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Covenant of Mayors in figures: 8-year assessment

Kona A., Melica G., Bertoldi P., Rivas Calvete S., Koffi B., Iancu A., Zancanella P., Janssens-Maenhout G. Dallemand J.F.

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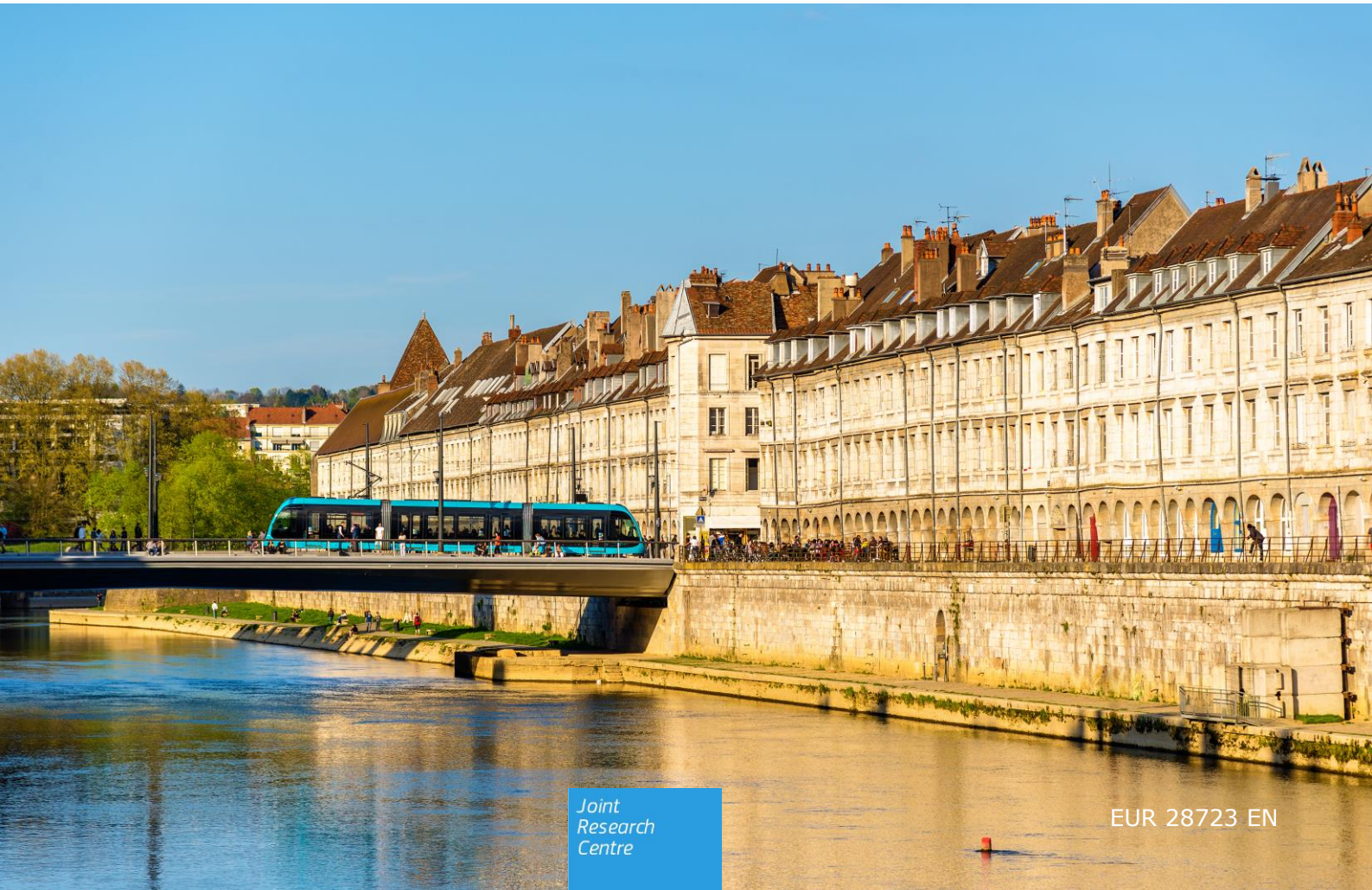

Joint Research Centre

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Contact information [optional element]
Name: Albana KONA
Address: European Commission, Joint Research Centre, Via E. Fermi 2749, I-21027, Ispra (VA), Italy
Email: Albana.kona@ec.europa.eu
Tel.: +39 0332 785327

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Covenant of Mayors in figures: 8-year assessment

Abstract
The European Commission's initiative Covenant of Mayors (CoM), one of the world's largest urban climate and energy initiatives, involving more than seven thousand local and regional authorities, proves that climate change has moved to the forefront of urban priorities.
Its integrated approach is in line with a number of EU priorities not only concerning mitigation and adaptation but also in terms of embracing a robust transparency framework for the implementation of the Paris agreement.
The Covenant of Mayors in figures 8-year assessment report, based on the data collected in the CoM platform as of September 2016, aims at providing an overall picture of the achievement and projections made by the signatories in terms of greenhouse gas emissions and the related energy consumptions.
Developing a sustainable energy and climate action plan that requires the establishment of a baseline emission inventory, target setting and the adoption of policy measures is already a tangible achievement for cities. This is the first step towards an effective, transparent system for tracking progress and concrete results.
Ultimately, the report emphasis that strong urban energy policies and increased involvement of citizens is of vital importance in the potential of urban mitigation of global climate change.

Contents

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Authors

Kona Albana, Melica Giulia, Bertoldi Paolo, Rivas Calvete Silvia, Koffi Brigitte, Iancu Andreea, Zancanella Paolo, Janssens-Maenhout Greet, Dallemand Jean-François.

Executive summary

Policy context

The 21st session of the Conference of the Parties (COP 21), held in Paris in December 2015, has underlined the importance of containing global temperature rises to within 1.5 degrees. Cities have come to play an important role in the global response to climate change as the urban energy consumption generates about three quarters of the global carbon emissions and they are particularly vulnerable to climate change effects (IPCC, 2014).

The Covenant of Mayors for Climate and Energy, one of the world's largest urban climate and energy initiatives, involving thousands of local and regional authorities, has moved climate change to the forefront of the urban priorities by facilitating and accelerating the implementation of effective actions. While climate change remains a global issue, the best strategies for sustainable energy systems are planned and implemented at local level.

The Covenant of Mayors' integrated approach is in line with a number of EU priorities not only concerning mitigation and adaptation but also in terms of access to affordable energy, embracing a robust transparency framework for the implementation of the Paris agreement. It is the first initiative of its kind addressed to local authorities which requires signatories to define a CO_2 reduction target, to develop an action plan addressing mitigation and adaptation and to monitor the results on a regular basis in order to track progress towards their targets.

Box 1. Covenant of Mayors for Climate and Energy: Three pillars

- At least 40 % CO_2 reduction in their respective territories by 2030
- Increased resilience to the impacts of climate change
- Increased cooperation with fellow local and regional authorities within the EU and beyond to improve access to secure, sustainable and affordable energy

Covenant of Mayors for Climate and Energy: commitments for 2020 and achievements in 2014

The report assesses the overall progress of the CoM initiative based on the sustainable energy action plans (SEAPs) and the implementation reports received up to 4 September 2016. At the cut-off date of the analysis, the number of CoM signatories totalled 6 201 ([1]) (96.5 % from the EU-28), covering 213 million inhabitants (85 % in the EU-28 Member States representing 36 % of the total EU-28 population ([2])), 5 491 of which had already provided a SEAP.

(1) 6 201 signatories cover 6 926 local authorities, 725 of which have adopted joint action plans, thereby resulting in fewer signatory profiles.
([2]) Undesa 2011: average from 2008-2011.

Box 2. Covenant mitigation commitments for 2020

- **5 403 Sustainable Energy Action Plans** in the JRC harmonised CoM dataset 2016 (98 % of the total SEAPs submitted), covering 183.8 million inhabitants were submitted by signatories as part of their commitment to the Covenant of Mayors 2020.
- Covenant signatories have committed to ambitious GHG emission reduction targets by 2020: **an overall commitment of 27 %**, almost 7 percentage points **higher than the minimum target by**:
  - **Implementing energy savings** aiming at reducing the final energy consumptions by **20 %** in 2020 compared to baseline years;
  - **Increasing the share of local energy production** (i.e. renewable sources, cogeneration and district heating power plants) in final energy consumption from 10 % in the baseline years to **19 %** by 2020.
- **Emission reductions** of the EU Covenant signatories **may represent 31 %** of the EU-28 GHG emission reduction target by 2020 compared to 2005.

An analytical method is proposed to allocate greenhouse gas emissions impacts between policies that lower energy consumption through savings and those that increase the supply of renewable energy. As a result of the applied method, the share of the GHG emission reductions due to energy saving policies is estimated at **82 %** of the total GHG emission reduction target by 2020, while the share of the GHG emission reductions due to the increase of renewable sources is estimated at 18 % of the total GHG emission reduction target by 2020 ([3]).

Box 3. Covenant mitigation achievements in 2014

- **315 monitoring emission inventories** covering 25.5 million inhabitants
- **Overall achieved GHG emission reduction of 23 %** *driven by:*
  - The reduction of final energy consumptions of **18 %** between baseline and monitoring inventories;
  - The increased share of renewables on total final energy consumption of **7 percentage points** between baseline and monitoring inventories.

Main policies of Covenant of Mayors for Climate and Energy signatories

Our analysis of the Covenant of Mayors initiative, representing all local authorities' sizes in Europe, demonstrates that climate change has moved now to the forefront of urban priorities. Developing a **sustainable energy and climate action plan** that requires the establishment of a baseline emission inventory, setting ambitious targets and adopting policy measures is already a tangible achievement for cities. This is the first step towards an effective, transparent system for tracking progress and concrete results.

Through **awareness raising and information campaigns**, local authorities mobilise public interest in sustainable energy and create broad-based political and social support

([3]) Due to lack of reported data, other factors influencing the level of greenhouse gas emissions are not considered under this method.

for the implementation of the SEAP. Behavioural changes are as important as building physics in reducing energy consumption. Awareness raising, contributing with 26 % to the total estimated GHG emission reduction by 2020, is the major policy instrument deployed by local authorities to mobilise public interest in sustainable energy policies and climate change.

