LOW CARBON URBAN STRATEGIES: AN INVESTIGATION OF 124 EUROPEAN CITIES

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ABSTRACT

Local governments play a crucial role in reducing CO_2 emissions. In order to endorse and support the efforts of local authorities, the European Commission launched the Covenant of Mayors (CoM) in 2008: by November 2016 more than 7,000 local authorities had signed the CoM, accounting for 212 million inhabitants. Covenant signatories commit to reduce CO_2 by at least 20 per cent in 2020 (in respect to the level in a baseline year), to prepare a Baseline Emission Inventory (BEI) and to submit a Sustainable Energy Action Plan (SEAP). The SEAP is the key document in which each Covenant signatory outlines how it intends to reach its CO_2 reduction target. It defines the activities and measures set up to achieve the target, together with time frames and assigned responsibilities. Each SEAP includes a list of actions for reducing emissions and the quantification of their intended emission reductions.

The aim of this paper is to assess the distribution of intended emission reductions by cities among sectors, and to evaluate the relevance of the policies and actions adopted by cities to achieve these reductions. The analysis is based on data provided by a subset of cities participating in the European Commission CoM initiative: all European cities with more than 100,000 inhabitants and with an accepted SEAP by February 2014 are included in the study. The sample is composed of 124 cities implementing more than 5,500 actions. Each action has been classified based on the official description into a “category of action” (area of intervention targeted by an action) and into a “policy lever” (instrument used by the local authority to implement the action).

Cities in the sample account for a total of 370 megatons of CO_2 emissions in selected baseline years and 94 megatons of intended emission reductions per year. The total emission reduction planned by cities corresponds to 25 per cent of baseline emissions, beyond the minimum target of 20 per cent required by the CoM. Emission reductions are concentrated in the Building and Transport sectors. Furthermore, sectoral analysis points out that the largest portion of intended emission reductions derives from actions implemented by private actors. However, actions in sectors under the direct control of cities’ administrations are planned to deliver higher reductions with respect to the correspondent baseline emissions.

In the Building sector, the category of action delivering the highest share of CO_2 emission reduction is integrated actions, which combines several types of intervention to maximise the energy efficiency of buildings; in the Transport sector, it is modal shift, which implies a transition from private transport to public and cleaner transport modes. In both the Building and Transport sectors, cities plan to reduce the major amount of CO_2 emissions through the implementation of management and organisation, infrastructure construction, and awareness-raising infrastructure policy levers.

The results can be used by policy makers at different government levels to facilitate the implementation of planned actions, to reshape their mitigation strategies in coherence with cities' commitments and plans and to replicate policies and actions on the basis of CoM signatories' experiences.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Role of cities in climate change mitigation

Cities are responsible for 67 per cent of the total global energy consumption (IEA, 2012) and more than 70 per cent of GHG emissions. Data from world cities suggest that climate, technology, density and wealth are important drivers of energy use and CO_2 emissions (Creutzig et al., 2015; Kennedy et al., 2009). Indeed, cities are important contributors to GHG emissions, even if different quantifications of their contribution are provided in statistics. The evaluation depends on methodological choices, like the definition of city boundaries, which could be administrative, functional or morphological.[1] Quantification also depends on the choice of emission accounting method (see paragraph 2.1). Furthermore, IPCC's last report (IPCC, 2014) shows uncertainty in the estimation of the urban share of global GHG emissions (Seto et al., 2014).)[2] Nevertheless, all estimations agree on the increase of total urban emissions in recent years, in correspondence with fast urbanisation and the concentration of human activities generating emissions. However, the empirical relationship between urbanisation and GHG emissions per capita is not conclusive (Lankao et al., 2008). Inventories show that urban emissions per capita can differ considerably in the world, ranging from 2 to 30 tCO_2eq (Dodman, 2009; Kennedy et al., 2009; Sovacool & Brown, 2009). Differences in emission levels depend on drivers, among which are climate conditions, urban form, demographics, economic activities in place, state of technology, mobility and housing infrastructures, and income and lifestyle of city residents and users (Croci et al., 2011; UN Habitat, 2011).

Urban form and infrastructures, in particular, significantly affect direct and indirect GHG emissions and are strongly linked to the throughput of materials and energy in a city, the waste it generates and the efficiency of its metabolism. Mitigation options vary by city features and development levels. The options available for rapidly developing cities include shaping their urbanisation and infrastructure development trajectories. For mature, built-up cities, mitigation options lie in urban regeneration (compact, mixed-use development that shortens journeys, promotes transit, walking and cycling, adaptive reuse of buildings) and rehabilitation/conversion to energy-efficient building designs (Seto et al., 2014). These drivers also affect urban GHG emissions through their influence on energy demand in buildings, transport, industry and services whose GHG emissions can be mitigated via either demand-side measures or technological improvements within each individual infrastructure system.

The urban scale provides unique opportunities for policy integration between the development of infrastructures, mobility planning and energy demand management: the largest opportunities for GHG emission reduction (or avoidance of unfettered emission growth) might be precisely in urban areas where governance and institutional capacities to address them are weakest (Bräutigam & Knack, 2004; Rodrik et al., 2004). Municipalities are increasingly recognised as having a high potential to drive sustainable energy

[1] Three common types of boundary include: 1. Administrative boundaries, which refer to the political boundaries of a city (Aguilar, Ward, & Smith, 2003); 2. Functional boundaries, which are delineated according to connections or interactions between areas, such as economic activity, per capita income, or commuting zone (Douglass, 2000; Hidle et al., 2009); and 3. Morphological boundaries, which are based on the form or structure of land use, land cover, or the built environment, often provided by satellite images (Rashed et al., 2003).

[2] The IPCC 5th assessment report (Seto et al., 2014) presents different estimates of the global share of urban emissions present in literature. According to IEA (2008), urban energy related CO_2 emissions amount to 71 per cent of global emissions (2006 data). Grubler et al. (2012) estimate urban final energy use as 56–78 per cent of global final energy use, which, converted into CO_2 emissions, amounts to 53–87 per cent of global emissions from final energy use (2005 data). Marcotullio et al. (2013) estimate GHG (CO_2, CH_4, N_2O, SF_6) in urban areas in the range of 37–49 per cent of global emissions (2000 data). Regarding the boundary choice, IEA (2008) refers to all urban areas, including towns. Grubler et al. (2012) downscale national energy statistics by using GIS-based data on urban extents. Also Marcotullio et al. (2013) use spatial databases to identify urban extents, considering only urban areas with more than 50,000 residents in 2000.

and climate change mitigation actions thanks to their knowledge of their territories and local governments' responsibilities and powers. Thus, sub-national and local actors need to be involved by central governments to properly address energy and climate change issues (Bulkeley and Betsil, 2013).

1.2 The Covenant of Mayors initiative

Over the past two decades, cities have been recognised as significant players in responding to climate change. In the policy arena, the number of transnational municipal networks engaged in climate change issues has increased while their membership has diversified (Bulkeley & Castán Broto, 2013). The number of initiatives of cities that seek to address climate change appears to be rapidly proliferating. Most of these initiatives are in the form of voluntary commitments by individual cities in the framework of city networks, like ICLEI, Climate Alliance, C40 and Energy Cities at global or continental level (UNEP, 2015). However the largest initiative is the Covenant of Mayors (CoM), which shows peculiar features. In fact, the CoM is a formal voluntary agreement (Croci, 2005) between individual city governments and the European Commission through which cities commit to specific emission reduction targets. The CoM was launched in 2008 by the European Commission to endorse and support the efforts of local authorities for GHG reduction and energy efficiency, in coherence with the European targets set by the Energy and Climate package[3]. The initiative currently involves more than 7,7000 municipalities[4] (November 2016).

Municipalities joining the initiative commit to develop and implement a Sustainable Energy Action Plan (SEAP) containing measures to reduce their energy-related emissions by at least 20 per cent by 2020 compared with the emissions calculated or measured in a baseline year. 1990 is recommended as the year for the Baseline Emission Inventory (BEI) reference; nevertheless, signatories are able to choose the closest subsequent year for which reliable data could be gathered. As a result, different years have been chosen for BEIs.

