However, in contrast to the IPCC Guidelines, the Corporate Standard only requires the quantification and reporting of the GHGs considered the most important under the Kyoto Protocol (Bader & Bleischwitz 2009: 8). This so-called "Kyoto basket" (Kennedy et al. 2011: 29) includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) (WBCSD & WRI 2004: 3).

The protocol first introduced the concept of emissions **Scopes** which enables companies to distinguish between emissions under their direct control and emissions from broader company

[3] As pointed out in the protocol, "it applies equally to other types of organizations with operations that give rise to GHG emissions, e.g. NGOs, government agencies, and universities" (WBCSD & WRI 2004: 3). This statement is reflected in the influence the Corporate Standard had on the development of inventory protocols specifically for local government operations, such as the IEAP.

activities (Kennedy et al. 2011: 27). The framework defines three Scopes that each resemble an operational boundary within which emissions are quantified for certain sets of company operations to avoid double-counting. It is fully compatible with the IPCC Guidelines.

Scope 1 covers direct greenhouse gas emissions from company-owned or controlled sources, including emissions from power generation, production, and transportation. Also included are fugitive emissions from intentional or unintentional releases, such as leaks, and emissions associated with the sale of electricity to another company (WBCSD & WRI 2004: 27). Direct CO_2 emissions from the combustion of biomass are reported separately. The same applies for GHGs not covered under the Kyoto Protocol.

Scope 2 includes indirect emissions from the generation of electricity imported into the organizational boundary for consumption by a company (WBCSD & WRI 2004: 25, 27).

Scope 3 emissions "are a consequence of the activities of the company, but occur from sources not owned or controlled by the company" (WBCSD & WRI 2004: 25). Their inclusion is optional and requires companies to have reliable information on activities of particular relevance to their business (WBCSD & WRI 2004: 29). This may include emissions from the extraction and production of materials and fuels acquired by the company, further transport-related activities, electricity-related activities not included in Scope 2, leased assets, franchises, and outsourced activities, or the use of products and services sold by the company, as well as waste disposal (WBCSD & WRI 2004: 29). Explicitly, this does not require a full life-cycle assessment (WBCSD & WRI 2004: 30; see 1.4). Scope 3 is of particular interest when emissions are to be quantified that occur upstream of the point of use by the company.

At a minimum, the protocol requires companies to separately account for Scopes 1 and 2 (WBCSD & WRI 2004: 25). However, a company's operational boundaries cannot be set unless the general extent of the inventory is defined by an **organizational boundary**. The organizational boundary can be understood as the border of the entity for which the inventory is compiled. It encloses the operational boundaries that are defined by the Scopes framework. Ultimately, it defines which operations are seen as associated with the company and can therefore be included into and categorized under the Scopes framework. As a consequence, emissions from operations that are not included in the organizational boundary are excluded from the inventory (WBCSD & WRI 2004: 17). To set the organizational boundary, the protocol allows to choose from two approaches.

Under the **equity share approach**, "a company accounts for GHG emissions from operations according to its share of equity in the operation" (WBCSD & WRI 2004: 17). Rewards are usually aligned with a company's ownership percentage in a particular operation, and an equity share approach means that the emissions will be distributed accordingly as well (WBCSD & WRI 2004: 17). Under the **control approach**, a company accounts for all GHG emissions from operations over which it has operational or financial control, but not for emissions from operations in which it only owns an interest but has no control (WBCSD & WRI 2004: 17).

Although the Corporate Standard provides a methodology for the accounting and reporting of a company's GHG emissions and claims to provide verifiable results, "it does not provide a standard for how the verification process should be conducted" (WBCSD & WRI 2004: 17). Consequently, inventories are not reported to the WRI or WBCSD. However, the Corporate Standard is used by the

CDP, a popular reporting platform for corporations and cities (Greenhouse Gas Protocol 2016; see Box 2).

In 2006, the standardization process initiated by WRI and WBCSD was pushed forward by the International Organization for Standardization (ISO) that incorporated the Scopes framework and several other key components of the Corporate Standard's methodology in its ISO 14064 range of specifications for the quantification and reporting of GHG emissions and removals at the organizational and project level (ABC 2010: 78ff; Bader & Bleischwitz 2009: 7). A memorandum of understanding was signed between ISO, WBCSD and WRI in 2007 with the aim to "jointly promote both global standards" (Greenhouse Gas Protocol 2016).

2.3 Emission quantification methods

According to Bader and Bleischwitz, the emission factor based method, as outlined in the IPCC Guidelines, is the most common method to estimate emissions from large entities. It can also be applied at the smaller scale of companies and other entities (Bader & Bleischwitz 2009: 12). Key to achieving reliable measurements is the accuracy of the emission factors. To guarantee such accuracy with respect to differing operation conditions across countries and sites it may be necessary to calculate site-specific or local emission factors, if possible (Bader & Bleischwitz 2009: 12).

Despite the emission factor based method being the most popular in the field of municipal emissions accounting, there are other methods that can be applied in particular situations, including the **mass balance method** that "follow[s] the mass flow of an element […] through a process" (Bader & Bleischwitz 2009: 12). Here, the input equals the output plus emissions. This requires the input and output streams as well as the chemical reactions of a process to be known (Bader & Bleischwitz 2009: 12). As mentioned before, this method is often chosen where emission factors and activity data cannot guarantee reliable outcomes, such as for time-lags in the decomposition of solid waste.

A **predictive emissions monitoring system** (PEMS) is based on both direct measurements and calculations. To calculate the amount of emissions resulting from a given process, it is first tested for the correlation between the parameters of the particular process and the unit in question. The correlation identified then serves as input data for the mathematical model calculating the amount of emissions (Bader & Bleischwitz 2009: 12). On the contrary, the **continuous emissions monitoring system** (CEMS) is based exclusively on direct measurements of emissions and therefore collects more accurate real-time data (Bader & Bleischwitz 2009: 12).

Bader and Bleischwitz recommend the emission factor or mass balance method for programs that deal with a great number of gases and emission sources. The first-mentioned also contributes to quality control as it allows results to be double-checked. It is also the most cost-efficient method. The most accurate data, however, are provided by the CEMS, which is also the costliest method (Bader & Bleischwitz 2009: 12f).

Besides these general quantification methods, there exists a variety of techniques for the calculation of **emissions from solid waste** due to the fact that emissions from landfills occur over time scales beyond a single year (Kennedy et al. 2011). According to Kennedy et al., commonly applied techniques include downscaling from national inventories, measurement from waste in place, a total yields gas approach, and the IPCC's first order decay (FOD) model. The latter is standard for national inventories and assumes that the rate of CH_4 emissions from decay is related to the amount of carbon remaining in the waste (IPCC 2006f: 3.6). Based on knowledge of the total amount of decomposing material currently on site, the model estimates the methane emissions, using an exponential function starting in the year after the first waste deposition (IPCC 2006f: 3.8f).

For the quantification of **emissions from road transportation**, the IPCC Guidelines and many municipal inventory methodologies based on them apply two different approaches. For CO_2 emissions alone, the quantification of **fuel sales records** is the most accurate and therefore the preferred approach. For CH_4 and N_2O emissions, the quantification from vehicle kilometers travelled (VKT) is often preferred, which depend on the age and technology of vehicles and the number of cold starts (Kennedy et al. 2011: 31).

Normally, GHG emissions are converted to CO_2 equivalents (CO_2e) to make them comparable. The conversion is based on the **global warming potential** (GWP) of each gas when compared to the same mass of CO_2 over a given time period, depending on the radiative forcing of a ton of the particular gas (Bader & Bleischwitz 2009: 9; IPCC 2006b: 1.5). As the time period gases remain in the atmosphere varies for each gas, it is crucial for an emission inventory to provide information on the time horizon chosen for the calculation of the GWP. Bader and Bleischwitz illustrate the effects as follows:

> „Methane for instance has on average a shorter lifetime in the atmosphere than CO_2. If the calculation of the global warming potential of methane is based on the second assessment report and a time horizon of 20 years, methane has a global warming potential of 56 (= 56 times greater than CO_2). A time horizon of 100 years yields a global warming potential of 21 and a time horizon of 500 years a global warming potential of 6,5 […].“ (Bader & Bleischwitz 2009: 9)

The most common time horizon used are 100 years, which is expressed as GWP_{100}. Since GWPs are provided in the IPCC's assessment reports (ARs) which have been updated over the years, the AR referred to has to be indicated (Bader & Bleischwitz 2009: 9).

Some inventory methodologies limit the number of compounds included by the "de minimis" rule which allows to exclude emission sources or gases if their amount of CO_2e emissions is negligible for the total inventory.

2.4 Municipal emission accounting: General approaches

Ramaswami et al. (2011) put forward a categorization of three general approaches of emissions accounting. **Purely geographic production-based GHG accounting** "tracks all GHGs emitted within the boundary of an entity and relates these to productivity metrics (e.g., GHG/GDP)" (Ramaswami et al. 2011: 4205). This is the predominant approach for GHG emissions accounting at the national scale, where the required geographic boundary is normally defined following the IPCC Guidelines as "national territory and offshore areas over which the country has jurisdiction" (IPCC 2006b: 1.4). As Chavez and Ramaswami argue, national accounting in the IPCC sense is, ultimately, territorial accounting and – due to the inclusion of final household consumption of fuel – goes beyond a pure production-based approach (Chavez & Ramaswami 2013: 376).

Although such strict territorial accounting has been established as an internationally agreed concept for national emissions accounting, its pitfalls become clear when it is adapted to the smaller spatial scale of cities, as was the case in the absence of suitable methodologies for municipal emission inventories, especially in the early 2000s (Chavez & Ramaswami 2013: 376). One main criticism is related to infrastructure which “provide key goods and services to cities [but] are artificially truncated at the city’s geographic boundary” (Chavez & Ramaswami 2013: 376f).

As pointed out by Dhakal (2010), embedded emissions in goods and services are likely to exceed total urban carbon flows, but cannot be estimated based on a purely geographic production-based approach (Dhakal 2010: 279). This also holds true for the national context where emissions embodied in imports and exports are not added to or subtracted from the emissions total, resulting in a misrepresentation of an individual’s global impact when expressed per capita (Ramaswami et al. 2011: 4205).

Geographic-plus infrastructure supply chain GHG footprints and related approaches can be seen as the result of city administrations’ and academia’s struggles in dealing with these issues. Adapting the methodologies set out in the IPCC Guidelines and especially those in the Corporate Standard to account for emissions from a company’s transboundary supply chains helps overcoming the limitations of territorial accounting (Ramaswami et al. 2011: 4205). The role of the Corporate Standard in this development is captured well in Kennedy et al.’s often quoted study on the construction of “GHG Emission Baselines for Global Cities and Metropolitan Regions” (2011). The introduction of the Scopes framework to the urban context finally provided cities with a methodology that allowed for the concurrent but discrete accounting for both in- and transboundary emissions, thereby making the geographic-plus approach compatible with both corporate and national inventories (Ramaswami et al. 2011: 4205f). A very common adaptation of the Scopes framework for cities can be derived from the GPC:

> „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 place within the city boundary“ (WRI et al. 2014: 11)

In their comparison of municipal inventory methodologies, Kennedy et al. stress the benefits of a complete inclusion of Scopes 1 to 3 to provide for greater consistency between municipal and national inventories in terms of per capita emissions. It allows to paint a more coherent picture of emission sources and dependencies, which can inform the development of potential reduction measures, and avoids “unintended credit being given to policies that may merely shift emissions ‘out of boundary’” (Kennedy et al. 2011: 39). Ultimately, it is possible to account of all three Scopes at the municipal scale, the authors argue (Kennedy et al. 2011: 40).