Urban and transport planning is one of the basic functions of municipal governments which substantially influences local energy use and offers opportunities to deploy sustainable energy in local territories. Main strategies such as embedding climate change in land-use planning and mobility planning regulations, may contribute with 18 % to the total estimate of GHG emission reductions by 2020. While fuel efficiency-driven policies for private and commercial vehicles fall under the competence of national policies, local authorities can encourage the transition and contribute to the so-called 'modal shift' to active mobility or cleaner/electric modes through urban transport planning.

Local authorities have a direct jurisdiction over **public services delivery**, such as public lighting, waste-water management, municipal fleet and public transportation; therefore the municipality itself assumes an exemplary role in the implementation of its local action plan by taking actions in these sectors. Local authorities notably set standards for the **monitoring and management of energy**. Furthermore, municipalities also engage in **green public procurement** of higher efficiency equipment as an effective and widely accepted strategy. These cumulated efforts by local authorities contribute with 17 % of the total estimated GHG emission reduction by 2020.

Financial incentives, such as grants, subsidies and third party financing, are important policy instruments used by local authorities to promote energy efficiency and deployment of renewables. Such financial incentives contribute with 21 % to the total estimated GHG emission reductions by 2020. In the local electricity and heat production sector, grants and subsidies are used to support specific techniques or pilot projects that the local authority would consider of particular relevance for the deployment of RES, considering its own context and objectives.

Most local authorities empowered with the jurisdiction to build upon national efficiency policies in the building sector are implementing **codes and regulation in the building** sector with more stringent requirements than national ones. In this way, they promote integrated action to improve energy efficiency in the building envelope and foster the use of renewable sources for space heating and cooling, contributing with 12 % of the total estimated GHG emission reduction by 2020.

There is an increasing interest in decentralisation of the energy supply with more local ownership (IEA, 2016). Municipalities in the EU-28 often have jurisdiction in **local energy production** and distribution systems, in some cases as owners of the utilities, in other cases in partnership with them. This makes the local energy supply system an important area of intervention to implement an integrated energy community planning to achieve high emission reduction and increase local employment.

The first results on the implementation phase (315 action plans) shows that 65 % of the actions are completed or ongoing. The majority of the completed and ongoing actions are in the Transport sector (93 %) followed by the Municipal buildings and Facilities (83 %) where the municipality itself demonstrates leadership and commitment.

The Covenant's rapid growth (213 million inhabitants and 6 201 signatories in 8 years) and its extended presence in the EU and beyond proves the success of the governance model developed under the Covenant of Mayors which is encouraging the local voluntary initiative on sustainable energy management and, since October 2015 also on adaptation, in the framework of a European Union's policy framework for climate and energy.

1. Introduction

In 2008, acknowledging the role of the local authorities, the European Commission (EC) launched the Covenant of Mayors (CoM) initiative to endorse their efforts in the implementation of sustainable energy policies.

Since its launch, the CoM has proved successful as the mainstream European movement involving those local authorities which commit voluntarily to contributing to the European Union's objective of reducing greenhouse gas emissions by both meeting and exceeding the target of a 20 % cut in CO_2 emissions by 2020, through better energy efficiency and the use of renewable energy sources within their territories. In 2014, in the context of the European Commission's European Strategy on adaptation to climate change ([4]), the European Commission launched a separate initiative called Mayors Adapt, based on the Covenant of Mayors model, with the aim of engaging cities in taking action to adapt to climate change. Merging the Covenant of Mayors and Mayors Adapt, the creation of the new **Covenant of Mayors for Climate and Energy** was announced in October 2015 by Commissioner Miguel Arias Cañete.

This report illustrates the results of the overall 8-year assessment of the initiative in terms of mitigation of climate change.

The assessment of the Covenant of Mayors initiative is based on the data from baseline emission inventories (BEIs), sustainable energy action plans (SEAPs) and monitoring emission inventories (MEIs) received up to 4 September 2016.

It looks at both planned and achieved CO_2 emissions reduction, energy savings and use of renewable sources to evaluate the progress made by signatories towards their climate mitigation target. It presents aggregated energy consumption and CO_2 emissions data and related reductions tackled by cities' plans, as well as the interim achievements to date. It also identifies the main drivers leading to the actual results and describes the main policies implemented by local authorities to reach their emission targets. Both SEAPs and implementation reports are submitted via online templates available on the signatories' restricted area of the CoM website: http://www.covenantofmayors.eu/sign-in_en.html.

The European Commission's Joint Research Centre (JRC) provides scientific, methodological and technical support to the Covenant of Mayors initiative. In earlier phases, the JRC developed methodologies mainly targeting the EU and non-EU Europe countries, collaborating with city networks and practitioners from local and regional authorities, energy agencies and academia. Subsequently, the JRC has adapted the Covenant's methodology to the specific circumstances of the EU's eastern and southern neighbours. This work has resulted in the publication of guidebooks on how to develop a sustainable energy action plan in the different regions (Bertoldi *et al.*, 2010), (Janssens-Maenhout *et al.*, 2012), (Cerutti *et al.*, 2013), (Bertoldi *et al.*, 2014),(Iancu *et al.*, 2014), (Saheb *et al.*, 2014).

The JRC also carries out individual SEAP analyses, providing feedback for cities and in-depth evaluations of selected SEAPs (Rivas *et al.*, 2015). Specific aspects of the Covenant are also explored in specific studies (e.g. on multilevel governance models in the Covenant (Melica *et al.*, 2014), and on the Covenant's contribution to security of supply in countries more exposed to the risk of fuel disruption (Kona *et al.*, 2014).

Since 2013, the JRC has published a series of assessment reports on the Covenant to track the overall progress of the initiative based on data from plans and progress reports transmitted by Covenant cities to the EC by (Raveschoot *et al.*, 2010), (A.K. Cerutti *et al.*, 2013), (Kona *et al.*, 2015), (Kona *et al.*, 2016). The expansion of the CoM initiative

([4]) COM/2013/216.

in Europe is also commented on in scientific literature by among others, (Christoforidis *et al.*, 2013; Dall'O' *et al.*, 2013) in 2013 , (Gagliano *et al.*, 2015; Pablo-Romero, Pozo-Barajas and Sánchez-Braza, 2015; Taylor *et al.*, 2015) in 2015, (Lombardi, Pazienza and Rana, 2016; Marinakis *et al.*, 2016; Pablo-Romero, Pozo-Barajas and Sánchez-Braza, 2016) in 2016 and (Delponte, Pittaluga and Schenone, 2017; Di Leo and Salvia, 2017) in 2017.

The following chapters describe the progress of CoM signatories towards climate and energy targets.

— Chapter 2 presents the methodology for building the sample of SEAPs and implementation reports to calculate the main statistics of CoM signatories.

— Chapter 3 presents the results of the analysis:

- Section 3.1 describes the Covenant of Mayors community in terms of population coverage/region.
- Section 3.2 analyses data from 5 403 submitted SEAPs, looking at the situation described in baseline emission inventories (in terms of GHG emissions, energy consumption and local energy production) and the level of ambition of CoM signatories based on planned GHG emission reduction, energy savings, increase in local energy production by 2020. This section also highlights the main policy measures planned to be implemented by CoM signatories.
- Section 3.3 analyses data from 315 full implementation reports and compares the results of the latest monitoring emission inventories against the results of the baseline emission inventories. This way, detailed information can be extracted with regard to the current progress towards GHG emission targets, and to the evolution of energy consumption and of local energy production (with a focus on renewable energy sources). This section also highlights the main policy measures currently being implemented by CoM signatories.

— Chapter 4 presents general conclusions based on this analysis.

2. Approach and datasets

2.1. The Covenant of Mayors approach

Within 1 year from signing up to the initiative, local authorities have to define a minimum CO_2 emission reduction target by 2020 and approve and submit a sustainable energy action plan. The SEAP is the key document through which the Covenant signatory presents its vision and target, together with the measures to be implemented to achieve its objectives. The SEAP includes the results of a baseline emission inventory. Signatories are requested to submit a monitoring report on implementation of the SEAP every second year, and to complement it with a monitoring emission inventory at least every fourth year.

Specific data and information on emission inventories and action plans must be reported by the signatories via an online template provided in a restricted area of the Covenant website (http://www.covenantofmayors.eu). This online template must accurately reflect the content of the official SEAP document, while the coherence of certain key figures is checked by the JRC.

According to the principles laid out in the CoM, each signatory could influence the emissions produced in its territory as the result of energy consumption. The BEI is not meant to be an exhaustive inventory of all emission sources in the territory but focuses on the consumption side and on the sectors upon which the local authority has a potential influence. Notably, GHG emitted by installations covered by the EU Emissions Trading System (EU ETS ([5])), should not be included.

The Covenant of Mayors methodology proposes a harmonised framework to enable local authorities (CoM signatories) to produce robust and comparable inventories of GHG emissions and action plans.

The greenhouse gas emissions data submitted in the baseline and monitoring emission inventories, described in detail in (Kona *et al.*, 2016), are summarised in Chapter 3 of the current report, which also provides information on the final energy consumption and local energy production, together with a detailed analysis of the mitigation actions planned in the SEAP (see Table 1).

For each action the signatories should report data on the sectorial area of intervention (i.e. energy efficiency in buildings, equipment and facilities, transportation, renewable deployment, urban planning, etc.), the policy instrument (distinguishing between the national/regional and the local ones) and the responsible body (local authority or third parties).

The timeframe, as well as the following quantitative information, must be reported:

- estimated energy savings by 2020 (expressed in MWh/year);
- estimated renewable energy production by 2020 (expressed in MWh/year);
- estimated CO_2 emissions reduction by 2020 (expressed in tonnes CO_2-eq/year).

The quantitative indicators (costs, energy savings, energy production and estimated CO_2-eq emissions reduction) from all actions are then totalled up under each specific activity sector.

Furthermore, signatories can highlight as Benchmarks of Excellence some actions which the local authority has successfully implemented and that have led to significant energy and economic benefits. Only ongoing and completed actions can be marked as BoE.

([5]) Directive 2003/87/EC.