Cities signing the CoM commit to follow given rules in the implementation of the agreement: i) signature of the CoM and creation of adequate administrative structures; ii) BEI and SEAP development iii) regular submission of implementation reports. Local authorities joining the CoM initiative have to submit a SEAP within the year following their adhesion and an "action report" at least every two years following the submission of the SEAP outlining the status of implementation of actions and a "full report" providing a detailed Monitoring Emission Inventory at least every four years. The main body responsible for the CoM initiative is the European Commission – DG Energy that endorses and supports the efforts deployed by local authorities in the implementation of sustainable energy policies. The European Commission also

[3] The Energy and Climate package is a set of directives and instruments aimed at reaching by 2020 the 20-20-20 targets: i) reduce GHG emissions by 20 per cent below their 1990 level; ii) increase the share of energy produced by renewable sources by 20 per cent; and iii) reduce energy use by 20 per cent below projections, increasing energy efficiency. The targets were set by the European Union leaders in 2007 and enacted in legislation in 2009. They represent the contribution of the EU to the international mitigation efforts under the UNFCCC (the United Nations Framework Convention on Climate Change). They are also headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth. The EU Energy and Climate package involves both ETS (emission trading system) and non-ETS actions. The ETS is the EU's key tool for cutting GHG emissions from large-scale facilities in the power and industry sectors, as well as in the aviation sector. The CoM contributes to emission reductions in the non-ETS sectors, accounting for some 55 per cent of total EU emissions, such as housing, agriculture, waste and transport.

[4] Besides its implementation in Europe, the CoM has also been promoted in non-European countries. In 2010, the CoM was extended to the Eastern Partnership (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine) and Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), with a specific requirement for GHG emission reduction, adapted to the characteristics of these countries. Furthermore, in January 2013, the EU opened the CoM initiative to local authorities of ten southern Mediterranean countries (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria and Tunisia) (Saheb et al., 2014).

established the Covenant of Mayors Office (CoMO), which is responsible for the coordination and daily management of the initiative. It provides signatories with administrative support and technical guidance, facilitates networking between Covenant stakeholders and ensures the promotion of their activities. The scientific and technical part of the initiative is managed by the European Commission - Joint Research Centre (JRC), which is responsible for providing technical and scientific support to the initiative and for evaluating SEAPs and monitoring reports. It works in close co-operation with the CoMO to provide signatories with clear technical guidelines and templates in order to assist delivery of their commitments as well as to monitor implementation and results. The European Commission also recognises CoM coordinators (supporting signatories in conducting CO_2 emission inventories as well as in preparing and implementing their SEAPs) and CoM supporters (providing tailored advice to signatories and identifying synergies with existing initiatives).

Reports on the first phase of CoM implementation outline the relevance of the initiative in terms of number of participants and ambition of commitments (JRC, 2015). As of mid-May 2014, 5,296 local authorities had signed the CoM, for a total of approximately 160 million inhabitants in the EU-28, and approximately 186 million inhabitants in the whole initiative. The majority of signatories with a submitted SEAP are small and medium towns below 50.000 inhabitants, representing 88 per cent of the total number of signatories in the CoM dataset. In terms of population, the highest share (72 per cent) belongs to large and medium size cities with a population over 100,000 inhabitants. The majority of signatories are located in Italy (51,6 per cent), followed by Spain (27,5 per cent), even if the distribution in terms of amount of emissions is much more even.

Building on the success of the CoM, in 2014, the Mayors Adapt initiative was launched. The initiative relies on the same governance model, inviting cities to make a political commitment and take action to anticipate and prepare for the unavoidable impact of climate change through adaptation. At the end of 2015, the initiatives merged under the newly integrated Covenant of Mayors for Climate and Energy, adopting the EU 2030 objectives and an integrated approach to climate change mitigation and adaptation. The new integrated Covenant of Mayors for Climate and Energy is based on three pillars: mitigation, adaptation and secure, sustainable and affordable energy. Signatory cities pledge action to support implementation of the EU 40 per cent GHG reduction target by 2030 and to the adoption of a joint approach to tackle mitigation and adaptation to climate change. In order to translate their political commitment into practical measures and projects, signatories of the Covenant of Mayors for Climate and Energy commit to submit, within two years of their Mayors signature, a Sustainable Energy and Climate Action Plan (SECAP) outlining the key actions they plan to undertake. The plan features a BEI to track mitigation advancements and a climate risk and vulnerability assessment. The adaptation strategy can either be part of the SECAP or developed and mainstreamed in a separate planning document. Cities are committed to reporting every two years on the implementation progress of their plans. This paper analyses data from the first Covenant of Mayors initiative. The CoM initiative has already been investigated for specific actions, such as achieving energy savings by retrofitting residential buildings (Dall'O' et al., 2013), increasing energy efficiency of public lighting (Radulovic et al., 2011) and increasing the acceptance of renewable energy within rural communities (Doukas et al., 2012). This paper aims to develop a more comprehensive analysis of all measures that can contribute to achieving CO_2 reduction targets in all sectors.

1.3 Definition of the sample

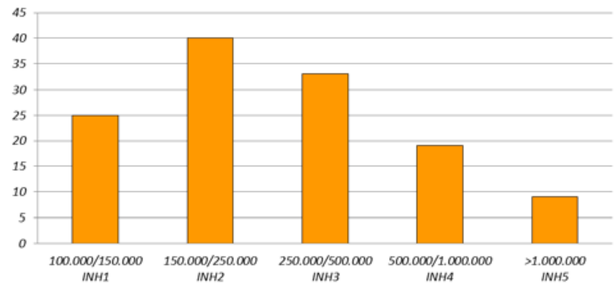
The analysis is based on data provided by a subset of cities participating in the CoM initiative. The cities included in the sample have been selected based on their size and on the SEAP acceptance status:[5] all European cities with more than 100,000 inhabitants and with an accepted SEAP by February 2014 are included in the study. The sample is composed of 124 cities (see Annex I), with populations ranging from about 108,000 to 7.67 million. Cities are well spread across Europe: 42 per cent are in Mediterranean Europe, 26 per cent in Continental Europe, 14 per cent in the UK and Ireland, 9 per cent in Northern Europe and 9 per cent in Eastern Europe.

Cities have been grouped according to six variables in order to study the sample composition: population size[6] (graph. 1.1); heating degree days (HDD); (graph. 1.2) GDP per capita[7] (graph. 1.3); population density[8] (graph. 1.4); geographical area[9] (graph. 1.5) and electricity emission factor (EEF)[10] (graph. 1.6). The variables have been selected on the basis of previous literature (Creutzig et al., 2015; Croci et al., 2011; Glaeser & Kahn, 2010; Grubler & Schulz, 2013; Kennedy et al., 2009; Makido et al., 2012; Minx et al., 2013; Peterson et al., 2009; Seto et al., 2014; UNFPA, 2009; Wiedenhofer et al., 2013).

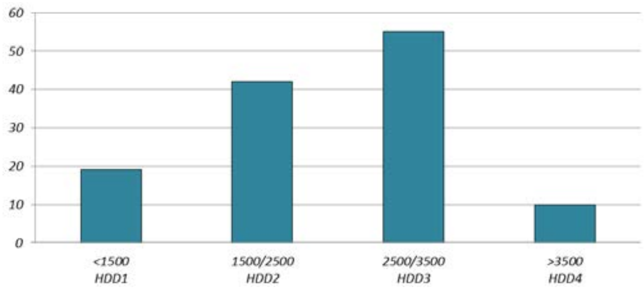
Considering the GDP, the distribution of cities shows a higher frequency in the 20,000–30,000 € class (55 cities). In population and urban density, cities are not

equally distributed among the different classes. Considering the geographical area, cities are concentrated in the Mediterranean area (53 cities). Finally, considering HDD and EEF, cities are concentrated in the average values.

Graph. 1.1 Population (number of inhabitants)



Graph. 1.2 Heating degree days (number)



[5] The acceptance of the SEAP assures that a quality check of the BEI and the intended emission reduction, as performed by the JRC, has been successfully passed.

[6] Population size on the BEI year and on the signing year, as self-declared by cities, has been used to assess scale effects on baseline emission and intended emissions reduction.

