



Widening the perspective in greenhouse gas emissions accounting: The way forward for supporting climate and energy policies at municipal level

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ABSTRACT

The transition towards low-carbon economy requires a number of specific actions by a multiplicity of actors in order to reduce greenhouse gas (GHG) emissions, entailing energy efficiency, production of energy from renewable resources as well as the diffusion of more sustainable production and consumption patterns. Among the actors, local authorities can play a leading role for climate action. However, properly accounting for GHG emissions at local scale and identifying actions for GHG reduction are still an open challenge in many contexts. In this paper, we propose a method for GHG emissions accounting to support the identification of proper actions to achieve GHG reduction targets. The method widens the classical production-based approach to accounting, by proposing an extension of the accounting to three main areas: waste management and recycling, consumption patterns, and local land management. Life cycle thinking is applied as methodological basis for such extension. To illustrate the benefit of the proposed approach, the method has been applied to 16 municipalities (in Northern Italy), which were signatories of the Covenant of Mayors (CoM) initiative. CoM is a European initiative by which local authorities voluntarily commit to reduce their GHG emissions through the implementation of Sustainable Energy Action Plans. A comparison of the emission profile of the different municipalities helps identifying common patterns and local peculiarities to be addressed to achieve the reduction target. For the analysed case studies, the biggest contribution to GHG emissions comes from the consumption of the natural gas and electricity by the household sector. Emissions from waste generation play a minor role in the selected case studies. However, the inclusion of avoided emissions coming from waste recycling highlights the reduction potential if an appropriate waste management system is in place. Consumption patterns, as well, may play a relevant role. For example, assessing GHG emissions related to food consumption on top of those due to other drivers, the total municipal emissions change by increasing for an average of 22.6% for the selected case studies. Moreover, local land use planning and management should be included in the assessment, being crucial not only for the emissions uptake but also for climate mitigation and adaptation. The proposed approach to GHG accounting, including consumption-based aspects, may help identifying a wider set of climate actions to be implemented by local authorities to reduce environmental burdens.

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1. Introduction

“Before the Industrial Revolution in the 19th century, global

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average CO₂ was about 280 ppm. During the last 800 000 years, CO₂ fluctuated between about 180 ppm during ice ages and 280 ppm during interglacial warm periods. Today's rate of increase is more than 100 times faster than the increase that occurred when the last ice age ended” (NOAA, 2013). Greenhouse gases (GHG) (such as: CO₂, CH₄, N₂O, CFCs, etc.) affect climate change strengthening the *greenhouse effect*. They are also measured as equivalents of CO₂, on the basis of their Global Warming Potential (GWP). Combustion processes for energy generation, mobility, heating, as well as

electricity consumption largely affect the GHG emissions (EEA, 2013a). Increasingly, the role of consumption patterns of energy and good is recognised as a key element to be addressed (Notarnicola et al., 2017). In Europe, the growth in GHG emissions calculated with consumption-based approaches contrasts with the decreasing trends for EU emissions calculated using production-based ones (EEA, 2017). For this reason, the energy planning and policies should be complemented with consumption-oriented considerations in order to better support climate policies.

Since the 70s, the United Nations has undertaken many international initiatives to tackle climate change. A milestone in these regards was the Kyoto Protocol, an international agreement linked to the United Nations Framework Convention on Climate Change, which committed its Parties (Countries) by setting internationally binding emission reduction targets (UNFCCC, 2005). At the end of 2012 the Protocol have been extended through the Doha Amendment (UNFCCC, 2014), and Post-Kyoto commitments have been framed within the Paris Agreement of 2015 (UNFCCC, 2015), which is a legally binding agreement between Parties (197 Countries) for climate change, including mitigation and adaptation. The agreement recognizes the role of non-signatory entities as regions, cities, and local authorities in addressing climate change.

At the European level, the EU Climate and Energy package (European Commission, 2010a, 2008) aimed at developing a low-carbon economy, and fixed targets for: i) increasing the share of energy produced from renewable resources; ii) decreasing the GHG emissions; and iii) improving energy efficiency. The 2030 climate and energy framework updates key targets for the year 2030 and builds on the 2020 climate and energy package. The envisaged “climate action” (European Commission, 2014) sets three key targets for the year 2030: i) at least 40% cuts in greenhouse gas emissions (from 1990 levels); ii) at least 27% share for renewable energy; and, iii) at least 27% improvement in energy efficiency.