Table 1. Description of the online data in action reporting of the sustainable energy action plan

Name	Title of the action	
Sector/area of intervention	Sector	Area of intervention
	Municipal, Residential, Tertiary buildings, Equipment/facilities	Energy efficiency in building envelope, lighting and appliances, Renewable sources for space heating and cooling, ICT, behavioural changes, other.
	Public lighting	Energy efficiency, integrated renewable sources, information and communication technologies (ICT), other.
	Industry	Energy efficiency in building and industrial processes, integrated renewable sources, ICT, other.
	Transport	Cleaner/efficient vehicles, electric vehicles (incl. infrastructure), modal shift to public transport; congestion charges, walking and cycling, car sharing/pooling, improvement of logistics and urban freight transport, road network optimisation, mixed use development and sprawl containment, information and communication technologies, eco-driving, other
	Local electricity production	Hydroelectric power, wind power, photovoltaics, biomass power plant, combined heat and power, other
	Local heat/cold production	Combined heat and power, district heating/cooling plant, network (new, expansion, refurbishment), other
	Other	Urban regeneration, waste and waste-water management, tree planting in urban areas, agriculture, other
Policy instrument	Building energy efficiency codes, standards and regulations, other. Energy management and green public procurement, other. Local energy efficiency policies for service delivery in: public lighting, waste-water management, other. City-owned/regulated energy utilities: energy supplier's obligations, land use planning, subsidies for connection to district heating networks, other. Urban and transport planning: integrated ticketing and charging; road pricing; zoning, transport land use planning and infrastructure, other. Information campaigns, awareness raising/training, community partnerships, other.	
Origin of the action	This field differentiates the level of the actions from national or regional to 'Local authority' policy decisions.	
Responsible body	The body responsible for implementing each action which might be also third parties, such as energy utilities, energy services companies (ESCos), other	
Implementation timeframe	Indicates the start and end year of each action in order to differentiate the short-, mid- and long-term actions.	
Estimated implementation cost	The implementation cost refers to the capital required or amount originally invested to implement the action plus the associated operational and running costs involved in the implementation timeframe of such an action.	
Estimates in 2020	The estimates on energy savings (in MWh/a), on renewable energy produced (in MWh/a) and on CO_2 emissions reduced (in tonnes/a) by 2020.	

2.2. The CoM datasets 2016

The Covenant of Mayors approach to building the sample analysed in this report which has been extensively described in (Kona *et al.*, 2016), is only briefly summarised hereafter.

The CoM signatories which committed to 2020 targets are requested to submit their SEAP, including the BEI and planned actions, within 1 year after signing the Covenant. Every second year from SEAP submission they have to submit an implementation report and every fourth year from SEAP submission the implementation report must be accompanied by a recent monitoring emission inventory. The information is reported in specific online templates on the CoM website:

(http://www.covenantofmayors.eu/index_en.html).

Experience has shown that, due to the voluntary nature of the initiative, the difficulty of adapting local specificities to the CoM reporting framework, and the presence of errors in the data inputted, not all the data collected on the online platform can be considered 100 % complete and reliable. For these reasons, the JRC has developed a methodology in order to build a robust and reliable sample of GHG emission inventories by removing the outliers (Kona *et al.*, 2016).

As a first check, the CoM baseline emissions were compared with national emissions per capita from several international inventories (Eurostat, EEA, EDGAR ([6])). Although such a direct comparison can be useful to highlight potential data inconsistencies, it can be misleading to some extent. Indeed, the CoM collects bottom-up data at local level, while the other databases collect data at national level using a top-down approach project their broader-scale results at the local level. Therefore, per capita values can significantly deviate from national averages, especially in urban areas. Setting validity ranges of per capita emissions, based only on the national or international inventories, may lead to the exclusion of an unnecessarily high number of emission inventories or, conversely, to accepting an excessive number of outliers.

For this reason, the preference is to rely on a self-consistent methodology for the identification and exclusion of outliers, based on the statistical principles currently accepted in literature (see Annex I of (Kona *et al.*, 2016)), using the comparison with external data sources simply as a first broad check at the national level.The statistical method for identifying and removing the outliers, based on the Generalised Extreme Studentised Deviate procedure is applied (Seem., 2007), (Kenneth L. *et al.*, 2012).

The procedure iteratively identifies the extreme values in the dataset before choosing to remove those observations which are higher than the extreme values with a confidence level of 95 %. The corresponding statistical approach are described in (Kona *et al.*, 2016), while results are reported in Chapter 3.

As a result the original inventory containing 5 491 entries was reduced to a clean dataset of 5 403 signatories (i.e. 98 % of the original data), hereafter referred to as the 'CoM BEI dataset 2016' (Table 2).

5 250 signatories in the CoM BEI dataset 2016 are from EU-28 Member States, hereafter referred as 'EU-28 CoM BEI dataset 2016' (Table 2).

Then, once the sample was selected in baseline emission inventories database, these selected signatories are coupled with their sustainable energy action plans in the SEAPs database and a series of checks for assuring the internal consistency are performed. The

([6]) EDGAR is a joint project of the EU-JRC and the Netherlands Environmental Assessment Agency (PBL). It provides past and present global anthropogenic emissions of GHGs and air pollutants by country on a spatial grid.

aim is to have a reliable dataset of final energy consumption data and related emissions and to assess the potential effectiveness of the CoM initiative in terms of estimated energy savings, clean energy production and GHG emission reduction. Further information related to the internal data coherence procedure can be found in the Annex of (Kona *et al.*, 2015).

By September 2016, a total of 1 779 signatories, hereafter referred as 'CoM MEI dataset 2016' (Table 2), should have reported on the implementation of their SEAPs by presenting a full monitoring report, including a monitoring emission inventory. However, due to the fact that the reporting framework on SEAP implementation was made available to signatories later than initially foreseen, an extension of the deadline was granted for the submission of the full report. By September 2016, only 315 signatories ([7]) i.e. 18 % of them, actually submitted a full report, hereafter referred as 'CoM MEI dataset 2016 — monitoring subset' (Table 2).

Table 2. Description of the Covenant of Mayors datasets 2016

Description of the dataset	Number of signatories	Million inhabitants
Signatories as of 4 September 2016	6 201	213
SEAPs submitted as of 4 September 2016	5 491	187
CoM BEI dataset 2016	5 403	183.8
EU-28 CoM BEI dataset 2016	5 250	162
CoM MEI dataset 2016	1 779	104
CoM MEI dataset 2016 — monitoring subset	315	25.5

([7]) 750 signatories submitted a progress report as of May 2017.

3. Results

Main figures of CoM signatories' community are first provided in section 3.1. The findings derived from the analysis of CoM sustainable energy action plans (CoM BEI dataset 2016; 5 403 signatories) are then provided in section 3.2 in terms of (i) GHG emissions, final energy consumption and local energy production ([8]) reported in the baseline year inventories and of (ii) committed GHG emissions reductions, estimated energy saving and estimated local energy production by 2020. The analysis of the actual progress in achieved emission reductions, final energy savings and local energy production for the 315 signatories who already provided full monitoring reports is presented in section 3.3.

3.1. Signatories

At the cut-off date of the analysis (4 September 2016), there was a total of 6 201 ([9]) CoM signatories (original full dataset), covering a total population of 213 million inhabitants. Table 3 below shows the number of signatories and their population categorised by region. The large majority (96.5 %) of the signatories (5 984 signatories, covering 85 % of inhabitants) are from the 28 Member States of the European Union, followed by signatories in the Eastern Partnership region (141 signatories — 2 % of signatories) representing 6 % of the total CoM population and then by 56 signatories from non-EU countries (1 % of signatories) covering 7 % of the total CoM population. In order to understand the impact of urban areas in the climate mitigation target, the analysis has been extended by harmonising the CoM dataset with the Eurostat dataset of Degree of Urbanisation (Dijkstra and Poelman, 2012), as the information related to the degree of urbanisation is not included in the CoM database. Therefore a classification of signatories based on the degree of urbanisation has been performed as follows: urban areas (densely and intermediate populated area with a population density of at least 300 inhabitants per km^2 and a minimum population of 5 000 inhabitants) and rural areas (thinly populated area, which are not urban areas). As a result of the harmonisation procedure, 50 % of the signatories are classified as urban areas, representing 92 % of the CoM population (EC, 2016b).

Table 3. Signatories per region as of 4 September 2016 ([10])

Region	Number of signatories	Million inhabitants
EU-28	5 984	181.70
Europe-non-EU ([11])	56	15.10
Central Asian ([12])	4	0.40
Eastern Partnership ([13])	141	13.10
Southern Mediterranean ([14])	15	2.45
Rest of the world	1	0.36
Total	6 201	213.10

([8]) Energy production is not a key sector in the CoM emission inventories, but is considered for the calculation of local emission factors for electricity/heat/cold.
([9]) 6 201 signatories covering 6 926 local authorities of which 725 have adopted joint action plans thus merging several local authorities under a single Covenant profile.
([10]) See also [17] for details per country.
([11]) Iceland, Norway, Switzerland and non-EU Balkan countries.
([12]) Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.
([13]) Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova, Ukraine.
([14]) Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Palestine, Tunisia.

3.2. Sustainable energy action plans

This chapter focuses on the analysis of 5 403 SEAPs of the **CoM BEI dataset 2016** described in section 2. It presents the greenhouse gas emissions in BEIs (3.2.1) and the corresponding estimated emission reduction by 2020 (3.2.2), the final energy consumption accounted for in BEIs (3.2.3) and the corresponding estimated energy savings by 2020 (3.2.4), the local energy production in BEIs (3.2.5) and the planned local energy production by 2020 (3.2.6), and finally main policies used by local authorities in the SEAPs (3.2.7).

3.2.1. Greenhouse gas emissions in baseline emission inventories

The recent COP 21, held in Paris, has underlined the importance of containing global temperatures rises to within 1.5 degrees. Cities have come to play an important role in the global response to climate change (Dodman and Uwi, 2009), (Rosenzweig *et al.*, 2010), (Rosenzweig *et al.*, 2015).