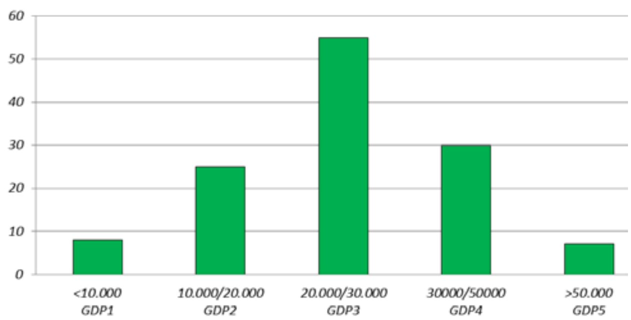
[7] Average GDP per capita for the BEI year and for the year of adhesion to the CoM have been computed based on the Urban Audit data (EUROSTAT). This allowed distinguishing between the level of GDP for the relevant year of baseline emissions and GDP in the year of emission reductions estimation, respectively. GDP at current market prices by NUTS 3 region has been associated to cities for available years. When the BEI (or signing year) was not available in the Urban Audit dataset, the closest available year in the Urban Audit has been adjusted, multiplying it by the appropriate national GDP growth at market prices (for the period between the closest available year and the year of interest). GDP growth was extracted from the World Development Indicators.

[8] Average population density has been computed as the ratio between population and city surface. Self-declared surface has been checked and corrected with data available on the official website of cities, when appropriate.

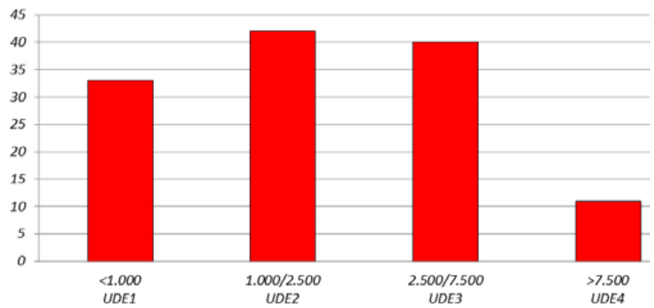
[9] Cities from Hungary, Poland and Romania have been included in the Eastern European group; cities from Greece, Italy, Portugal and Spain are included in Mediterranean Europe; Denmark, Finland, Lithuania and Sweden have been included in Northern Europe, and Belgium, France and Germany in Central Europe. The last group includes cities from the United Kingdom and Ireland.

[10] The local electricity emission factor is the self-declared amount of CO_2 emissions associated to a unit of electricity consumed in the city. This is a combination between national average emission factors for electricity consumed in the country and the emission factor associated to the share of electricity produced and consumed locally.

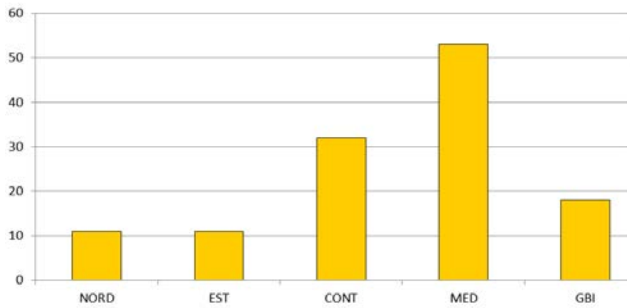
Graph. 1.3 Gross domestic product per capita (euros)



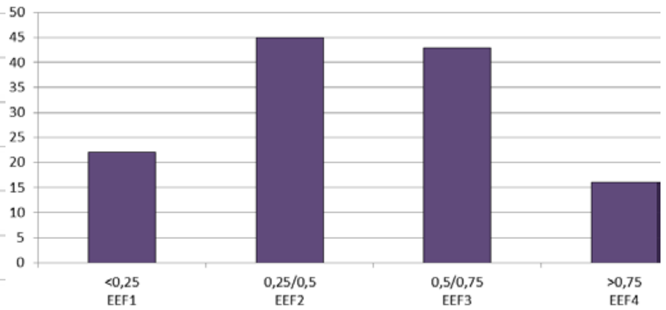
Graph. 1.4 Urban density (inh./km^2)



Graph 1.5 Geographical area



Graph 1.6 Electricity emission factor (tCO2/MWh)



2 METHODOLOGY

The paper analyses data from BEIs and SEAPs of a sample of cities. The aims are: i) to analyse the distribution of emission reductions commitments in SEAPs (intended emission reductions planned by cities); and ii) to verify which actions and policy instruments have been adopted by cities to reduce their CO_2 emissions. The paper is structured as follows: i) analysis of the distribution of emission reduction commitments; and ii) assessment of the categories of action and policy levers with the major amount of CO_2 emission reductions in SEAPs.

This chapter explains the methodology used to analyse the data provided by CoM signatories. The first paragraph introduces the guidelines and the rules that cities should follow to participate in the CoM (BEI and SEAP design). The description of the hierarchical approach used to classify the measures follows.

2.1 Guidelines for BEI definition and SEAP design

Through the SEAP, signatories commit to a minimum CO_2 emission reduction target of 20 per cent by 2020 and define the actions they intend to put in place to reach their commitment. The SEAP is a detailed set of actions, including project management information (e.g. implementation time frame, responsible bodies, costs) and estimations of impacts, per action and per sector, in terms of energy saving, renewable energy production and overall CO_2 emission reduction. The scope of the SEAP is: i) to define, to describe and to estimate quantitatively energy-related GHG reduction measures with respect to a BEI; ii) to define strategies for efficiently monitoring the effect of the implementation of measures; and iii) to define the roles of the various stakeholders in the implementation of the measures. The Covenant of Mayors methodology proposes a consolidated and flexible framework to enable local authorities to produce robust and comparable inventories of CO_2 emissions and encourages a regular reporting practice. The BEI sets the starting point and the subsequent monitoring inventories allow monitoring progress towards the target.

BEIs serve as an instrument to support local action planning on energy; therefore they are focused on emissions mainly associated with final energy consumption (including electricity and other fuels/carriers) in sectors, which can be influenced by policies implemented by local authorities (housing, services, transport). Mayors are strongly recommended to compute emission and design a strategy for emission reduction that includes both the transport and building sectors. They are key sectors for the CoM because they are relevant contributors to total emissions and they fall under the regulatory control of the local administration.

For EU signatories, the recommended baseline year is 1990, or the closest subsequent year for which the most comprehensive and reliable data can be provided. The emission reduction target is set against the baseline year and it can be set either as absolute reduction or per capita reduction. The energy-related emissions coming from other sectors might be included in the BEI, if the SEAP foresees measures for them (e.g. industry not under the ETS, highways not serving the city but on its territory). Some emission sources not related to energy consumption might be also included in the BEI, for example, wastewater and solid waste treatment. Local energy (electricity, heat/cold) production should be accounted for in the BEI when the municipalities intend to develop and implement actions aimed at reducing the CO_2 emissions also on the supply side (e.g. development of the district heating network, wind farms, PV, etc.). Emissions are calculated using the standard formula: $\sum Final\ Energy\ Consumption\ (MW\text{h}) \cdot \text{E}mission\ factors\ (tCO2/MW\text{h})$, where all relevant emission sources and their emission factors are accounted for. The CoM allows signatories to apply emission factors in energy consumption according either to the IPCC approach[11] or to the Life Cycle Assessment (LCA) approach[12], where LCA emission factors are higher than IPCC ones. Reporting of CO_2 emissions is mandatory, as it is the most important among all the GHGs associated with fuel combustion. Signatories can include emissions of methane (CH_4) and nitrous oxide (N_2O), converted into CO_2 equivalents (CO_2 eq.) according to their global warming potential (GWP). CO_2 emissions from the sustainable use of biomass/biofuels, as well as emissions from certified green electricity, are considered carbon-neutral on an annual basis. A key difference between the BEI and the SEAP emissions accounting is related to the local production of electricity and heat/cold. In the BEI, emissions from electricity and heat/cold production are associated with the sectors of final consumption. In contrast, in the SEAP intended emission reductions associated with local electricity production and local heat/cold production are allocated to a dedicated sector and estimated as the level of emissions forgone thanks to fuel substitution. This requires first estimating the type and amount of fuel that will be substituted by local production as a consequence of the action. This is multiplied by the appropriate emission factor for the fuel (or the fuel mix) substituted. For example, the share of local production of electricity generated by renewables that is consumed by households will be accounted for in the local electricity production sector of the SEAP and it will not be included in the intended emission reduction of the residential sector, to avoid double counting.