Globally, local authorities play a key role in the achievement of the energy and climate objectives. At European level, since 2008, a specific initiative for involving local authorities in achieving GHG reduction has been promoted: the Covenant of Mayors (CoM) initiative (European Union, 2017). CoM initiative has been originally defined in order to support local authorities which voluntarily commit to reduce their GHG emissions beyond the 20% target (European Commission, 2010b). At the end of 2017, the initiative involves more than 7700 local and regional authorities going beyond EU (across 57 countries) and resulting in a worldwide multi-stakeholder movement (European Union, 2017). One of the peculiarity of the CoM initiative is the broad involvement of small municipalities in the effort to reduce GHG emissions. Indeed, small and medium municipalities are representing more than 80% of the total number of signatories of the initiative (Kona et al., 2015).

When the CoM initiative was launched, the minimum commitment was to reduce the level of emissions by 20%. The first CoM signatories had estimated for 2020 an overall reduction of 28% of the GHG emissions in comparison with the reference years (Kona et al., 2015). Nowadays, new signatories are committed to reduce CO₂ emissions by at least 40% by 2030 and to adopt an integrated approach to tackling mitigation and adaptation to climate change.

From the geographical point of view, the initiative has been successful especially in the Mediterranean Europe, since “the Country with the biggest number of inhabitants involved in this action is Italy (30 million inhabitants), followed closely by Spain (24 million inhabitants)” (Cerutti et al., 2013).

Key element to define climate actions and plans is a comprehensive analysis of the actual situation of GHG emissions, including sectors, carriers, and vectors that cause the GHG emissions. Building from the GHG emission accounting, Sustainable Energy Action Plans (SEAPs) may be defined, namely identifying concrete

reduction measures, together with time frames and assigned responsibilities, which translate the long-term strategy into actions. CoM initiative concerns mainly actions at local level within the competence of the local authority, defining measures aimed at reducing the GHG emissions and final energy consumptions by end users. The CoM's commitments cover the whole geographical area of the local authority. Therefore, the action plans should include actions concerning both the public and private sectors (European Commission, 2010b).

In the context of the Covenant of Mayors, the Baseline Emission Inventory (BEI) is defined as the quantification of the amount of GHG emitted due to energy consumption in the territory of a Covenant signatory within a given period of time (European Commission, 2010b). The BEI allows identifying the principal sources of GHG emissions and their respective reduction potentials. Local authorities should use the results of the BEI to identify the best areas of intervention and opportunities for achieving GHG reduction target. In order to help local authorities developing their emission inventories and designing their own action plan, the guidelines for the Covenant of Mayors have been evolving over time, towards inclusion of additional aspects, e.g. related to climate change adaptation and mitigation (Neves et al. 2016). However, the original focus of the GHG accounting has been mainly production-based.

However, three broad consumption categories — housing and utilities, mobility, and food — account for approximately half of European household expenditure and more than two-thirds of the direct and indirect environmental pressures caused by household consumption (EEA, 2013a,b). Consumption-based approaches to GHG accounting has been already extensively discussed in literature, including the analysis of the possible link with local authority socio-economic structure (Larsen and Hertwich, 2010). Hence, besides what already is included in BEI (namely housing and mobility), it could be important to include other drivers of consumption-based emissions.

In this paper, we propose an extended GHG emission accounting method which is including additional perspective in the accounting, building on generally available data, needing limited data collection but still capable to provide useful insight for action planning. The proposed method aims at addressing several drivers of emissions, related to a different policies at local scale (energy, waste, land use planning, sustainable production and consumption), highlighting their relevance in terms of GHG emissions. Hence, the method includes the sectors inventoried in the CoM, plus an additional estimation of GHG emissions avoided through: recycling of waste (relevant for including aspects related to e.g. circular economy), land use planning, and consumption of goods (relevant for addressing broadly the production and consumption patterns).

Specifically, the method has been tested on 16 municipalities of Lombardy Region which adhere to the CoM in 2010 (Fondazione Idra, 2011). This formal commitment was accompanied by the proposal of a SEAP, describing the emission reduction actions planned by the local authorities and to be achieved by 2020.

2. Materials and methods

Approaches to GHG accounting for local authorities can be different. For example, EEA (2013b) identifies three accounting perspectives, with reference to the scope of the emission inventory of a defined geographical area:

- **Territorial perspective.** Emissions are accounted for when emitted within the local authorities boundaries (being a country, region, municipalities). At country level, this is the only

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