The GHG emissions reported in the BEI 2016 dataset have been aggregated per CoM sector and sub-sector in Table 4. The total emissions are 951 Mt CO_2-eq/year, with a preponderant contribution from the buildings sector (67 %) followed by the transport (26 %) sector, which are equivalent to the GHG total emission in Germany in 2012 ([15]).

Buildings, Equipment, Facilities and Industries: The distribution of GHG emissions into the different CoM sub-sectors (see (Kona *et al.*, 2016) for more details) shows that the three most-emitting building sub-sectors are responsible for 26 % (Residential buildings), 14 % (Tertiary buildings) and 14 % (Non-ETS industries) of the total CO_2-eq emissions, respectively. The other emissions from the buildings sector, which are not classified in a specific sub-sector but reported under 'buildings sector — other', represent 11 % of the total CO_2-eq emissions.

Transport: The emissions in the Transport sector are largely dominated by the Private and commercial transport sub-sector, which contributes to 19 % of total GHG emissions. All other emissions from the Transport sector represent 7 % of the total CO_2-eq emissions.

Other: The macro-sector 'Other' (7 % of the total emissions) encompasses non-energy GHG emissions from Waste management (1.2 %) and Water management (0.2 %), energy-related emissions associated with Agriculture (0.2 %) and other non-energy-related emissions (5 %).

([15]) *Source:* Eurostat, Greenhouse gas emissions by source sector (All sectors and indirect CO_2 (excluding LULUCF and memo items, including international aviation) [env_air_gge].

Table 4. GHG emissions in CoM sub-sectors: CoM BEI dataset 2016

Macro-sectors	Sub-sectors	Aggregated emissions [tCO_2-eq/year]	Shares
Buildings, Equipment, Facilities and Industries	Municipal buildings, Equipment, Facilities	16.35	2 %
	Tertiary buildings, Equipment, Facilities	131.70	14 %
	Residential buildings	249.96	26 %
	Municipal public lighting	5.25	0.6 %
	Industries (non ETS)	132.90	14 %
	Not assigned in the macro-sector	100.04	11 %
	Subtotal	636.19	67 %
Transport	Municipal fleet	1.68	0.2 %
	Public transport	8.07	0.8 %
	Private and commercial transport	176.01	19 %
	Not assigned in the macro-sector	66.02	7 %
	Subtotal	251.79	26 %
Other	Waste management	11.51	1.2 %
	Water management	1.79	0.2 %
	Agriculture	2.07	0.2 %
	Other emissions	47.88	5 %
	Subtotal	63.24	7 %
	Total	951.22	100 %

Comparing these statistics with the previous assessment report (Kona *et al.*, 2015) shows an increase by 39 % in the reported GHG emissions over the last 28 months, which reveals the Covenant's ever-increasing coverage.

3.2.2. Estimated emissions reductions by 2020

Statistics on the committed emission reduction by 2020 have been calculated for the direct and indirect (associated with the consumption of grid distributed energy) emissions reported by the signatories in the CoM platform. Table 5 shows the planned GHG emission reduction by 2020 per sector, as estimated from CoM BEI dataset 2016.

It is important to highlight that the biggest contribution to the overall estimated GHG emission reduction by 2020 is expected from the buildings sector (49 %), followed by the transport sector (23 %).

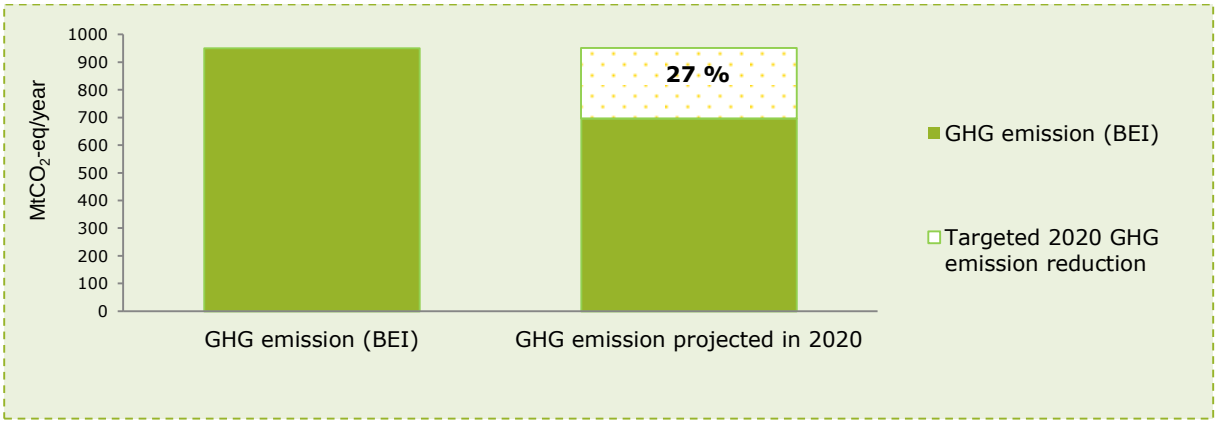
According the CoM signatories' commitments, 49 % of GHG emissions reductions would come from the **Building sector**. In this sector, the national policies promoting energy efficiency implementing the EU directives and policies, as well as specific local authorities building policies bring about energy efficiency improvement. The Municipal buildings, Equipment and Facilities sectors and Public lighting include measures planned in areas of Municipal building and facilities (building renovation, energy management of public lighting, energy efficiency in waste and waste-water management, etc.). Although this sub-sector represents the lowest share of GHG emissions reductions (3.1 %), they are important as the municipality itself assumes an **exemplary role** in the implementation of the local action plan.

Table 5. Shares of estimated GHG emission reductions by 2020 per sector and sub-sector: CoM BEI dataset 2016

Macro-sectors	Sub-sectors	Estimated GHG emissions reductions by 2020 [tCO_2-eq/year]	Shares
Buildings, Equipment, Facilities and Industries	Municipal buildings, Equipment, Facilities	5.99	2.4 %
	Tertiary buildings, Equipment, Facilities	13.90	5.5 %
	Residential buildings	50.35	19.8 %
	Municipal public lighting	2.46	1.0 %
	Industries (non ETS)	6.86	2.7 %
	Not assigned in the macro-sector	44.00	17.3 %
	Subtotal	123.6	49 %
Transport	Subtotal	59.7	23 %
Local electricity production	Subtotal	31.3	12.2 %
Local heat cold production	Subtotal	20.3	8.0 %
Other	*Not assigned in the macro-sector*	19.8	7.8 %
Total		**254.55**	**100 %**

GHG emissions reductions in the Transport sector would represent 23 % of overall GHG emissions reductions by 2020. In this sector, the main driver of lowering the GHG emissions and related energy demand is the improvement of the fuel efficiency driven policies and the uptake of cleaner technologies. While fuel efficiency driven policies fall under the competences of the EU and national policies, local authorities' policies in transportation are related to urban transport planning, prioritise public transport versus private ones, and structural changes in the sector, such as shifting towards less polluting vehicles (electric cars, etc.).Actions in the local energy production sector would be responsible for 20.2 % of the GHG emission reduction by 2020 according to CoM signatories' commitments. Local energy productions options vary from decentralised power production from photovoltaics, mini-hydro and mini-wind power plants with community partnership, to decentralised heat production such as solar thermal plants, geothermal, biomass and cogeneration plants combined with district heating networks. Figure 1 shows the overall absolute emissions and committed reductions by 2020. Although the minimum commitment requirement in the CoM is to reduce the emissions by 20 % by 2020, the CoM signatories have committed on average to a significantly higher target of **27 %**.

Figure 1. Share of GHG emission reduction: CoM BEI dataset 2016



The performance indicators reported in Table 6 indicate an average GHG emissions per capita of 5.17 tCO_2-eq/cap*y in CoM BEI dataset 2016, while the EU-28 average for GHG emissions in all sectors in 2014 (EEA, 2014) is 8.4 tCO_2-eq/cap*y. The average committed reduction per capita by 2020 is of 1.41 tCO_2-eq/cap*y, which corresponds to a reduction per capita of 27 %.

Table 6. Performance indicators on GHG emissions and reduction: CoM BEI dataset 2016

Per capita GHG emissions in the BEIs reference years [tCO_2-eq/cap*y]	5.17
Per capita GHG emission reduction by 2020 [tCO_2-eq/cap*y]	1.41
Per capita GHG emission reduction by 2020 [%]	27 %

When calculating the greenhouse gas impacts of policies in the local authorities' territory on greenhouse gas emissions, an analytical challenge arises: how to allocate discriminate between greenhouse gas emissions impacts between from policies that lower consumption through efficiency and those that increase the supply of renewable electricity (Anders *et al.*, 2015).

The logic behind the method proposed in this report is to consider first the increase of the renewable sources that would lower the average emission factor in the signatory's territory. In a second step, the difference between the overall emission factor target for 2020 and the lower emission factor owing to the increase of renewables is allocated to GHG emissions due to energy efficiency policies (see Annex 1 for details).

As a result of the applied method, it is estimated that GHG emission reductions thanks to energy efficiency policies would contribute **82 %** to the total GHG emission reduction target by 2020, whereas the increase of renewable sources would contribute 18 % to the reduction.

An attempt has also been made to assess the contribution of local actions towards achieving EU GHG emission reduction targets (Table 7).

The emission reduction needed at the EU level to achieve its 20 % reduction target by 2020 has been calculated using EEA data for 2005 (EEA, 2014).

- The emission reduction committed by 2020 by the CoM signatories of the EU Member States (239 $MtCO_2$-eq) represents 98 % of the overall reduction committed by all CoM signatories (CoM BEI dataset 2016);
- By achieving their commitment, the CoM signatories in the EU Member States, which cover 33 % of the EU population ([16]), would achieve 31 % of the EU's overall emission reduction target by 2020, including all sectors (i.e. ETS and ESD) ([17]).

([16]) The reference year for the total EU population is 2005, the baseline year with the highest representatives in terms of population in CoM BEI dataset 2016.
([17]) The scope of CoM in terms of sectors and GHG targeted is just a part of the overall GHG emissions from all sectors targeted by EU.