[11] The standard method for reporting GHG quantifies emissions using a national sector-based approach (Schils et al., 2005). The approach estimates emissions from the production and consumption of goods within defined national boundaries and emissions from the production of goods exported from a nation, but does not consider emissions from the production of goods imported into a country (Peters, 2008). Consequently, this method, when applied to the urban scale, includes both direct emissions (generated inside city boundaries) and indirect emissions (generated out of city boundaries, but induced by city activities, like emissions generated from electricity production plants or landfills located out of the city).

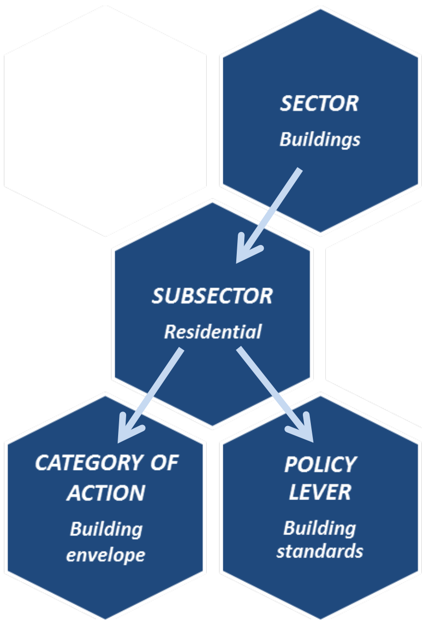
[12] LCA is a holistic system approach that aims at quantifying the potential environmental impacts generated throughout a product's lifecycle, from raw material acquisition through production, use, recycling and final disposal (International Organisation for Standardisation [ISO], 2006).

2.2 Definition of sectors and subsectors

SEAPs are organised according to a hierarchical categorisation of sectors and subsectors defined in the SEAP and monitoring templates developed by the JRC (Covenant of Mayors Office & Joint Research Centre of the European Commission, 2014; European Commission, 2010), which constitute the standard reporting framework for Covenant signatories. These have been used as main references to define the classification approach used in the analysis. All the SEAP sectors and subsectors defined in the original template (Building: *residential buildings and facilities, tertiary building and facilities*, *municipal buildings and facilities*; Transport: *private and commercial transport, public transport and municipal fleet;* Industry; Public lighting; Local electricity production; Local heat/cold production; Land use planning; Waste and Water; Working with citizens and stakeholders; Others) have been considered in the analysis; some further subsectors to the building and transport sectors, named "mixed-actions", to highlight holistic actions have been added in our analysis. Any other sector is classified as "other".

2.3 Definition of the categories of actions and policy levers

SEAPs provide specific information and descriptions of planned actions for intended emission reductions, in the form of specific actions univocally related to a sector and a subsector. Actions have been further classified, based on their description, into a "category of action", including all actions characterised by the homogeneity of the area of intervention under a certain sector and subsector, and into a "policy lever" describing the instrument used by the local authority to implement the action. Overall 5.000 actions described in the cities' SEAP sample have been analysed. 117 categories of actions and 28 policy levers have been defined. Each category of action is associated with a specific sector and subsector. Policy levers can be common to different sectors (e.g. awareness raising) or specific to a sector (e.g. building standards). For example, if the action is "thermal insulation of residential buildings", the category of action is "building envelope" and the policy instrument to implement the action could be setting new "building standards", while the subsector is "residential" and the sector is "Buildings". The following graph synthesises the classification used in the paper, providing an example of classification for the building sector.



Disaggregated reporting is compulsory up to the sector level only. Moreover, cities are allowed to report only the most significant actions. A certain amount of intended CO_2 emission reductions has not been disaggregated into actions by Covenant signatories (see paragraph 3.1) or has not been possible to attribute to specific sectors by the authors, so residual sectors have been created. These sectors are: i) "Emissions not disaggregated into specific actions", reporting intended emission reductions that have not been disaggregated among subsectors; and ii) "Not possible to assign", reporting emissions associated to actions with unclear descriptions (e.g. alphanumeric codes attributed to an action instead of a description of it) and thus impossible to attribute to a category.

Based on the share of emissions by sector and subsector in the sample, an analysis of the intended emission reductions sectoral distribution is developed. The categories of action and the policy levers are analysed in terms of recurrence in the SEAPs and in terms of amount of intended emission reductions attributed to them by cities.

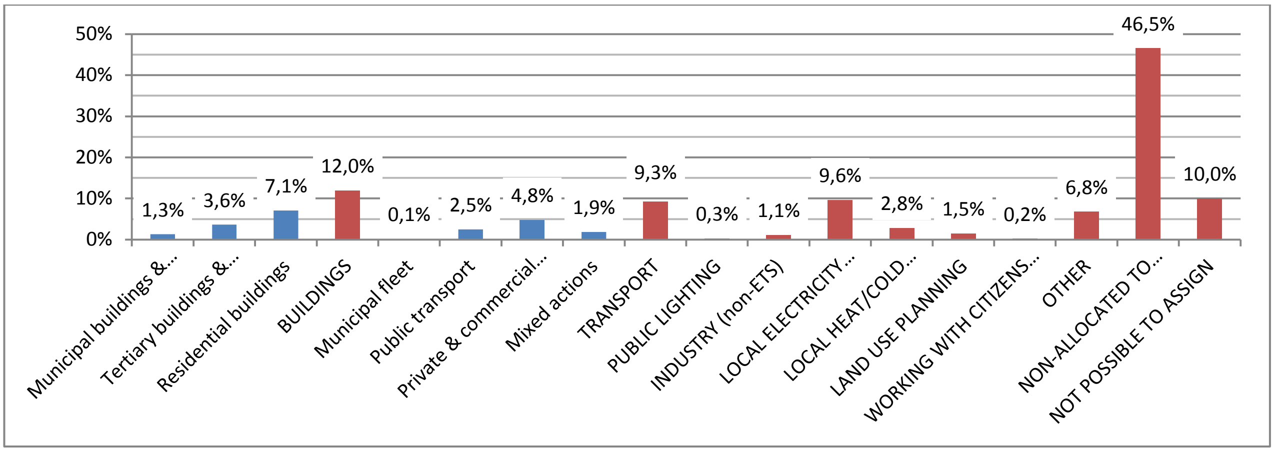
3 RESULTS

Cities in the sample account for a total of 370 megatons of CO_2 emissions in selected baseline years and 94 megatons of intended emission reductions per year. This is mainly due to direct CO_2 emissions in sectors covered by the CoM.[13] Total emissions in the sample correspond to 10 per cent of total CO_2 emissions from the EU in all sectors in 2013 (Jos et al., 2014). The total level of emission reduction planned by cities corresponds to 25 per cent of baseline emissions in the sample, beyond the minimum target of 20 per cent required by the CoM.

3.1 Disaggregation of intended emission reductions in the sample

The analysis of SEAPs data confirms that cities face increasing difficulties in computing intended emission reductions according to the increase of the degree of detail (disaggregation) to be provided (sector, subsector, action, energy source, etc.); thus the detail of analysis is sometimes limited by data availability. The distribution of intended emission reductions between sectors and subsectors is reported in graph 3.1, with blue bars referring to intended emissions in the subsectors and red bars referring to aggregated emissions by sector (as a sum of blue bars on their left).

Graph 3.1 Distribution of intended emission reductions by subsector and sector in SEAPs



[13] Most cities in the sample computed direct emissions based on IPCC emission factors, while only 12 per cent followed a LCA approach.