Despite general debates whether it is necessary to include Scope 3 emissions in full or at all, the geographic-plus approach does indeed address many issues related to transboundary and embedded emissions. However, it still builds on a production-based methodology which does not recognize emissions from consumption, and thus underestimates emissions of high consumption and service-oriented cities and neglects the effects of offshoring. This way, Dodman (2009) argues, „the responsibility of successful production-oriented centers (such as Beijing and Shanghai) is exaggerated, while that of wealthy service-oriented cities (including many cities in North America and Europe) is underemphasized (Dodman 2009: 195).

Pure consumption-based accounting, in contrast, marks the other end of the spectrum. Sometimes also referred to as consumption-based footprints (CBF), these approaches allocate the ecological impacts of economic processes solely to the consumer side, often following an ecological footprint methodology (Chavez & Ramaswami 2013; Dodman 2009: 195). By incorporating trade between cities, including international trade, such inventories provide the most complete estimates of GHG emissions per capita (Ramaswami et al. 2011: 4206). Emissions are represented by household expenditures, government expenditures, and business capital investments (Chavez & Ramaswami 2013: 376). Ramaswami et al. (2011) emphasize the advantages of municipal and community GHG emission inventories that allocate trade of all goods and services across cities to “economic final demand consumption” (Ramaswami et al. 2011: 4206). They argue that this way, “the unique characteristics of communities that makes [sic] some develop into resort towns and others into industrial cities, is ‘evened out’” (Ramaswami et al. 2011: 4206). Unlike production-based approaches, consumption-based accounting goes beyond infrastructure and across geographic boundaries, thereby eliminating issues of transboundary emissions accounting (Chavez & Ramaswami 2013: 378), e.g., “commercial energy-use in an office building or in a resort is allocated not to the city where these facilities are located but to households in other cities that purchase and consume these services” (Ramaswami et al. 2011: 4206).

Some authors see a potential to redirect household and government spending toward less emission intensive sectors or regions, at least in theory, given that these actors are empowered to make purchasing decisions based on information about the global impact of their consumption (Dodman 2009: 196; Ramaswami et al. 2011: 4206; see also Dhakal 2010: 280). In general, the calculation of emissions of low- and middle-income countries results in lower numbers if compared to a production-based approach, whereas urban emission estimates yield higher numbers, especially for service-oriented cities in the Global North (Dodman 2009: 195f). Dhakal (2010: 279) estimates the CO_2 emissions of the City of London applying a consumption-based approach at twice the amount of a production-based approach (90 $MtCO_2$ compared to 44 $MtCO_2$).

However, despite its many advantages, consumption-based accounting is not without flaws and problems. Ramaswami et al. note that relevant data, such as input-output tables below the national scale, are often scarce or unavailable. Furthermore, financial flows do not necessarily correspond to the physical flows of material and energy, and lastly, “local commercial-industrial production exported elsewhere is no longer allocated to the local community, even though these activities generate local jobs and can be shaped by local governments to reduce GHG emissions” (Ramaswami et al. 2011: 4206). Chavez and Ramaswami add that due to the focus on final demand consumption, “local businesses and industries that serve visitors or produce goods and services for export are allocated out, and excluded from the city’s CBF” (Chavez & Ramaswami 2013: 378).

Balancing the greater degree of uncertainty of consumption-based accounting and its relevance for mitigation policies, some authors argue for an integrated approach in which production-based inventories are complemented by consumption-based indicators (Dodman 2009: 196; Kennedy et al. 2011: 50; Ibrahim et al. 2011: 226). One such integrated concept is the transboundary community-wide infrastructure footprint (CIF) proposed by Chavez and Ramaswami. The CIF is aimed at “reporting direct community-wide energy use and GHGs within city boundaries plus transboundary life-cycle GHG emissions associated with essential infrastructures serving the community as a whole” (Chavez & Ramaswami 2013: 378).

By extensively incorporating Scope 3 emissions as implied by its supply chain focus, the concept takes an intermediate position between pure production-based and consumption-based accounting. Chavez and Ramaswami define infrastructures as essential "when community productivity (Gross Domestic Product (GDP)) is highly correlated with community-wide use of that infrastructure, while the production/export of these services is patchy/sparse across multiple cities and hence poorly correlated with city-GDP" (Chavez & Ramaswami 2013: 378). It is notable that the food sector is included here as "another form of energy required to be productive" (Chavez & Ramaswami 2013: 378). This effectively bridges the gap between consumption-based and production-based accounting. Chavez and Ramaswami expect the CIF to result in a larger footprint for high-production communities and a lower footprint for high-consumption communities when directly compared to a pure consumption-based approach (Chavez & Ramaswami 2013: 382).

Bader and Bleischwitz (2009: 11) provide an alternative categorization of approaches to emissions accounting, which differentiates between energy end-use approaches, source approaches, and life cycle assessment/analysis approaches. Energy end-use approaches account for the energy use of final consumers, and exclude losses and emissions from refining, transport and energy conversion. The limited scope of these approaches makes them less data demanding, but provides only a rough representation of the climate impact. Source approaches allocate emissions to the territory where they occur, comparable to the geographic-plus methodology. Life cycle assessment/analysis approaches (LCA) aim to account for the total environmental impact of products, including emissions and material input from production. These approaches give the most accurate representation of the emissions of a territory but are highly demanding in terms of the necessary data, which can make them impractical or at least very time-consuming at the local level. Principally, these approaches consider both the production and consumption of goods and services, but are not exclusively based on these two approaches as they also include end-of-life emissions and emissions from unfinished products.

3 Municipal emission inventories: a classification

This section discusses five protocols for municipal emission inventories. Their selection is guided by Ibrahim et al. (2012), who define global inventory protocols as "frameworks, methods, or software that have been […] used to determine GHGs for cities or urban regions in more than 10 countries" (Ibrahim et al. 2012: 229). This analysis builds on their work and a similar study by Bader and Bleischwitz (2009). It includes the International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP) developed by ICLEI, the International Standard for Determining Greenhouse Gas Emissions for Cities by the World Bank, UNEP and UN-Habitat, the Covenant of Mayors' Baseline Emission Inventory (BEI) and Monitoring Emission Inventory (MEI) Guidelines, and Bilan Carbon, a methodology designed by the Agence de l'environnement et de la maîtrise de l'énergie (ADEME) specifically for French cities, and finally the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC).

In regard to their technical specifications, three types of emissions accounting schemes can be identified. The first one includes protocols that follow a mostly production-based geographic-plus approach, are closely tied to the IPCC Guidelines, and apply a Scopes framework that is either identical to or represents only a slight modification of the framework introduced in the Corporate

Standard, thereby providing a high degree of standardization. The IEAP and the International Standard can be allocated to this category of **conventional protocols (2.1).**

The second category includes the BEI/MEI, a protocol that, although oriented towards the IPCC Guidelines and limited to energy consumption, still provides the greatest degree of flexibility and free choice. The BEI/MEI can be seen as an example of an **open protocol (2.2)** that is designed to cover a variety of possible users, thereby sacrificing a high degree of standardization.

The third category includes Bilan Carbone as an example of an extremely **specialized protocol (2.3)** designed for a particular group of users in a certain context. Bilan Carbone applies a unique Life Cycle Analyis (LCA) often referred to in academic studies, and offers an unusual view on municipal GHG emissions when compared to the aforementioned protocols, most of which apply a geographic-plus approach. What makes Bilan Carbone stand out among the other protocols is its unique combination of specialization, openness and flexibility, while at the same time providing the most complete emission inventory, plus a considerable degree of standardization within its particular context.

In the following sections (2.1-2.4), the four inventorying methods predating the GPC and the GPC itself will be analyzed in relation to criteria partly adapted from Dhakal (2010), including accounting methods and boundaries concept, application of the Scopes framework, quantification method and data precision levels, and provision for verification and reporting. An overview, including additional information on tools, GWP calculation and compounds included, is provided in Table 1. Section 2.5 will discuss how the GPC can be included into this characterization, and give a general assessment of the way forward in municipal emissions accounting.

	International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP) Version 1.0 (2009)	The International Standard for Determining Greenhouse Gas Emissions for Cities (Int. Standard) Draft 2.1 (2010)	Baseline Emission Inventory and Monitoring Emission Inventory Guidelines (BEI/MEI) Version 1.0 (2010)	Bilan Carbone Version 6.1 (2010)	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) 2014
Initiator(s)	ICLEI	UNEP, UN-Habitat, World Bank	Covenant of Mayors, Joint Research Centre (JRC), European Commission, Climate Alliance	Agence de l'environnement et de la maîtrise de l'énergie (ADEME)	WRI, ICLEI, C40
Users	ICLEI, cCR, CDP, Covenant of Mayors	cCR, CDP, World Bank	Covenant of Mayors, cCR, Climate Alliance	City of Paris & other French cities	ICLEI, C40, Compact of Mayors, cCR, CDP
Accounting approach	geographic-plus	geographic-plus	consumption-based or LCA, geographic-plus for production-side accounting	LCA	geographic-plus
Boundaries	organizational & geopolitical; separate analyses for LGOs & community activities	geopolitical	geopolitical	organizational & geopolitical	(organizational) & geopolitical
Scopes	1-2(-3), Scopes recognized	1-2-3, Scopes recognized	1-2 equivalent, but Scopes <u>not</u> recognized	1-2-3 equivalent, but Scopes <u>not</u> recognized	1-2-3, Scopes recognized, alternative city-induced framework (BASIC and BASIC+)
Quantification method	emission factor based	emission factor based	emission factor based	emission factor based	emission factor based
Data precision levels	IPCC Tiers recommended	IPCC Tiers or others, have to be reported	free to choose (IPCC Tiers or others)	undefined	3 levels: high, medium or low
Reporting requirements & verification	separate reporting of energy emissions from LGO and community activities, acc. to IEAP Global Reporting standards	activity data & emission factors, data precision, energy emissions acc. to IPCC	activity data & emission factors, energy emissions acc. to alternate sub-sectors, LGOs	unclear	inventory boundary, emissions by sector, Scope, gas & total, emissions from biogenic origin, methodologies, data precision, emission changes
Compounds	6 Kyoto gases at minimum, exceptions according to de minimis rule	CO_2, CH_4 & N_2O recommended at minimum, others can be included if relevant	focus on CO_2, other compounds optionally included if reductions	6 Kyoto gases, CFC regulated under Montreal Protocol + stratospheric water vapor from planes	6 Kyoto gases & nitrogen triflouride (NF_3)

			addressed in SEAP/SECAP		
Global Warming Potential & CO_2e	metric tons of CO_2e, GWP_{100} from 2nd IPCC AR	metric tons of CO_2e, GWP_{100} from latest IPCC AR	metric tons of carbon content or CO_2e, GWP_{100} from 2nd IPCC AR depending on the chosen tool	CO_2e & CE in metric tons, GWP_{100} from 4th IPCC AR	metric tons of CO_2e, GWP_{100} from 2nd IPCC AR
Tool	HEAT/HEAT+	no tool provided methodological foundation to build compliant tools in accordance with IPCC Guidelines	no tool provided free to choose any tool that meets its methodological and reporting requirements	proprietary tools for each module extensive data sets of emission factors, qualification course by ADEME required	HEAT+

Tab. 1: Overview of municipal emission inventory protocols compiled by authors, according to Bertoldi et al. (2010); ICLEI (2009; 2015a); UNEP et al. (2010); Covenant of Mayors (2010); ABC (2010); WRI et al. (2014), applying criteria developed by Dhakal (2010)

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3.1 Conventional protocols

3.1.1 The International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP)

The IEAP, published by the ICLEI city network in 2009, was designed to provide globally applicable guidelines for local governments to account for GHG emissions from both their own internal operations and the community. However, its community section has now been superseded by the GPC, which makes it especially relevant for a closer look at the roots of the new protocol. The IEAP follows a mostly **production-based geographic-plus accounting approach** with the exception of energy consumption, which is allocated to the end user. Accordingly, there is no methodology provided for the additional inclusion of upstream emissions or emissions from consumption, yet, including these is encouraged (ICLEI 2009: 10, 12f).