Table 7. CoM contribution to the EU 2020 target in terms of GHG emission reduction: EU-28 CoM BEI dataset 2016

EU-28 2005 GHG emissions [$MtCO_2$-eq]	5 199
EU-28 2020 GHG emissions reductions target [$MtCO_2$-eq]	778
CoM EU-28 2020 estimated GHG emissions reductions [$MtCO_2$-eq]	239
CoM potential contribution to EU-28 2020 GHG emission reduction target [%]	31 %

3.2.3. Final energy consumption in baseline emission inventories

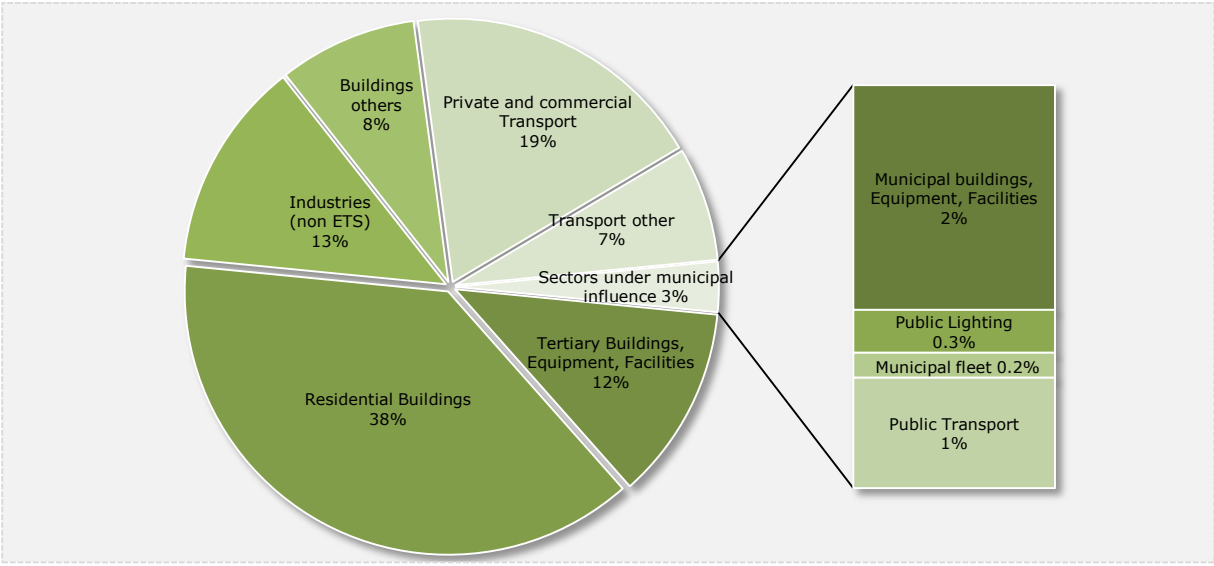
Figure 2 illustrates the shares of the final energy consumption into CoM sectors. A total final energy consumption of 3 667 TWh/year has been reported in the BEIs, with a preponderant contribution from the buildings macro-sector (73 %) followed by the transport one (27 %).

Buildings, Equipment, Facilities and Industries: The three most-emitting buildings sub-sectors (see Table 3) are responsible for 38 % (Residential buildings), 12 % (Tertiary buildings) and 13 % (Non-ETS industries) of the total final energy consumption, respectively. The final energy consumption in the Buildings sector that is not assigned to a specific sub-sector represent 8 % of the total final energy consumption.

Transport: The final energy consumption in the Transport macro-sector is largely dominated by the Private and commercial transport sub-sector, which contributes to 70 % of the final energy consumption from transportation and to 19 % of the total final energy consumption. The energy consumption in the Transport sector, not assigned to a specific sub-sector represents 7 % of the total final energy consumptions.

The 'Sectors under municipal influence' cover the final energy consumptions from Municipal building and facilities (2 %), Public lighting (0.3 %), Municipal fleet (0.2 %) and Public transport (1 %). It represents 3 % of the total final energy consumption.

Figure 2. Final energy consumption in CoM sectors reported in BEIs: CoM BEI dataset 2016



3.2.4. Estimated energy savings by 2020

CoM signatories have planned to implement energy efficiency and energy savings measures in all sectors covered by the initiative. Energy efficiency refers to using less energy input to deliver the same service (IRENA and C2E2, 2015) (or, similarly using the same amount of energy input to deliver more service), while energy savings refers to reducing the use of energy thought for example behavioural changes, etc. In the present report the use of 'energy saving' term refers to two meanings, i.e. energy efficiency or energy savings.

Statistics on **aggregated targeted energy savings by 2020** per sub-sector for the 5 403 SEAPs of CoM BEI dataset 2016 are reported in Table 8. While in the previous assessment report dated 2015 (Kona *et al.*, 2015), estimated energy savings by 2020 totalled 478 TWh/year, they are now estimated at **744 TWh/year**.

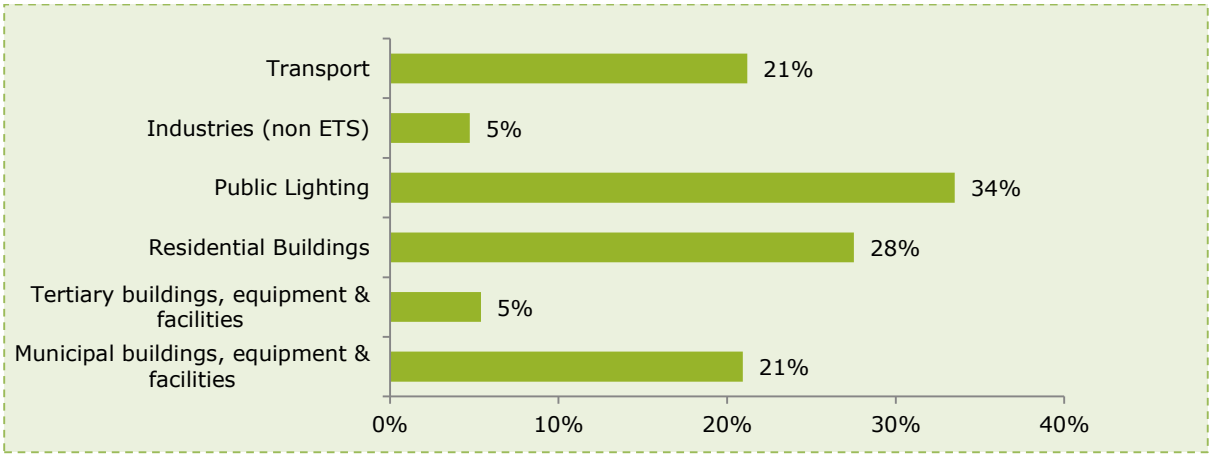
Table 8. Estimated energy savings by 2020 per sector and subsector: CoM BEI dataset 2016

Macro-sectors	Sub-sectors	Estimated final energy savings by 2020 [TWh/year]	Shares
Buildings, Equipment, Facilities and Industries	Municipal buildings, Equipment, Facilities	13.09	1.8 %
	Tertiary buildings, Equipment, Facilities	23.61	3.2 %
	Residential buildings	441.11	59.3 %
	Municipal public lighting	4.03	0.8 %
	Industries (non ETS)	22.33	4.2 %
	Not assigned in the macro-sector	92.18	17.3 %
	Subtotal	533.3	71.4 %
Transport	Subtotal	206.7	28 %
Local electricity production	Subtotal	1.3	0.2 %
Local heat cold production	Subtotal	2.9	0.4 %
Total		**744.2**	**100 %**

Renovation of existing buildings leads to better insulation of the buildings (window replacement, better facade insulation, roof insulation) or efficient heating devices, resulting therefore in energy savings in the building sector. The Covenant signatories use building codes to impose more stringent building energy performance requirements than those applied at national level. In fact, through such stricter application of national policies on building codes and other local policies in the building sector, the Covenant signatories estimate to reduce by 28 % their final energy consumption in the residential sector and 5 % in the tertiary sector and industries facilities where the local authorities' influence is lower (Figure 3).

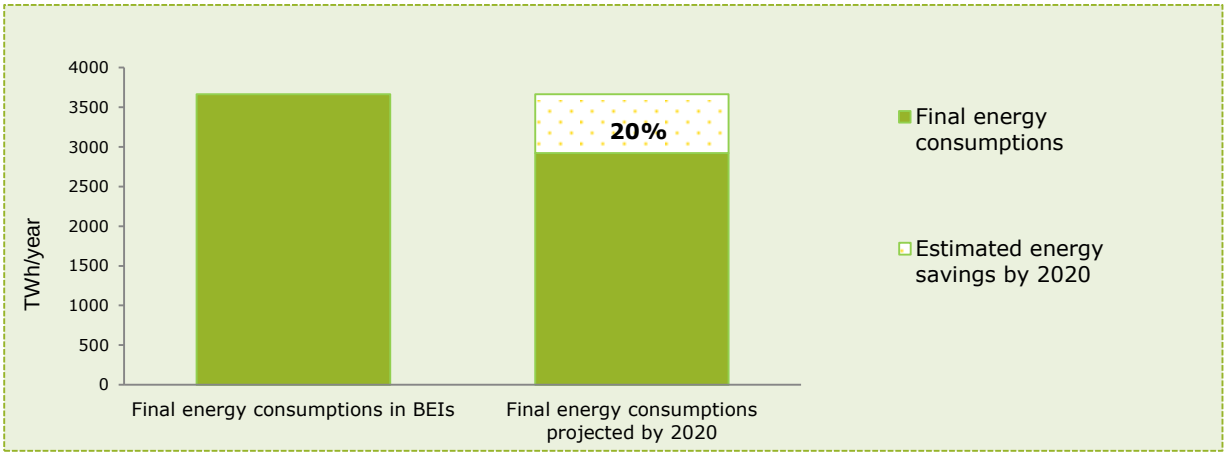
Figure 3 shows the estimated energy savings by 2020 on final energy consumptions, per sub-sector. Public authorities often prioritise the implementation of energy management systems, public procurement and awareness raising for improving efficiency and reducing energy consumption in their buildings and facilities. Indeed, the biggest contribution to energy savings by 2020 is expected to come from the Public lighting (34 %) and the Municipal buildings and facilities (21 %) sub-sectors.