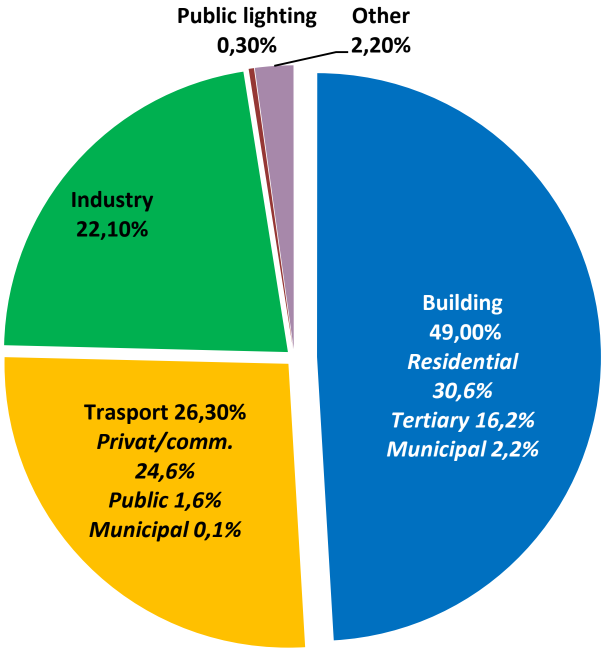
There is a relevant share of cities providing only a partial disaggregation of total intended emission reductions. Overall, almost half (46.5 per cent) of emission reductions are not assigned to sectors, subsectors and specific actions by municipalities, so they have been attributed to the sector "Emissions not disaggregated into specific actions". Moreover, an additional 10 per cent of intended emission reductions is related to actions with unclear descriptions and thus attributed to the sector "Not possible to assign". In the following analysis it has been assumed that emissions from these residual sectors show the same distribution of emissions, which have been attributed to specific sectors, subsectors and categories of action.

3.2 Intended emission reductions distribution by sector and subsector

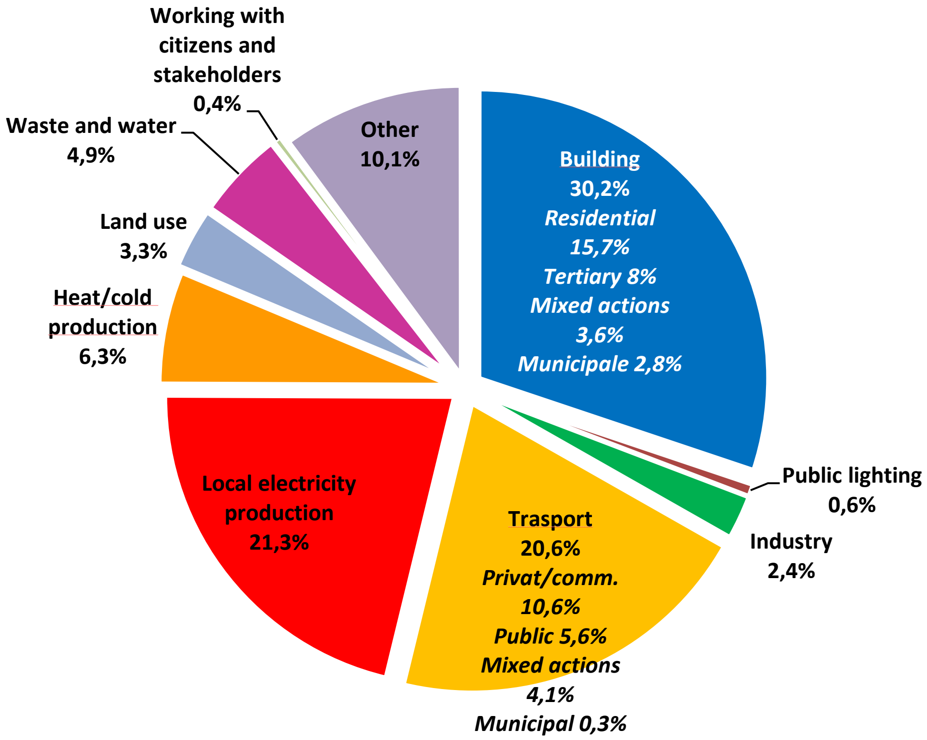
A comparison of the distribution of aggregate emissions from BEIs (graph 3.2) and intended emission reductions from SEAPs (graph. 3.3) in the city sample shows the prevalence of both emissions and intended emission reductions in the Building sector (respectively 49 per cent and 30.2 per cent). Emissions in the Transport sector amount to 26.3 per cent and in Industry amount to 22.1 per cent, while intended emission reductions in the Transport sector amount to 20.6 per cent and in Industry sector to 2.4 per cent. Intended emission reductions in the Local electricity production sector amount to 21.3 per cent while intended emission reductions in the Local heat/cold production sector amount to 6.3 per cent. Local electricity and Local heat/cold production sectors do not appear in the BEI sectors because their emissions are associated to final consumption sectors. The discrepancy between the relevance of emissions and intended emission reductions in the Industry sector can be explained by two main elements: i) the Industry sector is not compulsory in the SEAP; ii) emission reductions generated by actions in the Industry sector are often accounted in the Local electricity and Local heat/cold production sectors. Overall a relevant coherence in the relative weight of considered sectors between emissions and intended emission reductions can be detected.

The amount of intended emission reductions in the Building sector is disaggregated in the following subsectors: actions in residential building are intended to yield 15.8 per cent of reductions, while tertiary buildings account for 8 per cent, municipal buildings for 2.8 per cent and mixed actions for 2.6 per cent. Looking at the Transport subsectors distribution cities intend to reduce emissions from public transport by 5.6 per cent, from private and commercial transports by 10.6 per cent, from municipal fleet by 0.3 per cent and from mixed actions by 4.1 per cent. Land use planning (3.4 per cent) and Working with citizens and stakeholders (0.4 per cent) are sectors that do not have a correspondence in the BEI. Overall, emissions are intended to decrease by 25 per cent with respect to BEIs. Through the analysis of the relevance of emission reductions per sector and subsector in relation to baseline emissions in the same sector and subsector, it emerges that actions in subsectors under direct control by cities' administrations (municipal buildings, public transport, municipal fleet and public lighting) are planned to deliver higher reductions with respect to the correspondent baseline emissions - though they deliver a small contribution to total intended emission reductions (9.4 per cent) - compared to actions in subsectors where private actors (households and firms) act, which are affected only indirectly by local governments' policies. In fact, based on disaggregated data, emissions from public transport, municipal fleet, municipal buildings and public lighting show the strongest intended reductions (54 per cent, 33 per cent and 20 per cent respectively).

Graph 3.2 Distribution of emission among sectors and subsectors



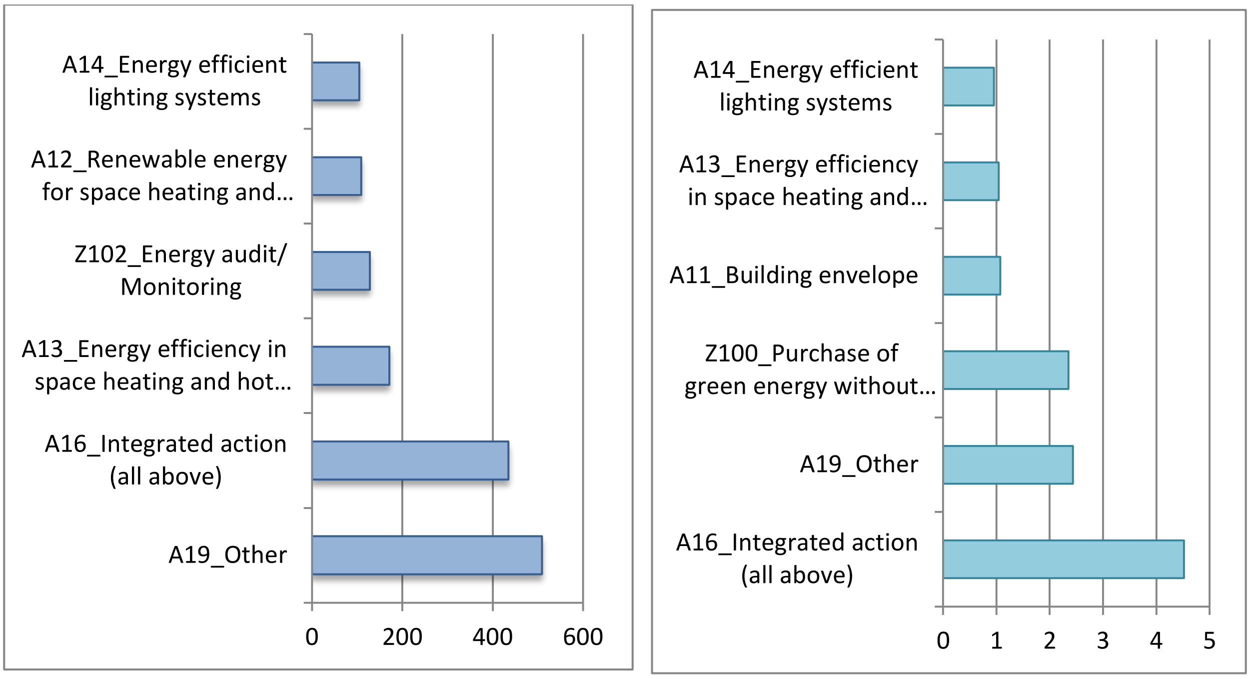
Graph 3.3 Distribution of intended emission reductions among sectors and subsectors