The protocol applies an **organizational** and a **geopolitical boundary concept** with separate analyses for emissions from local government operations (LGO) and community activities, respectively (ICLEI 2009: 12f). A complete emission inventory always includes both the LGO and the community section. The organizational boundary of the LGO section includes "functions directly under local government control" (ICLEI 2009: 12) and is consistent with corporate emissions reporting. The Corporate Standard alongside the IPCC Guidelines served as an important blueprint for the development of the IEAP, especially for the LGO section. The orientation towards corporate emissions accounting is justified by the similarities between emissions from local governments' internal operations and those generated by private sector firms. Consequently, the IEAP's inventory requirements are similar to those of the Corporate Standard (ICLEI 2009: 7). The geopolitical boundary of the community section is defined as "the physical area or region over which a local government has jurisdictional authority" (ICLEI 2009: 12). Therefore, emissions from LGOs are normally recognized as a subset of community emissions (ICLEI 2009: 4). Although the geopolitical boundary defined here seems similar to national boundary concepts, the IEAP argues that the methodology needs to reflect the opportunities of local governments to influence in-boundary community activities and take mitigation measures that differ from those of national governments (ICLEI 2009: 7, 12). While the IEAP sticks to the separation of organizational and geopolitical boundaries, it states that the "physical location of the site where emissions occur is not relevant to the decision regarding what emissions should be included in the analysis" (ICLEI 2009: 13).

In compliance with the Corporate Standard, the IEAP fully recognizes the **Scopes framework** and recommends including emissions from all three Scopes if possible. The Scopes framework is adapted to the IEAP's approach by defining separate governmental and community Scopes. **Governmental Scope** 1 includes "[d]irect emission sources owned or operated by the local government" (ICLEI 2009: 15f), whereas "[i]ndirect emission sources limited to electricity, district heating, steam and cooling consumption" are allocated to Scope 2 (ICLEI 2009: 15f). Scope 3 relates to "[a]ll other indirect and embodied emissions over which the local government exerts significant control or influence" (ICLEI 2009:

15f). As a rule, local governments should report the total Scope 1 and 2 emissions, at a minimum[4] (ICLEI 2009: 20). Since LGOs can be outsourced to contractors, the IEAP recommends including emissions from contracted services as Scope 3 emissions as if these were still part of LGOs (ICLEI 2009: 16; Bertoldi et al. 2010: 50).

Community Scope 1 includes "[a]ll direct emission sources located within the geopolitical boundary of the local government" (ICLEI 2009: 12). Scope 2 includes "[i]ndirect emissions that result as a consequence of activity within the jurisdiction's geopolitical boundary" but limited to "electricity, district heating, steam and cooling consumption" (ICLEI 2009: 12). Scope 3 comprises "[a]ll other indirect and embodied emissions that occur as a result of activity within the geopolitical boundary limited to electricity, district heating, steam and cooling consumption" (ICLEI 2009: 12). Generally, **emission sectors** are compliant with IPCC sectors. However, the IEAP provides a further differentiation of the IPCC sectors for the governmental and community scale.

For quantification, **emission factors** are used. There is no requirement to report the factors (Ibrahim et al. 2012: 229). Detailed guidance is provided for the calculation of specific emission factors for district heating and cooling, cogeneration and combined heat and power (CHP) production (ICLEI 2009: 21f). Stationary combustion in the energy sector includes fuel use, electricity and heat consumption data from energy providers. Emissions from fuel for energy production, heating and cooling are reported separately when supplied to the grid (Bertoldi et al. 2010: 50; ICLEI 2009: 22f, 26f, 33f). Transmission and distribution (T&D) losses are included (ICLEI 2009: 23). Input data for the governmental transportation sector include estimates of fuel used by government vehicles (ICLEI 2009: 28f). For community transportation, fuel consumption is calculated by vehicle distance travelled, often based on estimates from transportation modeling (ICLEI 2009: 35). While accounting emissions from aviation and marine transport is optional in general, emissions from intra-community water transportation are included (ICLEI 2009: 37f). Methane emissions from waste are estimated based on the FOD model (Ibrahim et al. 2012: 229; ICLEI 2009: 31, 41ff). The incorporation of upstream emissions, e.g., from material and fuel consumption, especially biofuels, is encouraged but optional.

ICLEI's web-based Harmonized Emissions Analysis Tool (formerly HEAT, now HEAT+) assists compiling local emission inventories in compliance with the IEAP. HEAT+ is based on the GPC (ICLEI 2015a). Since the GPC does not provide a methodology for LGO emissions, these remain in the IEAP governmental section (WRI et al. 2014: 159).

Essential **reporting requirements** cover reporting of energy emissions according to the IEAP's governmental and community scale and additional reporting of government operations (Ibrahim et al. 2012: 229). In addition to its emission inventorying methodology, the IEAP defines two Global Reporting Standards to make governments' performance internationally comparable. Once again, there are separate standards for comparisons of LGO emissions inventories (Comparative Government Operations

[4] Scopes are supplemented by a range of information items, such as biogenic emissions, offsets, 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" (ICLEI 2009: 15f). This also includes "electricity generated from solar photovoltaic panels owned or operated by the local government" (ICLEI 2009: 16).

Emissions Standard) und inventories for community emissions (Comparative Community Emissions Standard) (ICLEI 2009: 46). The IEAP also encourages users to develop custom reporting standards according to their needs and recommends the simultaneous reporting according to the requirements of the Global Reporting Standard.

Box 1. ICLEI – Local Governments for Sustainability

ICLEI – Local Governments for Sustainability was founded at the World Congress of Local Governments for a Sustainable Future in New York in 1990 under the original name International Council for Local Environmental Initiatives. ICLEI describes itself as "an international association of local and metropolitan governments dedicated to sustainable development" (ICLEI 2016a). With over 1000 member cities in 86 countries, representing more than 570 million people, the network has since established itself as one of the major players amongst transnational city networks, thereby following its premise "that locally designed and driven initiatives can provide an effective and cost-efficient way to achieve local, national, and global sustainability objectives" (ICLEI 2016a). As one of its first global programs, ICLEI adopted the Local Agenda 21. ICLEI is a non-profit organization funded mostly by membership fees, service contracts, and grants by national governments, international and regional organizations, such as the EU, several UN agencies, foundations and NGOs.

As a membership association, ICLEI is governed through a global council by mandate of its member cities, local and regional governments, and municipal authorities organized into nine world regions ICLEI. The World Secretariat is located in Bonn. ICLEI's work is structured along ten urban agendas covering sustainability, low-carbon cities, resource-efficiency and productivity, resilience, biodiversity, smart cities, urban mobility, health and inclusion, local economies and procurement, and city-region cooperation. Through these agendas, ICLEI cooperates or is associated with a variety of other networks and institutions, such as the C40 (see Box 4), UCLG, the Covenant of Mayors (see Box 3), the Compact of Mayors (see Box 5), the Compact of States and Regions, the Global Cities Covenant on Climate, and the World Mayors Council on Climate Change.

The network puts great effort into high-level lobbying and holds special consultative status at the UN Economic and Social Council (ECOSOC). ICLEI is accredited as observer at the UNFCCC and serves as focal point of the Local Government and Municipal Authorities (LGMA) Constituency to the UNFCCC, a network of local and subnational governments accredited to the process. ICLEI further observes the UN Conventions on Biodiversity (CBD) and Desertification (UNCCD), takes part in the UN High-Level Political Forum which replaced the former Commission on Sustainable Development, and has signed memoranda of understanding with other UN bodies, such as UNEP, UN-Habitat and the Office for Disaster Risk Reduction (UNISDR).

In 2007, responding to the UN Climate Roadmap established at the UNFCCC COP13 in Bali and the Bali Action Plan, ICLEI launched the Local Government Climate Roadmap (LGCR) "to ensure recognition, engagement and empowerment of local and subnational governments in the new global climate regime" (ICLEI 2016a), which, according to ICLEI, had so far been overlooked by the UNFCCC and the Kyoto Protocol. In 2015, ICLEI declared the mission of the LGCR accomplished without abandoning the project. ICLEI has developed the carbonn Climate Registry (cCR), the IEAP and the associated HEAT+ software tool for local governmental and community emissions accounting and reporting, as well as recently the GPC. In 2015, ICLEI launched the Transformative Actions Program (TAP) to support cities' climate action projects by "actively advocating for better and quicker access to larger amounts of climate finance for cities and regions" and "assisting the pre-brokering between subnational authorities and financing bodies […] and mobilizing cities and regions to design transformative and bankable climate actions" (ICLEI 2016a).

(Sources: ICLEI 2012, 2014, 2015a, 2015c, 2016a).

3.1.2 The International Standard for Determining Greenhouse Gas Emissions for Cities

The International Standard was launched by UNEP, UN-Habitat and the World Bank at the 5th World Urban Forum in Rio de Janeiro in 2010, one year after the IEAP. The last draft version was never turned into a final protocol and has now been superseded by the GPC. Compared to other protocols, the methodology of the International Standard is the least elaborate with the least detailed guidance.

However, it does not fall short of its competitors as it incorporates several already existing methodologies, benefitting from their particular strengths, such as the IEAP and Bilan Carbone.

The International Standard aims to establish an “open, global and harmonized protocol for quantifying the GHG emissions attributable to cities and local regions” and to provide the basis for suitable inventory tools (UNEP et al. 2010: 1). The openness of the protocol makes it applicable to both cities and metropolitan regions with populations over 10 million. For cities and metropolitan areas with smaller populations, the document recommends using the Baseline Emission Inventory (BEI) Guidelines by the Covenant of Mayors instead (Ibrahim et al. 2012: 229; UNEP et al. 2010: 2). The International Standard applies the IPCC Guidelines’ principles of transparency, consistency, comparability, completeness and accuracy (UNEP et al. 2010: 1). As Ibrahim et al. point out, “[a] significant aspect of this framework is that it requires a city’s GHG inventory methodology and results to be transparent, accessible, and available to everyone” (Ibrahim et al. 2012: 225).