Figure 3. Estimated energy savings by 2020 (% in final energy consumption) in CoM main subsectors: CoM BEI dataset 2016



Mobility and land use planning is an area of direct intervention for local authorities, which combined with cleaner and efficient vehicles policies, is estimated to reduce by 21 % the final energy consumptions in the Transport sector. Raising awareness is presented as a key lever of cities and one aspect could be in promoting cycling and walking, as well as by taking measures that foster cycling and walking (e.g. pedestrian areas, cycling lanes …). On average the CoM signatories estimate saving 20 % of energy by 2020 compared to the BEI (Figure 4). This is as ambitious as the EU 2020 target.

Figure 4. Overall final energy consumptions reported in BEIs and estimated energy savings by 2020: CoM BEI dataset 2016



The yearly average final energy consumption per capita in CoM (Table 9) is 19.51 MWh/cap, which is very similar to the EU-28 yearly average of 19.2 MWh/cap (Eurostat 2005 reference year: Final energy consumption in transport, residential and services sectors). The **average energy saving** is **3.9 MWh/cap**, which also corresponds to a **20 %** reduction compared to the BEIs.

Table 9. Per capita indicators on final energy consumption and estimated energy savings: CoM BEI dataset 2016

Per capita final energy consumptions in the BEIs reference years [MWh/cap*y]	19.51
Per capita final energy consumptions in the BEIs reference years [MWh/cap*y]	3.9
Per capita estimated energy savings by 2020 [%]	20%

3.2.5. Local energy productions in baseline emission inventories

Local authorities can and do have a significant impact in both energy production and energy consumption and are important participants for implementing distributed generation (Scott and Pollitt, 2011).

In CoM framework, the energy production installations which are defined as 'local' are those which are situated on the administrative territory of the local authority. Further restrictions related to the size apply to the power production units: with the exception of big installations which are both owned/operated by the local authority and included in the SEAP actions, only installation units below 20 MW thermal input for combustion installations, should be reported as local energy production.

Table 10 illustrates the local energy production reported in the CoM BEI dataset 2016. The total local energy production is 375.5 TWh/year (with a contribution from renewable energy sources of 31 %), which corresponds to 10 % of the final energy consumption.

Table 10. Local energy production reported in the BEIs: CoM BEI dataset 2016

Local energy production	**[TWh/year]**	**Shares**
Renewable energy in buildings sector	57	15 %
Renewable energy in local electricity and heat/cold power plants	59.5	16 %
Non-renewable sources in local electricity and heat/cold power plants	259	69 %
Total local energy production	*375.5*	*100 %*

3.2.6. Estimated local energy production by 2020

Besides reducing their emissions through energy efficiency improvement, local authorities take the lead in the transition to renewables and through the integration of the energy supply and demand between different sectors (e.g. by encouraging district heating and cooling systems).

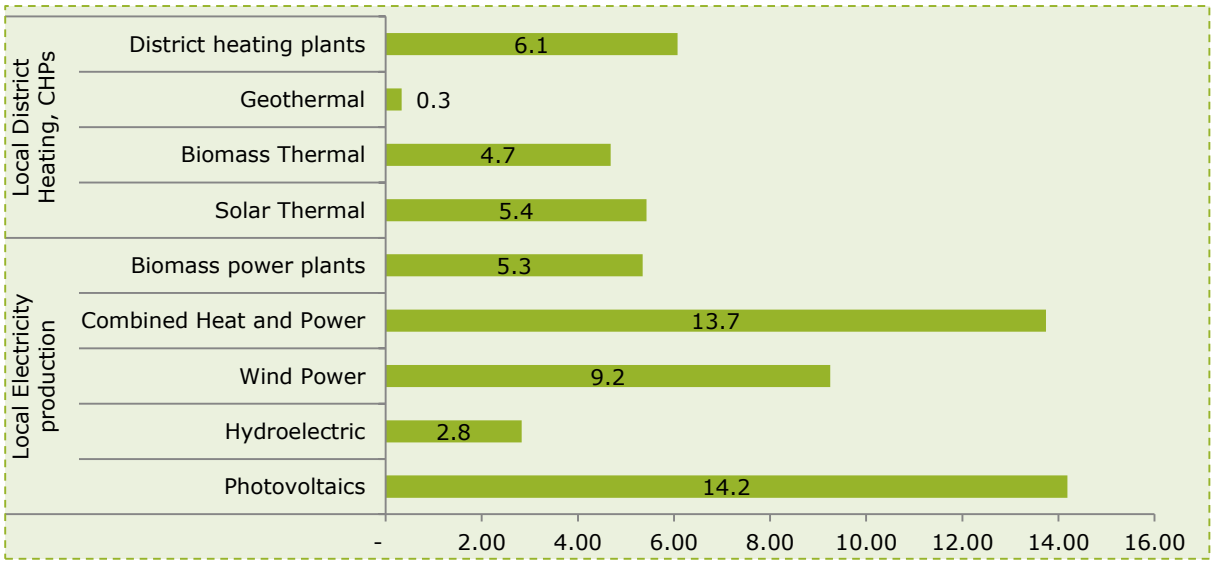
Table 11 shows the planned local energy production by 2020 per CoM sector. The biggest contribution to local energy production comes from electricity (49 %), which includes building-integrated electricity production (e.g., rooftop, photovoltaics). Another 37 % of energy production by 2020 is planned in the Buildings sector: this includes essentially renewable energy for space heating and hot water, e.g. from technologies such as solar thermal and heat pumps.

Table 11. Estimated local energy production by 2020: CoM BEI dataset 2016

Macro-sectors	[TWh/year]	Shares
Buildings, equipment and facilities	69	37 %
Transport	2.8	1 %
Local electricity production	92	49 %
Local district heating, CHPs	24.6	13 %
Total	*188.4*	*100 %*

Figure 5 shows the planned local energy production by 2020 as a function of the technology. Given that it is mandatory for signatories to provide estimates on GHG emission reduction per sector, but not for energy production, only 33 % of the energy production is associated with specific technology.

Figure 5. Estimated energy production by technology in 2020 (TWh): CoM BEI dataset 2016



Box 4. Integrated district heating and cooling helps to achieve climate obligations in Helsinki, Finland

In a country where temperatures are below 10 °C for half of the year, heating buildings is a crucial basic utility. As a result, Finland has been leading in cogeneration of heat and power (also known as combined heat and power — CHP) for a long time. In Helsinki, some 93 % of the buildings are connected to district heating. What may be more surprising is that the city has also been seriously investing in cooling solutions for its districts in the last few years. District cooling is now clearly a growing business in Helsinki, already covering a volume of buildings of 11.5 million m^3. In 2015, district cooling in Helsinki is estimated to save about 60 000 tonnes of CO_2 emissions. But the advantages of 'Helen-IT' are not limited to the energy savings. The solution is also totally silent and unobtrusive, as the district cooling equipment installed in the clients' premises takes up much less space than traditional cooling devices. http://www.covenantofmayors.eu/IMG/pdf/Helsinki_Case_Study_Covenant_Mayors_1_.pdf

The set of the EU and national specific policies that promote RES (mostly the implementation of the feed in tariffs) drive significant penetration of RES in power and heat generation (EC, 2016a).

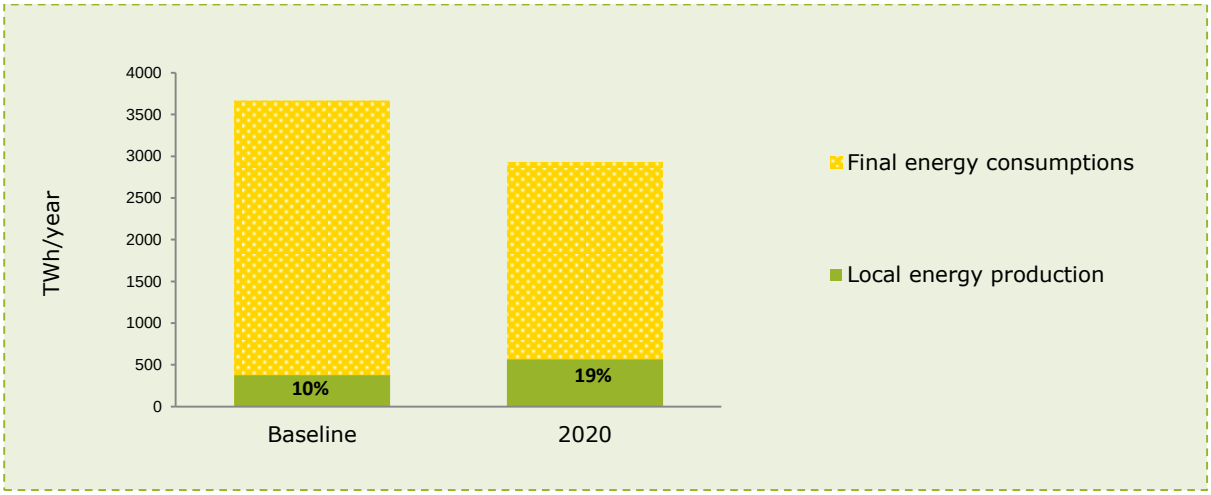
The share of cogeneration in EU-28 reached 13 % of the gross electricity produced in 2010 (EC, 2016a). Amongst the CoM signatories, the use of RES sources in combined heat and power plants are planned to increase by 13.7 TWh/year by 2020. The use of biomass in local power production would increase by 5.3 TWh/year. Similarly, in district heating systems an increase of 6 TWh/year is expected through the integration of renewable sources in the energy mix.

In the EU-28, generation from photovoltaics should contribute 4 % of the net generation by 2020. Investments are mostly driven by support schemes and the decreasing costs of solar panels. While support schemes are being reduced, costs continue to fall and total PV capacities are projected to reach 110 GW in 2020, up from 30 GW in 2010. In the EU-28, generation from photovoltaics should contribute 4 % of the net generation by 2020. Investment is mostly driven by support schemes and the decreasing costs of solar panels. While support schemes are being reduced, costs continue to fall and total PV capacities are projected to reach 110 GW in 2020, up from 30 GW in 2010 (EC, 2016a).