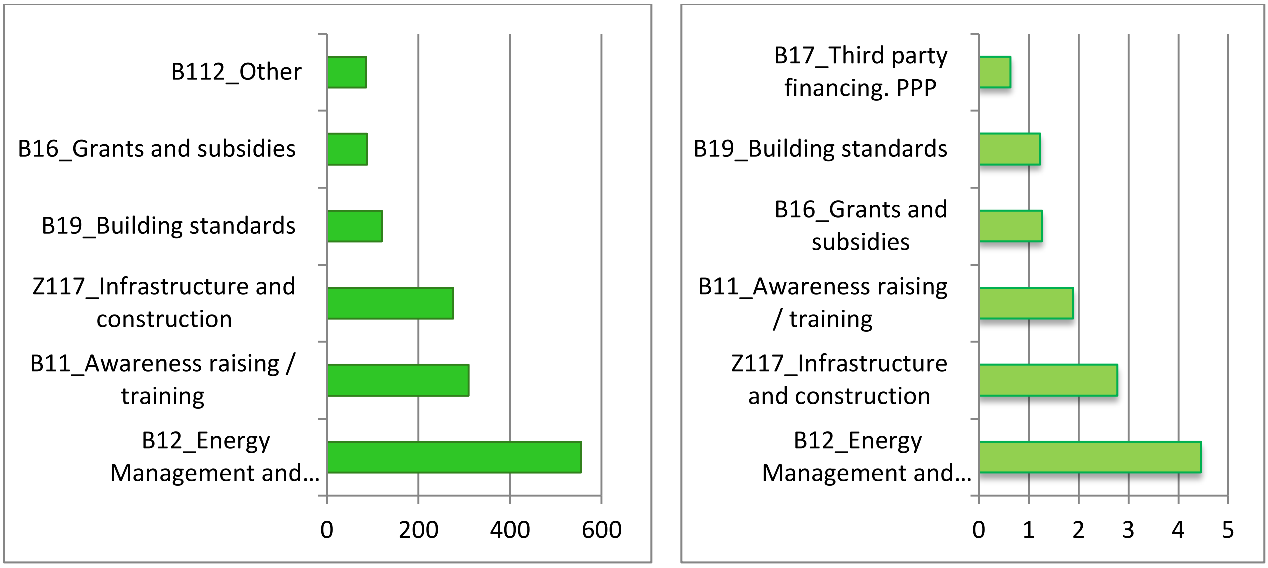
3.3 Intended emission reductions distribution among categories of action and policy levers

Most cities in the sample tackled all of the three main mitigation sectors: 68 per cent of cities plan actions in the Building sector, 66 per cent in the Transport sector and 49 per cent in the Local electricity production sector. The categories of actions and policy levers in these sectors are analysed here considering their recurrence and the intended emission reductions attributed to them by cities in the SEAPs. In the Building sector, the most recurrent categories of actions are: “integrated actions” and “energy efficiency in space heating and hot water”. These categories of action represent respectively 4.5 per cent and 1.1 per cent of the total intended CO_2 reductions (graph. 3.4). The “purchase of green energy production” category of action rarely shows, but delivers a high share of CO_2 emission reductions (2.3 per cent). The most recurrent policy levers include “energy management”, “infrastructure construction” and “awareness raising”. There is full correspondence between recurrence of policy levers and the intended CO_2 reductions attributed to them (see graph 3.5).

Graph 3.4 Recurrences and intended emission reductions of each category of action for the Building sector in the SEAP sample

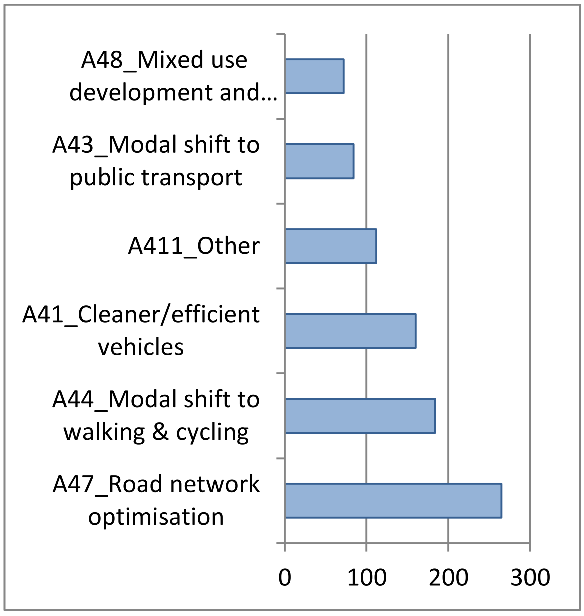


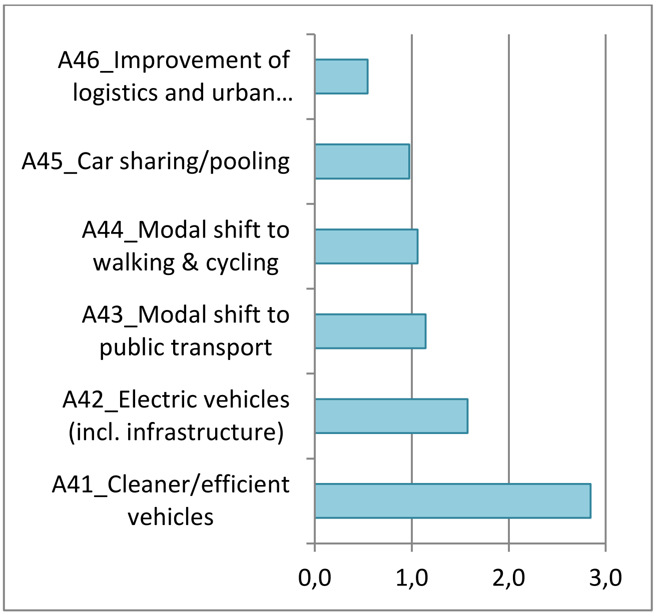
Graph 3.5 Recurrences and intended emission reductions of each policy lever for the Building sector in the SEAP sample



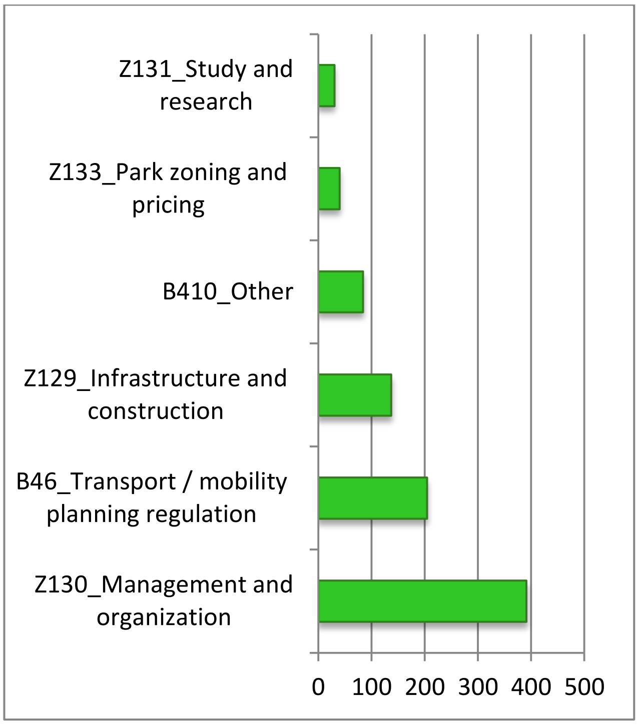
The most recurrent categories of action in the Transport sector are related to “road network optimisation” (cycle paths, restricted traffic zones, etc.) and “modal shift to walking and cycling”. Their frequency does not always correspond to high intended reductions of CO_2 emissions (respectively 0.51 per cent and 1 per cent). Instead, the categories of action that foster the “use of cleaner vehicles” and “electric vehicles” are the ones which show the highest amount of intended emission reductions (2.84 per cent and 1.58 per cent respectively) (see graph 3.6). The most used policy levers in the Transport sector are related to “management and organisation”, “transport/mobility planning regulation” and “awareness raising”. The most recurrent policy levers are also the ones delivering the highest intended CO_2 emission reductions (see graph 3.7).