The International Standard follows a **geographic-plus accounting approach** with a production-based accounting methodology. Similar to the IEAP, energy-consumption is allocated to the end-user, while any other consumption is generally included as an additional information item only. For the coverage of upstream emissions, the International Standard refers to Bilan Carbone and provides a supporting spreadsheet template. Alternative methodologies for consumption-based accounting or LCAs are not provided (UNEP et al. 2010: 2, 11).

The protocol applies a **geopolitical boundary** and rejects LGO-only inventories since “major sources of GHGs in cities are sometimes beyond local government control (e.g., power supply, vehicle technology standards)“ (UNEP et al. 2010: 2f). Rather, inventories should reflect the governance required to reduce these emissions. For example, emissions caused by tourists and emissions from the industrial production of exported goods should not be excluded (UNEP et al. 2010: 2f). Nevertheless, emissions from LGOs alone may be attached to the regular inventory as additional information (UNEP et al. 2010: 5). The International Standard refers to the IEAP for further guidance on LGO emissions.

The International Standard requires all three **Scopes** to be included in the inventory. Scopes definitions are similar to the Corporate Standard (UNEP et al. 2010: 4), whereby Scope 3 emissions are defined more specifically as “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” (UNEP et al. 2010: 4).

Unlike the IEAP, the International Standard requires separate reporting of upstream emissions embodied in food, water, fuels and building materials consumed in cities as additional information items in order to avoid outsourcing of emissions beyond the city boundary (UNEP et al. 2010: 2f). The protocol mandates the inclusion of out-of-boundary emissions from electricity generation and district heating if these are consumed in-boundary, as well as emissions from in-boundary-generated waste and from air travel and marine transport carrying passengers and freight out of the boundary territory (UNEP et al. 2010: 2).

Emissions from the export of electricity, heating or cooling are subtracted from the emissions total. The same applies to emissions from the import of waste (UNEP et al. 2010: 4).

The reporting format is designed to be compliant with national and regional emissions inventories that meet the requirements of the IPCC. **Emission sectors** are identical to those recommended by the IPCC Guidelines (UNEP et al. 2010: 1f, 3, 7ff). Key emissions categories should represent at least 95% of total emissions (UNEP et al. 2010: 2). Despite the International Standard's claim to be a universally applicable global protocol for emission inventorying, it is admitted in the document that, "[w]ith 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" (UNEP et al. 2010: 2). This statement reflects the constraints that come with an exclusive focus on emissions from local government operations in other methodologies.

The International Standard applies an **emission factor based quantification method**. Generally, emissions from any sort of combustion are reported by fuel type, using specific emission factors and thereby considering differences between several sectors and industries in fuel use and applications. Weighted average emission factors are accepted for particularly complicated cases, such as methane from road transportation (UNEP et al. 2010: 9f). Except for air and water transportation, sources for input data are not defined. On-site renewable sources can be included separately or incorporated into a customized local emission factor for electricity (UNEP et al. 2010: 10).

In the stationary combustion sector, emissions from the generation of electricity consumed within the boundary territory are counted, regardless of whether these are generated inside or outside the boundary. This includes T&D losses, whereas emissions from Combined Heat and Power (CHP) are excluded (UNEP et al. 2010: 8). Biogenic fuels should only be added if used in "significant quantities" (UNEP et al. 2010: 10), although a precise definition of significance is not provided. In the transportation sector, emissions from aviation are separated between domestic and international emissions. International take-offs and landings are allocated to the domestic share, which is in accordance with the IPCC Guidelines (UNEP et al. 2010: 2). Data is based on fuel loaded within the city boundaries. The same rule applies for emissions from marine transport (UNEP at el. 2010: 2, 8). Emissions from waste are calculated using a total yield gas method (Ibrahim et al. 2012: 22). Emissions from solid waste disposal on land include emissions from residential, commercial and industrial waste emitted inside or outside of the boundary. Emissions from energy generation are excluded from the category of waste incineration. Those from waste water handling may also include emissions that occur out-of-boundary (UNEP et al. 2010: 8).

Reporting requirements are based on the assumption of an ideal reporting level. Where sufficient data are unavailable or emissions are insignificant, as is often the case for AFOLU and IPPU emissions in urban contexts, the International Standard allows to deviate from this ideal level (UNEP et al. 2010: 2). However, overall reporting requirements are strict and include the reporting of activity data and emission factors used in calculations, reporting of data precision levels and methods used, and reporting of energy emissions according to IPCC energy sub-sectors (Ibrahim et al. 2012: 229; UNEP et al. 2010: 10). Furthermore, it is recommended to use existing reporting guidance by the IPCC, the IEAP, and the

Covenant of Mayors' BEI Guidelines (UNEP et al. 2010: 5). There are no verification requirements or processes mentioned in the document.

Box 2. Carbon registries: CDP and Carbonn Climate Registry (cCR)

The **former Carbon Disclosure Project, now CDP**, was founded in 2000 in London as a non-profit organization under the premise that "[m]easurement, transparency and accountability drive positive change in the world of business and investment" (CDP 2015a: 1). The CDP discloses environmental information from companies and cities to investors and the public to "incentivize companies and cities to measure, manage and reduce their impact on the environment and build greater resilience" (CDP 2015a: 1). One of its main goals is to inform and change investment decisions. By its own account, "CDP holds the largest and most comprehensive collection globally of primary corporate climate change, water and forest-risk information" (CDP 2015a: 1). CDP is funded by companies and investors, sponsorships, partnerships, memberships, governments, and philanthropic grants.

As of 2015, more than 4,500 companies and over 200 cities are reporting to the CDP, among them 66 major multinational companies with US$1.15 trillion of annual purchasing spend. Corporate inventories are mostly based on the Corporate Standard. The data has been requested by 767 institutional investors, equaling more than a third of the world's invested capital, according to CDP. Investors use the CDP data to "identify leaders among potential investments, identify the laggards for engagement dialogue and possible future divestment, construct internal ratings for portfolio managers and integrate environmental risk into portfolio and fund analysis" (CDP 2015: 11). In 2013, CDP convened 190 investors under its Carbon Action initiative and actively requested investments in emissions reduction projects that deliver a positive return on investment from 300 high-emitting companies. The platform announced to publish a yearly list of companies that deny disclosure requests. Strategic partners of the CDP include Bloomberg LLP, C40 (see Box 4), the Global Investor Coalition on Climate Change, the Global Reporting Initiative (GRI), R20, the Climate Group, UNEP, UNFCCC, the UN Global Compact, WBCSD, WRI, and WWF. CDP aims to become "the leading data provider for multilateral institutions" (CDP 2014: 9), building on the existing partnership with C40 in order to "provide insight and intelligence for UN policy makers and the World Bank on the role and actions of cities in fighting climate change" (CDP 2014: 9).

The **CDP Cities program** was launched in collaboration with C40 in 2008 to provide "a standard global reporting platform for urban environment data that fosters innovation, adaptation and investment towards the prevention of climate change and natural resource protection" (CDP 2015a: 16). The Cities platform accepts inventories compiled under the GPC, the IEAP, the International Standard, the IPCC Guidelines, or the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions which is based on an early version of the GPC developed for the needs of US communities (ICLEI USA 2013). However, the reporting questionnaire has been streamlined to support the use of the GPC as the recommended protocol. CDP plans to extend the platform to state and regional governments.

The **carbonn Climate Registry (cCR)** was developed by ICLEI and the City of Copenhagen building upon the City Climate Catalogue, a global collection of community-scale climate actions. It was launched at the World Mayors Summit in Mexico City in 2010. cCR is operated by the Bonn Centre for Local Climate Action and Reporting hosted by the ICLEI World Secretariat. Since 2014, the registry includes sub-national states and regions. cCR is funded by ICLEI, the EU European Regional Development Fund through the German State Government of North Rhine-Westphalia, R20, Urban LEDS, the European Commission, and WWF.

The platform describes itself as "a global mechanism developed for local governments by local governments" that enables them to "publicly and regularly report their local climate action developments: greenhouse gas (GHG) reduction commitments, emissions inventories, [and] climate mitigation/adaptation actions" (cCR 2016). As of 2016, there are 613 entities from 62 countries reporting to cCR, representing 553 million people. In sum, these entities commit to emissions reductions of up to 1Gt CO2e by 2020. Partnerships exists with C40, UCLG, R20, Bloomberg Philanthropies, UN -Habitat, WWF, the EcoMobility Alliance, Plan de Acción Climática Municipal, Urban Low Emission Development Strategies (Urban LEDS), the 100% Renewable Energy Cities and Regions Network, the Low Carbon City Lab (LoCal), the Climate and Clean Air Coalition (CCAC), and ICLEI's Transformative Actions Program (TAP).

cCR is the designated reporting platform for Compact of Mayors signatory cities (see Box 5) and also collects data that has been reported to CDP already. It is also recognized as the reporting platform for Resilient Communities for America, the Mexico City Pact, the Earth Hour City Challenge, the Durban Adaptation Charter, and the Compact of States and Regions. The data is used by the Local Government Climate Roadmap (LGCR) and presented in annual reports. Generally, reporting is voluntary, free and addresses operations at the government, community and territory level. Reporting entities can restrict the public display of data but have to accept their use for internal analysis. Ninety per cent of reported community inventories were publically accessible in 2015. Since 2014, the registry follows a multi-level governance approach by aggregating and integrating data horizontally and vertically. In 2015, 29% of reported data were verified by external auditors. cCR is a crucial data source for measurable, reportable and verifiable (MRV) climate actions under the UNFCCC.

cCR explicitly recommends the GPC to reporting entities. Other inventory protocols supported by cCR include the IEAP, the IPCC Guidelines, and the BEI/MEI. However, with the publication of the final version in 2014, the GPC became the main reporting protocol of cCR, superseding ICLEI's own IEAP. cCR has been supporting the launch of the Non-State Actor Zone for Climate Action (NAZCA) platform for climate actions commitments by companies, cities, sub-national regions and investors in 2014. The platform was established as part of the Lima-Paris Action Agenda under the UNFCCC and cCR has been "the first data provider of local climate action to the […] NAZCA portal" (cCR 2015: 7). It will be interesting to observe the potential conflict of interest between CDP and cCR, since both platforms are currently supported by the Compact of Mayors and the C40 city network. In February 2016, C40 reported that 92% of C40 cities used CDP to disclose their emissions data in 2015 and called for all C40 cities to follow the example of the Compact of Mayors to report their emissions to CDP using the GPC. Nevertheless, the ultimate reporting platform for this data will most likely remain cCR as it reports the aggregated Compact data to the NAZCA-platform.