With regard to the CoM signatories, the energy production from photovoltaics is estimated to reach 14.2 TWh by 2020, i.e. 0.5 % of the projected final energy consumption by 2020. Wind power is planned to increase by 9.2 TWh by 2020, while hydro power plants would increase by 2.8 TWh. Solar thermal energy would increase by 5.4 TWh and biomass used for heat production by 4.7 TWh in 2020, while geothermal heat is expected to increase by 0.3 TWh by 2020.

Figure 6 shows the share of local energy production in the overall final energy consumption as projected by 2020. The local energy production in the baseline inventories is the sum of the final energy consumptions using RES (solar, geothermal, biomass) and the local energy production from local power and heat production plants (CHP and district heating). The share of the local energy production on the total final energy consumptions is 10 %. The local energy production in 2020 is the sum of the local energy production in the BEI inventories and the renewable energy production planned by 2020. The local energy production is planned to make up 19 % of the total final energy consumption in 2020.

Figure 6. Estimated share of local energy production on final energy consumption: CoM BEI dataset 2016



3.2.7. Main policies of the sustainable energy action plans

Addressing climate change has moved now to the forefront of urban priorities. Municipalities have a variety of options in relation to energy usage in the built environment, transportation, land use planning, waste and water services. This chapter summarises major policies per area of intervention/subsector planned to be used by local authorities to reach their 2020 climate and energy targets. Out of 140.4 thousand measures reported by municipalities in the CoM BEI dataset (i.e. 5 403 signatories), only 47.7 thousand measures (i.e 34 % of the measures reported) were classified by the local authorities as a function of the type of policy applied per area of intervention.

Figure 7 shows the shares of estimated GHG emission reduction by type of policy of those measures of which a classification by type of policy was reported. Table 12 shows the shares of the number of measures per type of policy, highlighting the most important areas of the interventions. In Annex II (Table 21), the overall shares of the number of measures per type of policy are reported.

Figure 7. Share of estimated GHG emission reduction by 2020 per type of policy: CoM BEI dataset 2016

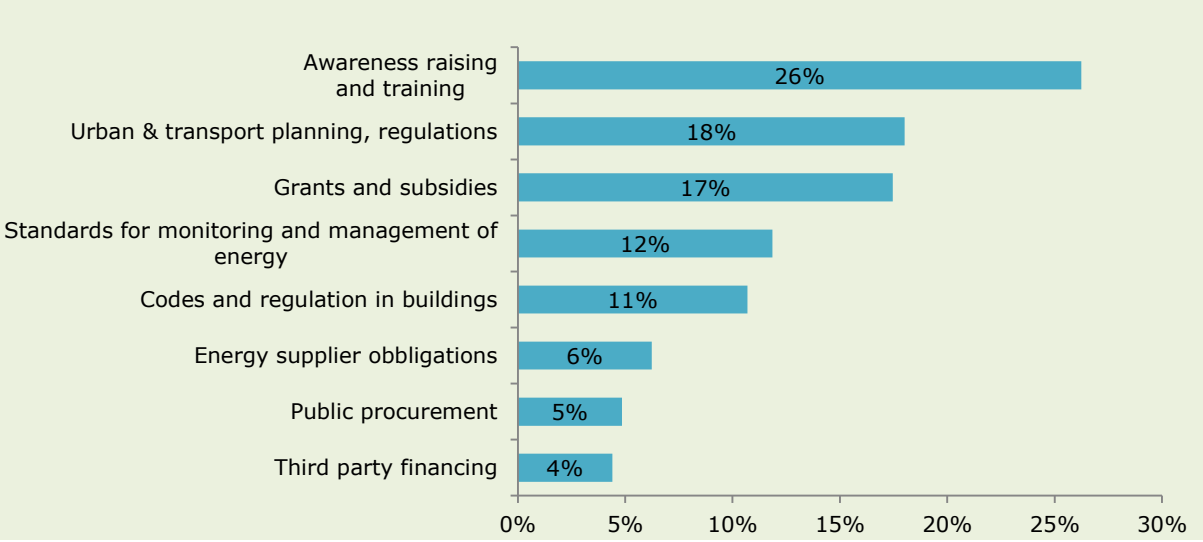


Figure 10 shows the shares of estimated GHG emission reduction by type of policy per each subsector mapped in the SEAPs. A detailed analysis on policies follows hereafter:

Awareness raising, contributing with 26 % to the total estimate of GHG emission reductions (Figure 7), is the major policy instrument deployed by local authorities to mobilise public interest in sustainable energy policies and climate change.

During the implementation phase of the SEAP, it is essential to ensure both good internal communication (between different departments of the local authority, the associated public authorities and all the persons involved (local building managers) as well as external communication (citizens and stakeholders).

This instrument is widely deployed by CoM's signatories, ranging from the Building sector, where it contributes with 34 % to the total emission reduction in the Tertiary sector, through Industry where its contribution to the total emission reduction in the sector amounts to 28 % to Transportation with a 27 % contribution to the total emission reduction in the sector.

All these elements contribute to awareness raising, increase the knowledge about issues, induce changes in behaviour, and ensure wide support for the whole process of the SEAP implementation.

Major areas of interventions related to awareness raising are (Table 12): behavioural changes (9 %), development of the activities of communication and awareness to the population and stakeholders with reference to integrated action in buildings for improving energy efficiency and use of renewable sources (7 %); awareness-raising campaigns for reducing the annual water consumption/waste production (4 %), cleaner and efficient vehicles (6 %) and eco-driving campaigns (5 %).

Box 5. Engaging citizens for energy efficiency: Ivanić-Grad, Croatia

Ivanić-Grad is a town 30 km south-east of Zagreb with a total population of 15 000. Despite its small size, the municipality has been a regional pioneer in promoting sustainable energy and engaging citizens in energy-saving actions. By 2020, Ivanić-Grad expects to have reduced its CO_2 emissions by 21 % as part of its Covenant of Mayors commitment. A large part of this reduction will come from the positive impact of awareness-raising campaigns with the citizens. Since 2010, some 300 citizens of all ages and backgrounds have been actively involved in energy-saving activities through the ENGAGE campaign. The objective of the campaign is to make citizens sign a personal energy-saving pledge on a poster that shows how they are going to use less energy in their everyday activities. All posters are then exposed in public spaces across the town, during large events like the European Mobility Week, local celebration days such as the Pumkpin Festival or the city day. 79 out of these 300 citizens also accepted having their energy consumption monitored. They provided data on their energy consumption at home and on their mobility habits. All the information was then put together in a document, that was revised a year later to assess the changes in the energy consumption. The results were very positive, with an average 17 % reduction in individual CO_2 emissions.

http://www.covenantofmayors.eu/IMG/pdf/Ivanic_Grad_Case_Study_Covenant_Mayors_final-1.pdf

Urban and transport planning, regulations: is one of the basic functions of the municipal governments which substantially influence local energy use and offers opportunities to deploy sustainable energy in local territories. Main strategies such as embedding climate change in land-use planning and mobility planning-regulations will contribute with 18 % to the total estimate GHG emission reductions (Figure 7).

Box 6. Stuttgart: combating the heat island effect and poor air quality with green ventilation corridors

Stuttgart's location in a valley basin, its mild climate, low wind speeds, industrial activity and high volume of traffic has made it susceptible to poor air quality. Development on the valley slopes has prevented air from moving through the city, which worsens the air quality and contributes to the urban heat island effect. A Climate Atlas was developed for the Stuttgart region, presenting the distribution of temperature and cold air flows according to the city's topography and land use. Based on this information, a number of planning and zoning regulations are recommended that also aim to preserve and increase open space in densely built-up areas. The Climate Atlas provides standardised climatic assessments for the 179 towns and municipalities in the Stuttgart region.

The Atlas comprises maps which show regional wind patterns, flows of cold air, air pollution concentrations, and other relevant information required to inform planners on what to do for urban climatic optimisation that could inform new projects and retrofits. A key element of the Atlas is an area classification based on the role that different locations play in air exchange and cool airflow in the Stuttgart region, based on topography, development density and character, and provision of green space. The Atlas distinguishes eight categories of areas in this manner, and for each of them different planning measures and recommendations are provided.

As a result of the implementation of the recommendations included in the Climate Atlas and Climate Booklet, over 39 % of Stuttgart's surface area has been put under the protection of nature conservation orders — a record in Germany.

http://climate-adapt.eea.europa.eu/metadata/case-studies/stuttgart-combating-the-

Land use planning has a significant impact on energy consumption in both Transport and Building sectors through its impact on balancing housing, services and work opportunities (mixed use) and clear influence on mobility patterns. Furthermore, this type of policy is used in development of new district heating networks and CHP power plant, contributing with 6-8 % to the total estimate of GHG emission reductions by 2020 in the subsector (Figure 10).

In order for the transport sector to be fully effective, a gradual transformation of the entire system is required towards greater integration between modes, innovation and deployment of alternative fuels, and improved management of traffic flows through intelligent transport systems. **Mobility planning and regulation** will contribute with 38 % to the total estimate of GHG emission reductions by 2020 in the transport sector (Figure 10).

Major areas of interventions related to urban and transport planning and regulations are (Table 12): modal shift to walking and cycling (14 %); urban regeneration (10 %) and cleaner efficient vehicles (9 %).

Box 7. Free electric biking in Águeda, Portugal

The electric bicycle scheme, piloted from June until December 2011, is one example of the many sustainable energy actions outlined in Águeda's sustainable energy action plan (SEAP). The municipality purchased 10 electric bicycles and designated 10 parking areas dispersed over the territory, as well as a main parking station and a monitoring and management system. The monitoring system works on wireless technologies — a WiMAX system — that covers the territory of Águeda and allows the scheme's manager to identify, online and with real time information, which bicycles are available, when they are in use and who is riding them. The electric bicycles are available for free to the public, and represent an investment cost of EUR 22 000 for the municipality. http://www.covenantofmayors.eu/IMG/pdf/Agueda_long.pdf

Grants and subsidies: Financial incentives, such as grants and subsidies, are an important policy instrument used by local authorities to promote energy efficiency and deployment of renewable energy sources, contributing with 17 % to the total estimate of GHG emission reductions by 2020 (Figure 7). The contribution of grants and subsidies to the reduction of the GHG emission in the Building sector ranges from 9 % in the Tertiary buildings to 26 % in the Residential buildings. In the local electricity and heat production sector, grants and subsidies are used to support specific techniques or pilot projects that the local authority would consider of particular relevance for the deployment of RES, considering its own context and objectives. The contribution to reducing the GHG emissions that can be attributed to grants and subsidies ranges from 24 % with regard to the local electricity production to 18 % for the local heat and cold production to the overall policies contributions in the respective sectors (Figure 10).