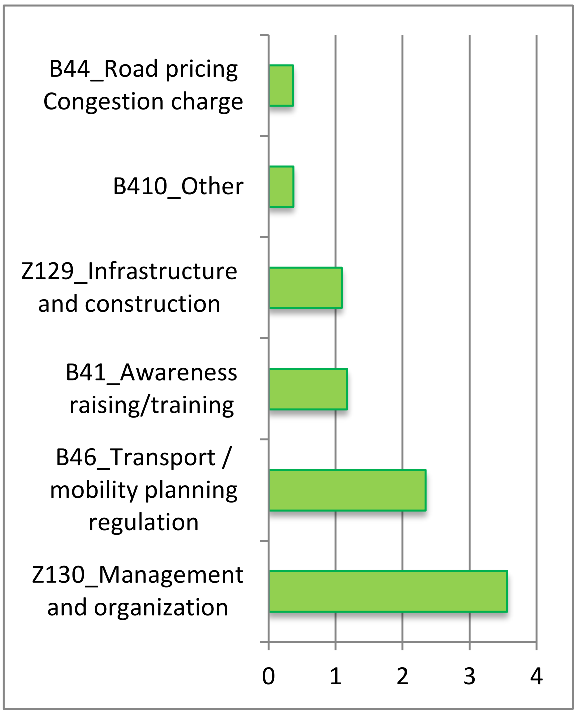
Graph 3.6 Recurrences and intended emission reductions of each category of action for the Transport sector in the SEAP sample





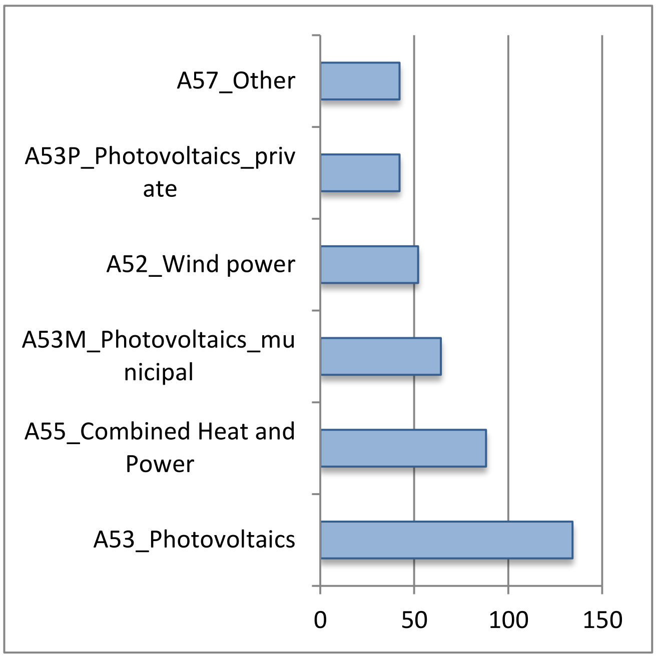
Graph 3.7 Recurrences and intended emission reductions of each policy lever for the Transport sector in the SEAP sample

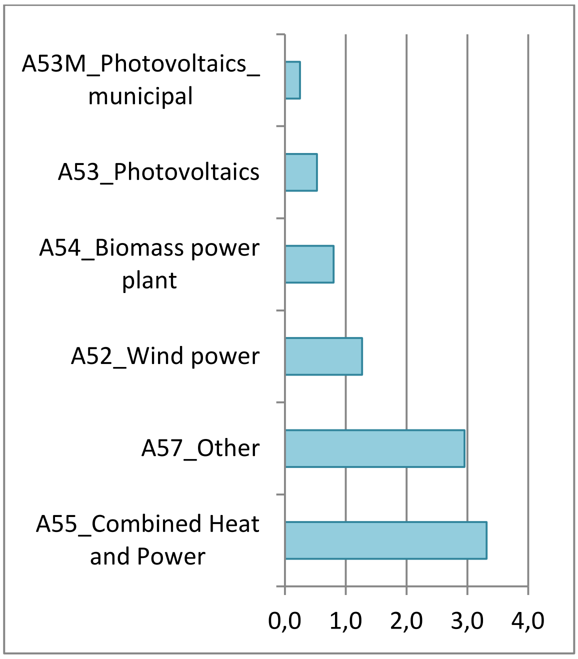




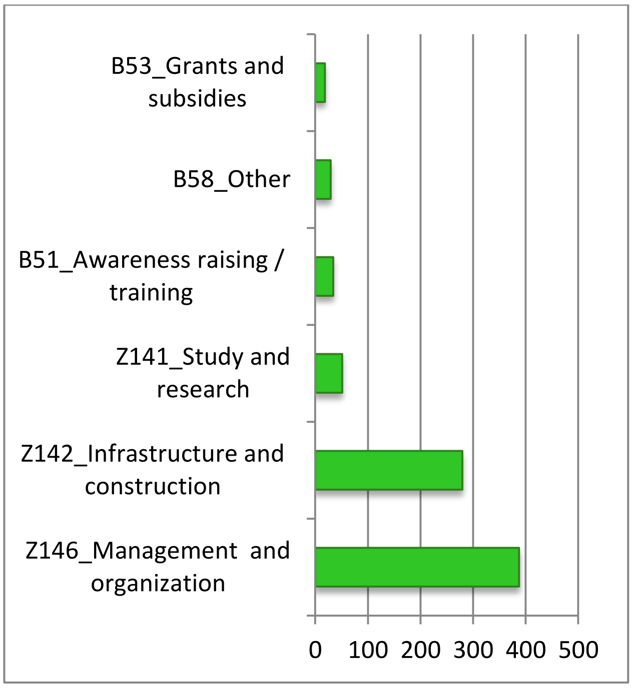
For Local electricity production, the most recurring category of action is photovoltaic (134), associated with a relatively low share of intended emissions reduction of 0.53 per cent. The category of action “combined heat and power” recurs less (88 times) but involves higher intended emission reductions (3.32 per cent) (see graph 3.8). “Wind power” (with 2.95 per cent) and “biomass power plant” (with 1.17 per cent) also involve higher intended emission reductions. The policy levers involving the highest intended emission reductions are: “infrastructure construction” (1.68 per cent), “access to credit” (0.29 per cent) and “study and research” (0.2 per cent) (see graph 3.8).