(Sources: cCR 2014, 2015, 2016; C40 et al. 2014; CDP 2014, 2015a, 2016; ICLEI 2015b)

3.2 Open Protocols: The Baseline Emission Inventory (BEI) and Monitoring Emission Inventory (MEI) Guidelines

The Baseline Emission Inventory (BEI) and Monitoring Emission Inventory (MEI) Guidelines have been developed by the Covenant of Mayors in 2010 (see Box 3). Unlike aforementioned protocols, the BEI specifically aims to quantify the amount of CO_2 emitted in a baseline year (Covenant of Mayors 2010: 55). The BEI is limited to emissions from energy consumption in the territory of the local authority, usually a signatory of the Covenant of Mayors. The predominant goal is to identify the main anthropogenic sources of CO_2 emissions and to derive reduction measures as part of a Sustainable Energy and Climate Action Plan (SECAP). Subsequent Monitoring Emission Inventories (MEI) allow for the evaluation of the emissions reduction measures which are tied to the EU climate goals. In methodological terms, the BEI is not related to the GPC or any other protocol. Although a number of existing inventory protocols are recognized, none of these are fully compliant with the requirements set out in the SEAP/SECAP, as shown by Bertoldi et al. (2010). This is mainly due to their less comprehensive estimations of emissions from energy consumption and their lack of a life-cycle assessment (LCA) approach, which is included in the BEI.

The BEI/MEI allows to **choose freely between a standard geographic-plus approach and an alternative LCA**. However, the inventory focuses on both municipal and non-municipal final energy consumption, following a consumption-based accounting approach. Thus, the methodology could also be classified as an energy end-use approach as defined by Bader and Bleischwitz. When accounting for emission sources that are not related to energy, a common production-based method is applied (Covenant of Mayors 2010: 56, 63). Emissions are counted within a geopolitical boundary that is defined by the administrative boundaries of the local authority (Covenant of Mayors 2010: 56).

Contrary to the conventional protocols mentioned before, the **Scopes** framework is not recognized. Instead, the BEI/MEI distinguishes direct and indirect emissions rather superficially. However, these categories are roughly equivalent to Scopes 1 and 2. Direct emissions are "due to fuel combustion in the territory in the buildings, equipment/facilities and transportation sectors" (Covenant of Mayors 2010: 56) and can be matched to Scope 1 emissions. Indirect emissions relate "to production of electricity, heat, or cold that are [sic] consumed in the territory" (Covenant of Mayors 2010: 56), regardless of the location of their occurrence (Covenant of Mayors 2010: 56). These match both Scopes 1 and 2. Scope 3 is not covered. As a major difference to the Scopes framework the BEI/MEI methodology does not include all emissions occurring in the territory and excludes emissions from large power and industrial plants, amongst others (Covenant of Mayors 2010: 56).

Due to the BEI/MEI's comparatively narrow approach, only the energy **sector** is compliant with the IPCC Guidelines. Emissions from local electricity production are only taken into account for units that are not included in the European Emissions Trading System (ETS) and produce no more than $20MW_{fuel}$, based on the assumption that these primarily serve the local electricity needs (Covenant of Mayors 2010: 64). Final energy consumption in the sub-sectors of buildings, equipment/facilities and industries include only entities that are not involved in the European Emissions Trading System (ETS). Moreover, these are only included if their emissions are addressed in the SEAP/SECAP. This rule applies to a variety of other emission sources, such as non-urban road and rail transportation or fuel consumed for the production of electricity, as well as the transportation and waste sectors. All other IPCC sectors remain irrelevant to the BEI/MEI (Covenant of Mayors 2010: 57f). Generally, there is great flexibility which emission sources to include in the inventory (Bertoldi et al. 2010: 65).

Regarding quantification methods, national or European **emission factors** provide the general base for the inventory. Local authorities, however, are free to choose between standard emission factors following the IPCC approach or specific LCA emission factors (Covenant of Mayors 2010: 59). Custom local emission factors developed by authorities themselves are accepted as well but have to be consistent with previous MEIs (Covenant of Mayors 2010: 62). The LCA approach supported in the BEI/MEI follows the ISO 14040 series of standards and is compatible with most LCAs undertaken by European companies. Emission factors for the LCA are based on the European Reference Life Cycle Database (ELCD) (Covenant of Mayors 2010: 59).

Local consumption data, meter readings or invoices are recommended as input data for the calculation of emissions from stationary combustion, municipal and non-municipal buildings, equipment and facilities (Covenant of Mayors 2010: 69). CHP emissions are recommended to be included under production, due to the generation of electricity in the process (Covenant of Mayors 2010: 68). T&D losses are excluded (Bertoldi et al. 2010: 65). Required input data on emissions from road transportation include fuel consumed within the territory based on the estimated mileage driven on the authority's street network, the vehicle fleet of the local authority, and the average fuel consumption of each vehicle type (Bertoldi et al. 2010: 65; Covenant of Mayors 2010: 72). Data on the consumption of electricity and fuel in rail transportation should be collected from service providers or else estimated by mileage travelled and average consumption (Covenant of Mayors 2010: 75). Emissions from aviation and marine transport are not counted, except for local ferries, given these are part of the SEAP/SECAP (Covenant of Mayors 2010: 57).

For emission sources other than those related to fuel combustion, the BEI/MEI recommends using other methodologies, such as the IEAP or the IPCC Guidelines. In case the local authority has chosen not to use standard emission factors, it is referred to the ELCD database for LCA emission factors (Covenant of Mayors 2010: 67).

Reporting requirements are comparatively strict. They include the reporting of activity data and emission factors, energy emissions according to sub-sectors, as well as the additional reporting of government operations (Ibrahim et al. 2012: 229ff). There are no verification procedures defined. The understanding of the principle of accuracy does not comply with the much stricter IPCC requirements, as BEI/MEI accepts data that, "[w]ithin the limits of possibility, should be accurate, or at least represent a vision of the reality" (Covenant of Mayors 2010: 68). Transparency, on the contrary, is exceeding the IPCC requirements, because calculations and formulas underlying the methodology are made explicit in the guidelines themselves, and not in accompanying tools as it is the case for the IEAP (Covenant of Mayors 2010: 66ff).

Box 3. The Covenant of Mayors

The Covenant of Mayors was launched by the European Commission in 2008 to foster the implementation of sustainable energy policies at the local authority level, following the adoption of the EU's 2020 Climate and Energy Package. The latter was recently superseded by the 2030 Framework for Climate and Energy which now frames the Covenant's activities. The Covenant describes itself as a "unique bottom-up movement" (Covenant of Mayors 2016a) aimed to encourage local authorities to voluntarily commit to reduce CO_2 emissions by at least 40% by 2030. Additionally, Covenant signatories commit to prepare a Baseline Emission Inventory (BEI) as a pre-condition to the submission a Sustainable Energy Action Plan (SEAP, now superseded by SECAP) within the year following signing up to the Covenant. After submission of the SEAP/SECAP, an implementation report has to be prepared at least every second year, including a Monitoring Emission Inventory (MEI) to evaluate the effects of the proposed actions. Further obligations include the development of administrative structures to implement the SEAP/SECAP, the organization of local Energy Days to raise public awareness, contributions at the annual EU Conference of Mayors, encouragement of other European Mayors to join the Covenant, and acceptance that the membership will be terminated if commitments are not met. The Covenant regularly publishes good practice examples of local initiatives by its signatories online as Benchmarks of Excellence.

In 2014, the Mayors Adapt was launched as a subsidiary to the Covenant focusing on adaptation projects. However, in accordance with the new EU 2030 objectives, both initiatives were merged under the integrated Covenant of Mayors for Climate and Energy in October 2015 to become "the mainstream European movement involving local authorities and their citizens in the fight against climate change" (Covenant of Mayors & Mayors Adapt 2015a). The new Covenant now aims to reduce at least 40% of CO_2 emissions by 2030, keep average global warming below 2°C, strengthen climate resilience, and ensure "universal access to secure, sustainable and affordable energy services for all", including a 27% increase in energy efficiency and renewables (Covenant of Mayors & Mayors Adapt 2015a, b). The former SEAP was expanded to a Sustainable Energy and Climate Action Plan (SECAP) and has to be accompanied by a Climate Change Risk and Vulnerability Assessment for adaptation measures. Implementation has to be reported every two years. As part of its newly established "global chapter" (Covenant of Mayors & Mayors Adapt 2015a), the Covenant of Mayors was integrated into the UNFCCC's NAZCA web portal.

As of February 2016, the Covenant counts 6,102 signatories. „European local authorities of all sizes" are eligible to sign up, given they are "democratically constituted with/by elected representatives" (Covenant of Mayors 2016a). Signatories are assisted by the Covenant of Mayors Office (CoMO) in meeting their commitments and raising the necessary funding. CoMO is funded by the Commission and managed by a consortium of European networks representing local and regional authorities, led by Energy Cities. The consortium collaborates with the Joint Research Centre (JRC) of the Commission where submitted SEAP/SECAPs are assessed. Besides the Commission, the Covenant of Mayors is supported by the EU Committee of the Regions, the European Parliament, the European Investment Bank and a variety of players organized into the categories of Covenant Coordinators, Covenant Supporters, and Associated Partners.

Covenant Coordinators are decentralized authorities (regions, provinces or groupings of local authorities), national public bodies (e.g. national energy agencies), or generally supportive entities "with the political will to sign up to the Covenant of Mayors, but lacking the skills and/or resources to fulfil its requirements" (Covenant of Mayors 2016a). These are considered key allies to the CoMO "as they play a decisive role in reaching out to local authorities in their territory and providing signatories with the technical, financial, administrative and political support necessary to fulfil their commitments" (Covenant of Mayors 2016a). Additional expertise is provided by Covenant Supporters which include networks and associations of local and regional authorities with considerable lobbying and networking skills. Local and Regional Energy Agencies (LAREAs) are accepted as active supporters of the Covenant unless they are financed mostly by private sources. The Climate Alliance city network is acting as a Covenant Supporter for its own members. Associated

Partners include amongst others "[a]ssociations of financial institutions such as public and private banks; industrial associations; European umbrella-associations of energy solutions providers that bring together private companies; NGOs" (Covenant of Mayors 2016a).

(Sources: Covenant of Mayors & Mayors Adapt 2015a, 2015b; Covenant of Mayors 2016a, n.d.)

3.3 Specialized Protocols: Bilan Carbone

Bilan Carbone was developed by the French Environment and Energy Management Agency (ADEME), originally as a methodology for corporate emission inventories. Since its first release in 2004, subsequent versions kept expanding the scope of the protocol. Version 5 published in 2007 was the first one specifically developed for local authorities and territories (ABC 2010: 7). In this paper, version 6.1, the latest version available in English dating from 2010, will be reviewed. Bilan Carbone has never been advertised as a global protocol since it has been designed for the particular needs of French cities. However, its unique methodology presents an opportunity to broaden the horizon of the analysis by contrasting the geographic-plus focus of most protocols considered so far. Bilan Carbone applies an **LCA accounting approach** that incorporates emissions from both production and consumption, as well as in many cases distribution, processing, end-of-life emissions and recycling (ABC 2010: 9).