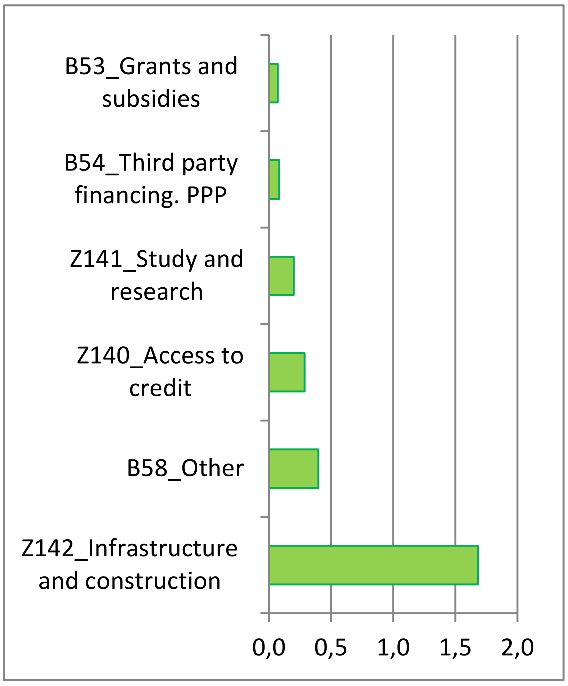
Graph 3.8 Recurrences and intended emission reductions for each category of action for local electricity production in SEAP sample





Graph 3.9 Recurrences and intended emission reductions of each policy lever for local electricity production in the SEAP sample





4 CONCLUSIONS

4.1 Main findings

European cities have responded positively to the CoM initiative. More than 7,7000 cities had signed the CoM by October 2016, committing to at least a 20 per cent reduction of their CO_2 emissions by 2020 with respect to a base year (suggested 1990).

The analysis, based on a sample of 124 European cities with more than 100,000 inhabitants, outlines: i) the intended emission reductions in the sample for each sector (and subsector); and ii) the actions and the policy levers most used by cities in the design of their SEAPs. Overall 5.000 actions have been analysed and then attributed to 117 categories of actions and 28 policy levers.

The strength of results is sometimes constrained by the bounded number of cities available in the sample and the limited degree of detail provided by some of them. Nonetheless, the uniform approach to emission accounting ensures the comparability of cities and the consistency of results with regard to available data.

Cities in the sample are committed to achieve a reduction of 25% of baseline emissions by 2020.

Buildings and Transport stand out as the sectors where cities intend to deliver the major emission reductions. This result is coherent with evidence from recent literature. In fact, the last IPCC report (IPCC, 2014) shows that in recent years, energy consumption in buildings has fallen in several European countries where strong policies have been implemented, also at the local level. Policy makers have focused on the building sector mainly through regulatory instruments, including building codes and standards (see, among others, Boza-Kiss et al., 2013; Koeppel & Urge-Vorsatz, 2007) and information to citizens and consumers, including energy labels, building labels and certificates (Boza- Kiss et al., 2013; Kelly, 2012). The relevance of the transport sector in recent policy making is also confirmed. Different policy mixes to reduce the use of private transport at city level have been used; cities have usually focused on land use patterns, public transport options, pricing and other strategies (Barth and Boriboonsomsin, 2008). More recent innovations include bicycle and car sharing (Sperling and Nichols, 2012; Orlau et al., 2011).

In general, the share of emission reductions compared to emissions in base year is higher in the public sector, even if its weight is relatively low compared to sectors where private actors have responsibility to implement actions and delivers results. Therefore local governments' strategies would need a further enhancement in order to design and implement actions in sectors involving private stakeholders. Public authorities can stimulate private actors in the implementation of sustainable energy measures through a range of norms, incentives and awareness raising actions. Alber and Kern (2008) show four modes of governance of climate change for local authorities. First self-governing (defined as the capacity of local government to govern its own activities, such as the improvement of energy efficiency in governmental offices and other municipality-owned buildings), second governing through enabling (local government coordinates and facilitates partnerships with private actors and encourages community engagement), third governing by provision (shaped through the delivery of particular forms procurement of services and resources), fourth governing by authority (use of traditional forms of authority such as regulation). These modes may overlap and individual measures are often based on a combination of several modes. Indeed municipalities can implement actions adopting a range of instruments (command and control, economic and voluntary instruments) to foster the participation of private stakeholders in the implementation of measures to reduce CO_2 emissions.

Cities' choices in actions to deliver intended emission reductions can be attributed to three main factors: i) abatement costs[14], ii) technical feasibility and iii) social acceptability. "Because mitigation inevitably take place in the context of multiple objectives, particular attention is given to the ability to develop and implement integrated approaches that can build on co-benefits and manage trade-offs" (IPCC, 2014). This paper does not analyse the factors underlying cities' mitigation choices because relevant elements concerning these three aspects[15] are not provided in the CoM process. These elements should be investigated in further research. Despite this, the results of the analysis can be useful to urban policy makers (especially in medium and large size cities) to shape their mitigation strategies and learn from the experience of cities in the sample.

For some of the signatories, the Covenant of Mayors initiative is a structured way of implementing national regulations, for others it is an opportunity to go beyond them and lead a transformation process. Initiatives to address climate change do not exclusively originate from national governments but are co-produced by different types of sub-national actors (Dellas, Pattberg and Bestill 2011). By contrast, in the absence of strong national policies, signatories have the possibility to design their own measures. In fact local authorities do not act in isolation. Each local authority is placed in a specific context, where national, regional and local competences, legislation and policies on energy and climate-related sectors interact. Numerous studies have pointed to the increased role played by non-state, and in particular sub-national, actors, in mitigating climate change (Hewson and Sinclair 1999; Kahler and Lake 2003; Avant, Finnemor and Sell 2010). These studies contend that different types of sub-national actors perform several functions that previously rested solely with national governments. In particular, sub-national actors play a crucial role in the field of global environmental policies. The most prominent examples is, indeed, the climate change related involvement of local governments (Bulkeley, 2010). The Covenant of Mayors initiative is a factual demonstration of such involvement of cities and of the potential relevance of their contribution.

[14] Abatement cost is the cost of reducing environmental negatives such as CO_2 emissions. Marginal cost is an economic concept that measures the cost of an additional unit. The marginal abatement cost (MAC), in general, measures the cost of reducing one more unit of CO_2. Although marginal abatement costs can be negative, such as when the low carbon option is cheaper than the business-as-usual option, MACs often rise steeply as more pollution is reduced. Marginal abatement costs are typically used on a marginal abatement cost curve, or MAC curve, which shows the marginal cost of additional reductions in pollution. MAC curves have been frequently used in the past to illustrate the economics of climate change mitigation and have contributed to decision-making in the context of climate policy. The concept of carbon abatement curves has been applied since the early 1990s to illustrate the cost associated with carbon abatement (see, for example, Jackson, 1991).

[15] In SEAPs the allocation of the implementation costs for each action is not mandatory.

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ANNEX I: Cities sample

Antwerp	Verona	Vantaa
Bruxelles-Capitale	Bielsko-Biala	Rostock
Gent	Cascais	Milton Keynes
Aachen	Lisboa	Bergamo
Bremen	Porto	Espoo
Dortmund	Vila Nova de Gaia	Cádiz
Frankfurt am Main	Baia Mare	Nice
Freiburg	Braşov	Brest Métropole Océane
Hamburg	Râmnicu Vâlcea	Bilbao
Hannover	Göteborg	Tbilisi
München	Birmingham	Duisburg
Münster	Gateshead	Loures
Nürnberg	North Tyneside	Cardiff
Stuttgart	South Tyneside	Wolfsburg
Århus	Newcastle upon Tyne	Mainz
Algeciras	Nottingham	Mannheim
Badalona	Redcar and Cleveland	Matosinhos
Hospitalet de Llobregat	Sunderland	Bari
Málaga	Stockton-on-Tees	Berlin
Mataró	San Sebastián-Donostia	Comunità Montana di Valle Trompia
Murcia	Pamplona	Forlì
Santa Coloma de Gramenet	Valencia	Firenze
Tarragona	Kaunas	Seixal
Terrassa	Bristol	Gdynia
Santander	Barcelona	Cork County
Vitoria-Gasteiz	Oeiras	Funchal
Helsinki	London	Salerno
Tampere	Bologna	Heraklion
Dijon	Warsaw	Valladolid
Dunkerque Grand Littoral	Zagreb	Huelva
Grenoble	Almería	Zaragoza
Mulhouse Alsace Agglomération	Genova	Venezia
Nantes Metropole	Alcorcón	Bottrop
Paris	Bonn	Oulu
Plaine Commune	Bordeaux (La Cub)	Arad
Patras	Copenhagen	Kerry Local Authorities
Rijeka	Manchester	Helsingborg

Dublin	Córdoba	Tirgu-Mures
Modena	Napoli	Bydgoszcz
Padova	Glasgow	Marbella
Ravenna	Jönköping	Unione dei Comuni NET (Nord Est Torino)
Torino	Reggio Emilia	