It provides accounting methodologies for industrial and service sector companies as well as for local authorities. Similar to the IEAP, its boundary concept is both organizational and geopolitical with separate modules for emissions from LGOs and those defined by a geographical boundary. The authority module "covers the emissions generated by the authority's own activity or by the services it provides" (ABC 2010: 49), whereas the regional module "covers the emissions generated by all of the activities located within the territory of the authority in question" (ABC 2010: 49). As Bader and Bleischwitz (2009: 21) argue, the methodology is in principle applicable to "any entity provided that the required data are available". It can also be used for future scenarios (ABC 2010: 13f).

Bilan Carbone does not recognize the **Scopes framework** but inherently covers all three Scopes (Bertoldi et al. 2010: 55), while still distinguishing direct emissions that "occur directly within the entity" from indirect emissions that occur "outside the entity, but […] are offset for the processes necessary for the existence of the activity or the organisation" (ABC 2010: 9). Thereby not only emissions for which an entity is directly or indirectly responsible, but also those that it is dependent on are counted, no matter where these emissions occur[5] (ABC 2010: 9). Due to the parallel accounting for both upstream and downstream emissions, Bilan Carbone is not compliant with the emission sectors derived from the IPCC's territorial accounting model.

The **quantification method** applies emission factors to the physical flows from and to the entities concerned (ABC 2010: 10). By its own account these factors can be applied to most Western European

[5] This is justified as follows: „As Bilan Carbone does not take the location of the emissions into account, there will be no reason for a strict geographic exclusion and therefore all the emissions that are 'necessary' for an activity will be taken into account, regardless of where the emissions occurred" (ABC 2010: 19).

countries, as well as French Overseas Departments and New Caledonia in adjusted form[6] (ABC 2010: 12; Bertoldi et al. 2010: 55). However, for situations or activities where prepared emission factors cannot be used, individual inventories can be conducted and combined for a total inventory (ABC 2010: 57). The comprehensive character of the protocol's methodology is reflected in its data sources, e.g., for stationary combustion, where the protocol recommends direct meter readings or utility bills for fuel use, electricity and heat consumption. Alternatively, estimates based on comparable facilities and square footage (Bertoldi et al. 2010) are also accepted. T&D losses have to be included (Ibrahim et al. 2012: 233).

For transportation, the regional module provides several approaches, such as transport departing from or arriving in the territory and transportation of domestic citizens and visitors (Bertoldi et al. 2010: 55). Input data for fuel use can be absolute fuel consumption or average consumption for different vehicle types, different types of travel or different types and sizes of territory (Bertoldi et al. 2010: 55). Aviation and marine transport are reported entirely, including vessels or flights from and to the territory. What sets Bilan Carbone apart from other protocols is its inclusion of food consumption and both upstream and downstream emissions of materials, such as glass, cardboard, paper, plastic and metals, amongst others (Ibrahim et al. 2012: 233).

With very few exceptions, carbon sinks, carbon offsetting and carbon sequestration are excluded from Bilan Carbone. For carbon sinks, impacts are too difficult to assess and attribute to the various beneficiaries. Therefore, the only carbon sink accounted for – although separately – is lumber from sustainably managed forests. Carbon offsetting is excluded since the protocol is "based on chemical and physical processes that have actually occurred" (ABC 2010: 28). The same principle is applied to carbon sequestration, but sequestration occurs too rarely in practice to be included in any of the modules (ABC 2010: 29).

Neither **reporting** nor **verification** requirements or processes are mentioned in the document. However, the protocol can report emissions according to existing standards, e.g., the ISO 14064 standard for corporate emissions reporting or the Corporate Standard (ABC 2010: 16, 74). Whether it is compatible with more recent standards, such as the ISO 37120 or the PAS 2070 for municipal GHG inventories, is yet to be examined.

[6] While some emission factors are also applicable to Asian countries, e.g., Japan, South Korea, Taiwan or Singapore, Bilan Carbone does currently not apply to North American entities, due to differences in the production of electricity, automotive engines, and agricultural production (ABC 2010: 12).

3.4 The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)

The GPC is the outcome of a collaboration between ICLEI, C40, WRI and the Cities Alliance Joint Work Program.[7] It was published in 2014 after two years of public consultation and testing by pilot cities (WRI et al. 2014: 22). The GPC strongly builds on the groundwork laid by the IEAP and the International Standard (WRI et al. 2014: 22). However, the parties involved agreed that both the IEAP developed by ICLEI and the International Standard developed by UNEP, UN-Habitat and the World Bank should make way for this new global protocol, advertised as the "the most comprehensive greenhouse gas […] accounting and reporting framework for cities around the globe" (ICLEI 2015b: 3). C40 (see Box 4) promotes the GPC as "the first widely endorsed standard for cities to measure and report their greenhouse gas (GHG) emissions" (C40 2016), and members of the Compact of Mayors (see Box 5) are required to use the GPC in order "[…] to ensure the consistency, credibility and quality of their local emissions data" (C40 2016).

The GPC aims to assess the GHG emissions of a geographically defined subnational area to establish a base year emission inventory that can be aggregated, e.g., to improve the data quality of a nation-wide inventory (WRI et al. 2014: 20). The methodology has clearly been influenced by the Corporate Standard and applies the same inventory principles of relevance, completeness, consistency, transparency and accuracy (WRI et al. 2014: 25f). Accordingly, it is designed to be fully compliant with the IPCC Guidelines (WRI et al. 2014: 20).

Box 4. C40

With over 80 member cities, representing 550 million people and 25% of global GDP, C40 is one of the major city networks. However, when compared to ICLEI, its history is rather short. Founded in 2006 as a joint effort by then Mayor of London Ken Livingston and the Clinton Climate Initiative (CCI), C40 aims at "tackling climate change and driving urban action that reduces greenhouse gas emissions and climate risks, while increasing the health, wellbeing and economic opportunities of urban citizens", by sharing knowledge and making the effects of such actions measurable (C40 2015a: 1). According to C40, member cities have taken over 10,000 climate actions since COP20 in Copenhagen and committed to emissions reductions of 3Gt of CO_2 by 2030. Current C40 Chair Mayor of Rio de Janeiro Eduardo Paes describes the ultimate goal of the network: "By working together, the world's greatest cities are forging a pathway to low carbon and climate resilient development, setting an example for nations to follow" (Arup & C40 2015: 6). Former New York City Mayor Michael R. Bloomberg took over the presidency of the Board of Directors after his term as C40 chair ended. Bloomberg has been appointed Special Envoy for Cities and Climate Change by UN Secretary General Ban-Ki Moon in 2014 and has since established himself as a popular figure in the field, showcasing high-level advocacy and frequent public appearances.

C40's activities are organized into seven overarching "initiative areas" and networks, including Adaptation and Water, Energy, Finance and Economic Development, Measurement and Planning, Solid Waste Management, Sustainable Communities, and Transportation. The organization supports its members through its C40 City Director Program in which

[7] The Cities Alliance is "a global partnership for urban poverty reduction and the promotion of the role of cities in sustainable development" (Cities Alliance 2016) and is best known for its Cities without Slums Action Plan which was incorporated into the UN Millennium Declaration in 2000. Its members include local authorities, such as ICLEI, Metropolis and UCLG, several governments, NGOs, international organizations, such as the World Bank, UNEP and UN-Habitat, private sector investors and foundations. Its goal is to "support cities in providing effective local government, an active citizenship and an economy characterised by both public and private investment" (Cities Alliance 2016).

regional directors act as multipliers serving “as an active conduit between regional C40 Cities, city staff and the organization, connecting cities and activities across the global C40 network” (C40 2016). Networking events, workshops, and a range of technical tools are provided, amongst them the GPC. At the 2011 C40 Cities Mayors Summit in Sao Paolo, C40 announced a partnership with ICLEI and the World Bank in order “to accelerate climate action in cities through streamlined financing, greenhouse gas accounting and uniform reporting” (C40 2016). The C40 Cities Awards were first held in 2013 to catalyze competition between C40 member cities and their efforts. Since 2015 the award provides a separate competition for members of the Compact of Mayors which includes the categories Carbon Measurement and Planning, Adaptation Planning and Assessment, Building Energy Efficiency, and Green Energy.

At the core of these activities, an extensive body of funders and strategic partners reflects the organization’s public-private character. Strategic funders include Bloomberg Philanthropies, the Children’s Investment Fund Foundation (CIFF) and Realdania. C40’s partnership with the CCI Cities program was enabled by a multi-year grant from Bloomberg Philanthropies. In 2015, the private research company Arup committed to US$1 million of consultancy support over three years as part of a partnership agreement with C40. In 2011, C40 partnered with ICLEI and WRI to develop the GPC as “the first internationally accepted framework for city-level GHG inventories” (C40 2016). In the same year, C40 partnered with CDP “to bring self-reported data from the world’s largest cities into a comprehensive report […]” (C40 2016). This included the development of a specific reporting portal for C40 member cities.

(Sources: Arup & C40 2015; C40 2015a, 2016).

The GPC follows a conventional geographic-plus **accounting approach** that emphasizes the inclusion of upstream emissions (WRI et al. 2014: 35). While consumption-based accounting is generally recognized as “complementary to the GPC” (WRI et al. 2014: 33), no alternative consumption-based or LCA methodology is provided. Nonetheless, to illustrate possible alternatives, a case study is presented in which both consumption-based and geographic-plus approaches were applied. The consumption-based inventory estimated more than twice the emissions total of the geographic-plus inventory described as “similar to the GPC” (WRI et al. 2014: 33). Although the protocol is primarily designed for cities, it can be used at all administrative levels, except for the national, as its geographic boundary concept is not limited to the city scale. However, emissions occurring from activities within the geographic boundary of a city and city-induced emissions are estimated separately.

Similar to earlier protocols, the **Scopes** framework is applied to distinguish between emissions that occur within and outside the city boundary. Scope 1, also called the territorial Scope, includes “emissions from sources located within the city boundary” (WRI et al. 2014: 30). City inventories can be aggregated at the subnational and national level by combining only Scope 1 emissions, called territorial accounting, to avoid double-counting. Scope 2 includes emissions “occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary” (WRI et al. 2014: 30). Scope 3 covers “[a]ll other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary”[8] (WRI et al. 2014: 30).

As an alternative to the Scopes framework, the **city-induced framework** covers emissions “attributable to activities taking place within the geographic boundary of the city” (WRI et al. 2014: 35) and includes only selected Scope 1, 2 and 3 emission sources. The city-induced framework offers two reporting levels

8 The protocol also refers to the optional inclusion of emissions “associated with activity in a city – such as GHG emissions embodied in fuels, water, food, construction materials” (WRI et al. 2014: 33) that are covered in other Scope 3 emissions. It is argued that this “[…] allows cities to take a more holistic approach […] by assessing the GHG impact of their supply chains, and identifying areas of shared responsibility for upstream and downstream GHG emissions” (WRI et al. 2014: 33). The guidance material for this operation has yet to be published.

to choose from according to the data available: The simplified BASIC level is less data demanding but results in a less complete inventory, whereas the BASIC+ level allows for a more complete inventory but demands more comprehensive data.

The BASIC level covers emissions that, according to the GPC, are similar for most cities and for which the required data and calculation methodologies are often readily available, such as emissions from stationary energy, in-boundary transportation, and in-boundary generated waste. As it does not cover all IPCC emission sectors, this limited framework is not compliant with the IPCC Guidelines (WRI et al. 2014: 35f). Emissions included are Scope 1 emissions from stationary energy, transportation and waste, all Scope 2 emissions from stationary energy and transportation, and Scope 3 emissions from the treatment of exported waste. Excluded from this are emissions from energy production supplied to the grid and imported waste, both of which are reported in the Scope 1 total (WRI et al. 2014: 35).

The more demanding BASIC+ level totals all BASIC sources, plus all Scope 1 emissions from IPPU and AFOLU and all Scope 3 emissions from stationary energy, limited to T&D losses, and transportation (WRI et al. 2014: 36).

The GPC does not provide a particular methodology for LGO emissions, but outlines a rudimentary framework based on the IEAP's government section. Emission Scopes for LGO inventories are defined following the IEAP's approach of control and influence. Thereby, the location of emissions occurrence is not taken into account (WRI et al. 2014: 158f). Similar to the Corporate Standard, "the local government should account for all quantified GHG emissions from the facilities over which it has financial and/or operational control" (WRI et al. 2014: 158) where facilities are jointly used by multiple levels of government. Specific LGO emission categories beyond the sectors and sub-sectors defined for the Scopes and city-induced framework include electricity or district heating/cooling generation, street lightning and traffic signals, buildings, energy consumption from the operation of facilities, such as water supply, wastewater or solid waste, vehicle fleet, employee commute, and emissions from biodegradation in wastewater and solid waste (WRI et al. 2014: 159).

Emission sectors covered by the GPC are stationary energy, transportation, waste, IPPU, AFOLU, and other Scope 3 sources (WRI et al. 2014: 30). These sectors are consistent with the IPCC Guidelines, although the GPC labels some sectors differently, e.g., it differentiates between stationary energy and transportation, whereas the IPCC Guidelines classify these emission sources entirely as energy (see WRI et al. 2014: 156). The GPC uses a common emission factor based **quantification method** (WRI et al. 2014: 47) and defines the stationary energy sector as covering the consumption of fuel and grid-supplied energy within the city-boundary, T&D losses from grid-supplied energy, and fugitive emissions from fossil fuels extraction and processing. Similar to other protocols, emissions from stationary energy are estimated from the consumption side. Grid-energy consumption is modeled from the amount of electricity consumed. T&D losses are estimated from the amount of energy transmitted and the average loss rate of the grid. Fugitive emissions are either measured directly or estimated from the quantity of production in fuel extraction and processing.

The transportation sector includes fuel combustion and grid-supplied energy for in-boundary transport, emissions from transboundary transportation, and T&D losses from grid-supplied energy used for transport. Mobile combustion both in-boundary and transboundary is calculated either from fuel sales or based on the GPC's own Activity, Share, Intensity, Fuel (ASIF) model, using the distance travelled by vehicle type and type of fuel used (WRI et al. 2014: 160).

In the waste sector, emissions from solid waste disposal are recommended to be estimated using the FOD method. If sufficient data is unavailable, the amount and composition of the waste disposed in the inventory year are accepted as input data, which is called the Methane Commitment method. Emissions from the biological treatment of waste are calculated from the mass of organic waste treated by treatment type. Emissions from incineration and open burning are calculated accordingly, based on the mass of waste incinerated and its fossil carbon fraction. Similar calculations are applied for emissions from wastewater treatment, using the organic content of wastewater per treatment type (WRI et al. 2014: 161).

The GPC does not recognize IPCC Tiers to signal **data precision levels** (WRI et al. 2014: 47). Instead, the quality of activity data and emission factors should be reported as high, medium or low "based on the degree to which data reflect the geographical location of the activity, the time or age of the activity and any technologies used, the assessment boundary and emission source, and whether data have been obtained from reliable and verifiable sources" (WRI et al. 2014: 52). Compared to the IPCC Tiers approach, this concept is easier to interpret but less precise.

Reporting requirements include the description of the inventory boundary, information on emissions by sector, Scope, gas and total, the separate reporting of emissions from biogenic origin, the methodologies used and the data quality, as well as information on emission changes (WRI et al. 2014: 39). Throughout the protocol, calculations are made transparent in detail for each emission sector and the respective methods applied. The GPC defines verification criteria and an accompanying **verification process** to ensure compliance of inventories with the requirements of the protocol as follows:

> "Inventory boundary is clearly and correctly defined. All required emission sources are included and notation keys have been used appropriately. Calculations are consistent with the requirements of the GPC. Data are time- and geographically-specific to the inventory boundary and technology-specific to the activity being measured. Data are sourced from reliable and robust sources and referenced appropriately. All assumptions are documented." (WRI et al. 2014: 148)

However, the protocol also states that „[t]he 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" (WRI et al. 2014: 145). Compliance does not depend on an external authority but can be declared by the city itself, unless the inventory is supposed to be submitted to a carbon disclosure platform that requires conformity with the GPC (WIR et al. 2014: 149).

Box 5. The Compact of Mayors

The Compact of Mayors is a joint initiative by ICLEI, C40 and UCLG, supported by UN-Habitat. According to the Compact, 491 cities have committed as of May 2016, representing more than 400 million people. The prestigious collaboration was launched in September 2014 by Ban Ki-Moon and Michael R. Bloomberg at the UN Climate Summit in New York City. The founding statement defines its character and goals as follows:

> "The Compact of Mayors is an agreement by city networks – and then by their members – to undertake a transparent and supportive approach to reduce city-level emissions, to reduce vulnerability and to enhance resilience to climate change, in a consistent and complimentary manner to national level climate protection efforts. The Compact of Mayors builds on the ongoing efforts of Mayors that increasingly set ambitious, voluntary city climate commitments or targets for greenhouse gas (GHG) emissions reduction and to address climate risk; report on progress towards achieving those targets by meeting robust, rigorous and consistent reporting standards (as established through City Networks); and make that information publically available by reporting through a recognized city platform." (Compact of Mayors 2016)

The focus of the Compact is on the standardization of emission measurements and reporting them in a publicly transparent way: "For the first time, the Compact will standardize the way city climate data is reported, establishing a universal approach to data collection. The data can be aggregated to highlight the collective impact of city actions, which will increase global and investor confidence" (Compact of Mayors 2016). Like C40, the Compact is chiefly funded by Bloomberg Philanthropies.

The Compact's standardization efforts are strongly reflected in its registration requirements. To become a member, firstly, along with a letter of intent, the mayors have to register their city on either cCR or CDP. Secondly, the city has to take inventory of their greenhouse gas emissions using the GPC, identify hazards and report the results either to cCR or CDP. Thirdly, reduction targets have to be developed and a system of measurement has to be established to update the inventory within the following two years. Finally, within three years, a strategic action plan has to be prepared to show the city "will deliver on its commitment to reduce greenhouse gas emissions and adapt to climate change" (Compact of Mayors 2016). Ultimately, the Compact advertises standardization as instrumental to advertising its members' climate and sustainability actions and encouraging public and private sector investments.

The GPC is the mandatory tool for Compact members to conduct their emission inventories, whereas both cCR and CDP serve as recognized reporting platforms. Ultimately, however, cCR is the single platform through which these data are made available to the public. This set up has clearly been influenced by previously existing agreements and partnerships between ICLEI and cCR and C40 and CDP, respectively. Still, cCR may also serve as the reporting platform for inventories that were conducted under commitments that are recognized by the Compact of Mayors but do not necessarily apply the GPC, such as the US Climate Protection Agreement (2005), the Covenant of Mayors (2008), the Making Cities Resilient Campaign (2010), the Mexico City Pact (2010), or the Durban Adaptation Charter (2011).

(Sources: C40 et al. 2014; Compact of Mayors 2016).

3.5 Which way forward in municipal emissions accounting?

Ibrahim et al. (2012) demonstrate how the specific characteristics of inventory protocols result in different inventories when applied to the same city or metropolitan region[9] (Ibrahim et al. 2012: 227, 231ff). For community inventories, the authors identify great inconsistencies in the inclusion of emissions, especially Scope 1 and Scope 3 emissions. Such differences cannot be attributed to accounting methods alone, but also mirror the different purposes that protocols are intended to serve. For example,

[9] Ibrahim et al. (2012) apply the IEAP, the International Standard, the BEI/MEI, Bilan Carbone, the Corporate Standard, the Greenhouse Gas Regional Inventory Project (GRIP) and the ISO 14064 to the cities of New York, Shanghai and Paris in order to compare the resulting LGO and community inventories in terms of absolute emissions captured and sectors included.

the BEI/MEI captures the smallest amount of emissions with its consumption-based accounting method. However, this does not mean that consumption-based accounting in general is a less robust approach to emissions accounting. Rather, the BEI/MEI is geared towards providing a methodology that is universally applicable to EU cities, while recognizing the diversity of traditions, needs and experiences in emission inventorying in each member state. It provides a great degree of openness and flexibility in order to avoid the exclusion of possible users, and has therefore here been categorized as an open protocol. Furthermore, because it is used to define a baseline for a Sustainable Energy and Climate Action Plan (SECAP), the BEI neglects emission sources other than final energy consumption.

On the other end, the International Standard and the IEAP, which we have termed conventional protocols, both claim to be global solutions to emission inventorying for cities. However, whereas the IEAP is designed to provide a comprehensive stand-alone methodology and trades a certain degree of completeness for a stricter standardization of reporting requirements, the International Standard benefits from the groundwork laid by the IEAP and, in a way, is built to exploit the strengths of pre-existing documents by incorporating them into its own framework. This approach may provide a more complete emission inventory, but must be assumed to result in a lower degree of comparability if the document does not use reporting requirements as strict as, for example, the IEAP.

Bilan Carbone as a specialized protocol, in turn, follows an entirely different approach and provides the most complete inventory of all protocols considered here. Nonetheless, the data requirements of the LCA are tremendous and demand a complex and costly data collection process. Ibrahim et al. suggest that Bilan Carbone clearly benefitted from its orientation towards French cities, especially when compared to conventional protocols, such as the International Standard (Ibrahim et al. 2012: 235).

The GPC as a new player in the field follows a geographic-plus approach that does not recognize alternative consumption-based or LCA approaches. It is strictly oriented towards the IPCC Guidelines with exception of its data precision levels and applies a modified version of the Corporate Standard's Scopes framework. Therefore, the GPC also can be classified as a conventional protocol that does not differ significantly from previously developed methodologies of the same category. Nevertheless, when directly compared to these protocols, the GPC can be deemed the most comprehensive and user-friendly methodology within its category: It provides the most detailed guidance on the calculation of emissions and input data and accepts a certain degree of flexibility by provision of its BASIC and BASIC+ reporting levels. It roughly prescribes a voluntary verification process (albeit it does not require an external auditor) and formulates extensive reporting requirements. It also extends the average number of compounds by adding NF_3 to the Kyoto basket and simplifies the IPCC's Tier method, making it easier to interpret but less precise. However, the GPC does not provide a stand-alone solution to municipal emissions accounting as it refers to the IEAP for LGO inventories. Also, it cannot solve the known issues of geographic-plus and production-based accounting described in section 1.4. This becomes particularly evident when the new protocol is compared to consumption-based accounting or LCA methodologies, such as Bilan Carbone or the energy-section of the BEI/MEI.[10]

[10] This is not to imply that the BEI/MEI is overall more comprehensive than the GPC, which it definitely is not.

Ultimately, the GPC does not bring much new in technical terms to the table of global inventory standardization. However, this might be a different story when the implications on the arena of transnational city networks are considered. The GPC now serves as the mandatory protocol for Compact of Mayors signatories and, accordingly, will supersede the IEAP as both the underlying methodology of the HEAT+ tool and the emission inventories reported to cCR. CDP supports its application by simplifying its reporting procedure for inventories that were compiled using the GPC. The PAS 2070:2013 Specification for the Assessment of Greenhouse Gas Emissions of a City (2013) by the British Standards Institution (BSI) incorporates parts of the GPC's methodology. ISO 37120 Sustainable Development of Communities[11] (2014c) requires cities to use the GPC to measure their GHG emissions (Greenhouse Gas Protocol 2016). Furthermore, the GPC is recommended by or incorporated into a variety of initiatives by city networks and international organizations, such as the World Bank's Low Carbon, Livable Cities Initiative or the Emerging and Sustainable Cities Initiative (ESCI) by the Inter-American Development Bank (Greenhouse Gas Protocol 2016).

The Compact of Mayors takes the lead role in lobbying and advertising the GPC as a means to make city-scale climate action visible and comparable. However, comparability of emission inventories and reductions can be expected to pose a general problem when a great number of cities with diverse characteristics are considered, notwithstanding their application of a common "standardized" inventory methodology. As Andrew and Cortese (2011) find for corporate emission inventories, comparability cannot be guaranteed between inventories from different companies even when these are from the same sector and apply the same inventory methodology. From a comparison of inventories of Australasian metal and mining companies that were conducted using the Corporate Standard and reported to CDP, the authors conclude that the inventories assessed were barely comparable. Similar problems may also occur among municipal inventories. Even those protocols that claim to provide a standardized methodology have been developed in a particular context and have to be re-interpreted by its users by a certain degree. Therefore, further research is necessary on the comparability of municipal inventories compiled under the same methodology.

4 Conclusion: The GPC as a sociotechnical passage point for future city climate actions

What can be concluded from this analysis is that contrary to the image that its advocators may want to create, the GPC is not capable of revolutionizing the field of municipal emissions accounting in technical terms. The GPC eventually represents what we argue is a conventional protocol. However, the GPC can be expected to play an important role in the political future of the city networks that initiated its

[11] ISO 37120 is an international standard on city data. It establishes a „set of standardised indicators that provide a uniform approach to what is measured, and how that measurement is to be undertaken" (ISO 2014b: 1). The standard is aimed at cities, municipalities and local governments to make their GHG performance comparable. It thereby requires cities to measure their GHG emissions using the GPC as part of its climate change indicators (Gold Standard 2016). As of mid-2014, by its own account, the standard has been used by about 250 cities (ISO 2014a).

development. Whether it will be successfully established as a globally agreed standard is yet to be seen, and the effects on the role of cities and regions in international climate negotiations are difficult to predict. However, we expect that the GPC's potential success will not so much be based on its technical specifications, but on the lobbying and advertising efforts and resources of its users and developers, first and foremost the Compact of Mayors. Due to its conventional geographic-plus methodology the GPC cannot solve known issues of production-based accounting, nor contribute to advance the field of municipal emissions accounting in general. Instead of working towards increasing inclusion of emission sources into municipal inventories, the GPC is working towards including as many political actors as possible.

However, the new protocol provides an ambitious attempt to demonstrate the climate change mitigation and adaptation efforts by cities and regions at the international level. The development of the GPC underlines the efforts by these actors to strengthen their role in relation to the UNFCCC process and the UN 2030 Agenda for Sustainable Development (ICLEI 2015b: 1f). It serves to demonstrate the role that local and subnational governments could play in future climate mitigation, and to argue for the distribution of international funds towards financing local climate actions, for example via the Transformative Actions Program (TAP) (ICLEI 2015b: 1).

Fuhr and Hickmann (in press) describe cities as particularly dependent on external finance to implement climate actions. However, financial support from national budgets remains insecure and limited as long as international climate negotiations lack reliable outcomes in the form of binding reduction targets (Fuhr & Hickmann in press: 4). On the other hand, transnational climate initiatives have been taking on strict regulations by themselves way before international negotiations produced binding results. Accordingly, the authors see sub-national and non-state actors as pioneers in the fight against climate change that could also catalyze more ambitious outcomes at the international level (Fuhr & Hickmann in press: 5). Some progress, in this respect, can be witnessed in Article 6 of the 2015 Paris Agreement (UN 2015a) where the role of cooperating state and non-state actors in fulfilling Nationally Determined Contributions (NDCs) to the agreement is both recognized and strengthened (UN 2015a; Marcu 2016; ENB 2015). Against this background, efforts such as the GPC appear plausible for city networks that aim to play an active part at the international level. Subscribing to GHG measuring tools might become an important argument in the competition for funding opportunities for community-scale climate actions, and to influence international regulations.

As part of this agenda, ICLEI shows particular interest in establishing the GPC as one of the indicators that will monitor the targets within the UN Sustainable Development Goals (SDG). The UNFCCC Local Authorities Majors Group (LAMG), for which ICLEI acts as focal point, successfully lobbied for the inclusion of SDG 11, „Make cities and human settlements inclusive, safe, resilient and sustainable“ (UN 2015b: 14). The LAMG recommends use of the GPC as one of five „selected bottom-up initiatives for monitoring sustainability at the local and subnational level“, with the cCR as a possible data source (LAMG 2015: 5). Such endeavors are clearly in line with UN Secretary General Ban Ki-Moon's call for a "data revolution",[12] which includes efforts to make climate and emissions data more easily accessible.

[12] For more information on Ban Ki-Moon's proposal, see http://www.undatarevolution.org/.

The literature on transnational municipal networks (TMN) has long argued that efficiency of local climate actions can only be proven by standardized measurements (Bulkeley/Nevill 2010, Giest/Howlett 2013, Bulkeley/Betsill 2013). As Fünfgeld (2015: 70) argues, such practices have the power to "enhance reputation" for participating cities. By using standardized emission reporting as a political argument, claims for effectiveness – based on quantifiable data on emission reductions – translate into political claims by transnational actors.

Furthermore, in order to establish a genuine political arena for local governments and city networks alongside international negotiations, a Climate Summit for Local Leaders was held by UCLG, the Climate Alliance, C40, Bloomberg Philanthropies, WRI, The Climate Group, ICLEI and others in the Paris City Hall during UNFCCC COP21 in 2015. In the ensuing Paris City Hall Declaration, the proponents declared their will to strengthen the ongoing initiatives of cities and regions' networks, and to support the UN NAZCA platform and the Local Government Climate Roadmap "to ensure the visibility of these initiatives" (Climate Summit for Local Leaders 2015). In all these efforts, the GPC is positioned as a means of demonstrating the importance of cities and regions for climate adaptation and mitigation. Thereby, these actors explicitly strive for greater influence on international climate negotiations, be it to receive further funding for climate actions or to unlock "green" investment opportunities and economic growth. Moreover, the GPC and cCR have explicitly been advertised as the only tool and platform, respectively, that allow for vertical and horizontal integration which is described by cCR as crucial to a change from business as usual scenarios of rising emissions to an optimization of national and local climate strategies (cCR 2015: 26).

We therefore argue that we are witnessing a strategic moment in transnational climate policy. While cities and transnational networks are pushing for recognition on the international stage, standardized municipal emissions reporting gains increasing political power. In this sense, emissions reporting can be understood as a sociotechnical practice. The statement "if you can't measure it, you can't manage it", used by a variety of actors to argue for use of the GPC, nicely demonstrates this point. Managing carbon here stands for the role of local and municipal actors as it has been increasingly recognized in the UNFCCC process (Pattberg & Widerberg 2015). The technology of the municipal emissions inventory then underlines the political aspirations of its proponents to enter the global stage of climate governance. This is therefore a coproductive moment (Jasanoff 2004) as well, because emerging transnational political agency – exemplified by the founding of the Compact of Mayors in 2014 – and the ongoing standardization of municipal GHG reporting are both building upon each other.

In this context, the GPC is instrumental to showcase the accountability and comparability of municipal climate actions, despite the technical difficulties of actual comparisons across inventories. The GPC might therefore have the potential to act as an "obligatory passage point" (Callon 1986) for transnational climate governance. If the ambitions to establish the GPC as a globally agreed standard for municipal emissions accounting should prove successful, it could reorder the field of transnational climate governance: the transnational arena might substantially change if standardized emissions accounting becomes a prerequisite for political representation or financing in the future.

The emergence of a widely-used standardized reporting tool such as the GPC can be interpreted as a widening as well as a narrowing of the political field. On the one hand, this practice facilitates the visibility and legitimacy of cities and other subnational actors. But on the other hand, if standardization and normalization foster legibility, accountability and legitimacy, there might also be effects on actors that do not take part in these practices, as they might be excluded from this emerging community of practice (Wenger: 1998). Therefore, it remains interesting to see how other important players of transnational climate governance that are not directly linked to the Compact of Mayors, such as the Covenant of Mayors and the Climate Alliance, will react to this agenda, and if they will accept the GPC as a methodology that is compliant with their own inventory requirements.

Finally, actors that aim for more fundamental changes in economic, social and political structures in answer to the global climate crisis might simply not be part of this picture. Unsurprisingly, the Paris Agreement and the Agenda for Sustainable Development (UN 2015a, b) are both based on the old formula of achieving climate protection and sustainable development through economic growth – a narrative that has been contested since the early 1970s and is seeing increasing opposition in recent years (Wilmsen 2015). With its underlying growth paradigm and technological optimism, the GPC clearly is an instrument to make the economic value and competitiveness of cities in the ever so often quoted transition to a low-carbon future or a “Green New Deal” (Friedman 2007) visible. In this sense, the GPC can ultimately be characterized as a new passage point on an old road.

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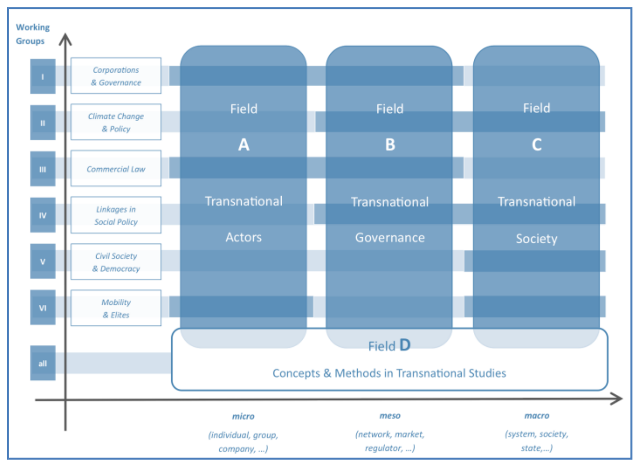

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