Grants and subsidies such as municipal incentives for purchasing electric bicycles or municipal incentives for electric vehicles will contribute 18 % to the total estimate GHG emission reductions in the transport sector (Figure 10).

Major areas of interventions related to these financial mechanisms are (Table 12): installation of photovoltaics (21 %); interventions in the building envelope (15 %) and cleaner efficient vehicles (9 %).

Box 8. Limburg Climate Fund: Province and towns team up for carbon neutrality in Province of Limburg, Belgium

The Province of Limburg and its 44 towns demonstrate how strong ambitions can be realised through cooperation through the launch of the 'Limburg Climate Fund'.

How does this cooperation take place? By joining forces with regional stakeholders (including utility companies), the province provides each town with the data to draw up the baseline emissions inventory and with tailored coaching on what to include in the sustainable energy action plan. In May 2012, a 'Climate Fund' was established in the province through which businesses and individuals voluntarily contribute. The fund will invest its resources in climate friendly projects by means of loans, and the profits will be distributed among the shareholders. The minimum price per share is EUR 100. Each Limburger can buy up to 25 shares on http://www.limburgsklimaatfonds.be

Standards for monitoring and energy management: Adoption of standards for monitoring and management of energy are important tools for all types of organisations (municipal, residential, industrial) and sectors (including buildings, transport, lighting,

waste water, etc.) to review their energy situation and improve their energy efficiency in a systematic and sustainable way.

Standards for monitoring and energy management are a consolidated policy instrument, in the CoM's context, contributing with 12 % of the total estimated GHG emission reduction by 2020 (Figure 7).

It is applied especially in municipal buildings, equipment and facilities and public lighting, contributing 46 % and 51 % respectively to the total estimated GHG emission reduction in these sectors (Figure 10). Although these sectors represent a small share of final energy consumptions in the BEI (4.5 %), they are important as the municipality itself assumes an exemplary role in the implementation of the local action plan.

Major areas of interventions related to standards for monitoring and energy management are (Table 12): public lighting (18 %), integrated actions in the buildings (15 %) and ICT (4 %).

Box 9. Energy Management System in the municipality of Dzierżoniów, Poland

Dzierżoniów was the first Polish municipality to integrate its sustainable energy action plan (SEAP) within the Energy Management System following ISO 50001, and is already benefiting from the synergies between those tools.

In order to support the implementation and monitoring of the SEAP, the municipality decided to introduce the Energy Management System with ISO 50001. Documentation was prepared by three city clerks and the implementation lasted 4 months (from February to May 2013). The staff costs for the implementation amounted to around EUR 3 500, while the certification (of all ISO in Dzierżoniów) was around EUR 4 250. The staff costs of the project were financed by the project 'Appetite for Climate', developed by the Polish Network Energie — Cités (PNEC) with support from the National Fund for Environmental Protection and Water Management. http://www.covenantofmayors.eu/IMG/pdf/Dzierzoniow_2016.pdf

Codes and regulations in building: Many local authorities empowered by law to build upon national efficiency policies are implementing codes for new buildings and regulation in the existing building stock with more stringent requirements than the national ones. In addition to setting energy performance standards, as mentioned above under 'regulation', urban regulations also facilitate authorisation procedures for RES installations such as solar panels on roofs of existing buildings.

The building regulations and energy certification labelling are the major policies instruments used by local authorities in the building sector (municipal, residential and tertiary buildings), ranging from 11 % to 25 % of the estimated GHG emission reductions.

Major areas of interventions related to codes and regulations in buildings are (Table 12): interventions in the building envelope (26 %), integrated actions in the buildings (24 %) and installations of photovoltaics (8 %).

Box 10. Municipal regulation on buildings: Vila Nova de Gaia, Portugal

Vila Nova de Gaia is the most populous municipality in the Northern Region of Portugal. Along with Porto and 12 other municipalities, Vila Nova de Gaia is part of the Porto Metropolitan Area. The municipality's competencies in climate and energy matters are limited to its legal area and to its own facilities. Regarding legislation, the local authority is limited to their urban planning regulations. One of the measures implemented by the municipality and Gaiurb — Urbanismo e Habitação, EEM (the company responsible for Urbanism, Social Housing and Urban Rehabilitation of the Municipality of Vila Nova de Gaia) is the 'Municipal Regulation of Urbanistic Fees and Compensation', which introduces a new policy at municipal level on the promotion of sustainable construction. Implemented in 2010, the purpose of this measure is to give a boost to the sustainable construction processes and environmental protection mechanisms. Therefore, those who opt for sustainable construction certification will enjoy a full or partial tax reduction.

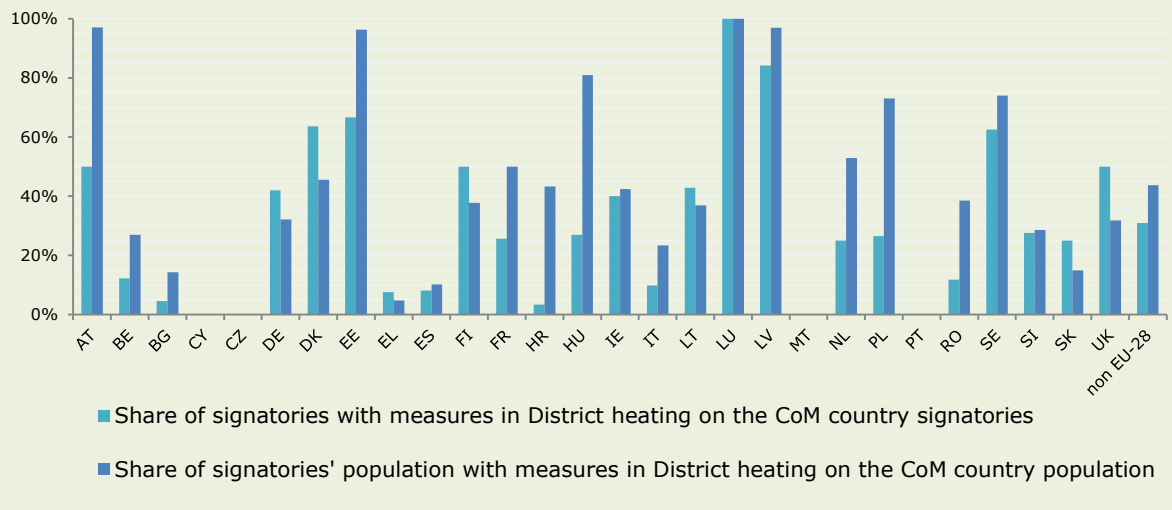
http://www.covenantofmayors.eu/IMG/pdf/Vila_Nova_de_Gaia_2016.pdf

There is an increasing interest in decentralisation of the energy supply with more local ownership (IEA, 2016). Municipalities in the EU-28 often have jurisdiction in **local energy production** and distribution systems, in some case as owner of the utilities, in other cases in partnership with them. This makes local energy supply system an important area of intervention to achieve emission reductions.

In the CoM initiative, as of September 2016, 655 local authorities, representing 61.4 million inhabitants (12 % of the total signatories and 33 % of population) have reported measures in the area of intervention 'Local heat cold production: District heating and cooling'.

Figure 8 shows at country level the shares of the number of signatories having reported measures in the area of 'Local heat cold production: District heating and cooling' on the total number of the CoM country signatories and in terms of population coverage. The share of these signatories in countries like: Belgium, Bulgaria, Greece, Spain, Italy and Romania represents less than 10 % of the CoM country signatories. In Denmark, Germany, Estonia, Latvia, Lithuania, Luxembourg, Austria, Finland, Sweden and the United Kingdom this share is higher than 40 %.

Figure 8. Share of signatories per country (in terms of numbers and population coverage) with measures in district heating sector: CoM BEI dataset 2016



Among the policy instruments introduced in the European Union to support energy efficiency, some Member States ([18]) have introduced obligations on some categories of energy market operators (in particular electricity and gas distributors or suppliers) to deliver a certain amount of energy savings. **Energy supplier's obligations** foster the uptake of standardised energy efficiency actions often targeting smaller energy users (residential sector), and in the CoM this policy contributes, by 45 %, the GHG emission reduction in the local heat production and 24 % in the local electricity production sector.

Public procurement: Public procurement and the way procurement processes are shaped and priorities are set in the procurement decisions, offer a significant opportunity for local authorities to improve their overall energy consumption performance. This policy instrument is estimated to contribute 5 % of the total estimated GHG emission reductions by 2020, mainly in the 'Municipal building and Facilities' (21 %) and in the Public lighting sector (34 %).

Major areas of interventions related to Public procurement are (Table 12): cleaner efficient vehicles (14 %); energy efficiency improvement in public lighting (12 %).

Box 11. Increase sustainability in buildings through Public procurements: Torino, Italy

The Municipality of Torino, as a partner of the European Project named 'Procurement of Lighting Innovation and Technology in Europe', decided to focus on the study and acquisition of innovative solutions for the indoor lighting of school buildings. Indoor lighting was considered a critical aspect, because of the large dimension of the public building stock (more than 700 buildings, half of which schools), and of the high expenditure for electric lighting. Furthermore, the choice of school buildings is also grounded on the potential it has in terms of replicability and educational value. The environmental requirements of the tender were not only referred to the lighting performances, but embraced a larger 'environmental' comfort performance concept (e.g. reduction of CO_2 emissions; reduction of energy use; classrooms acoustics; quality of air; thermal conditions, etc.) (Deambrogio *et al.*, 2017).

Third party financing (TPF): This financial scheme is perhaps the easiest way for municipalities to undertake comprehensive energy retrofits, as it allows someone else to provide the capital and take the financial risk. TPF is estimated to contribute 4 % of the total estimated GHG emission reductions by 2020. Major areas of interventions related to third party financing are (Table 12): energy efficiency in public lighting (21 %), installations of photovoltaics (17 %).

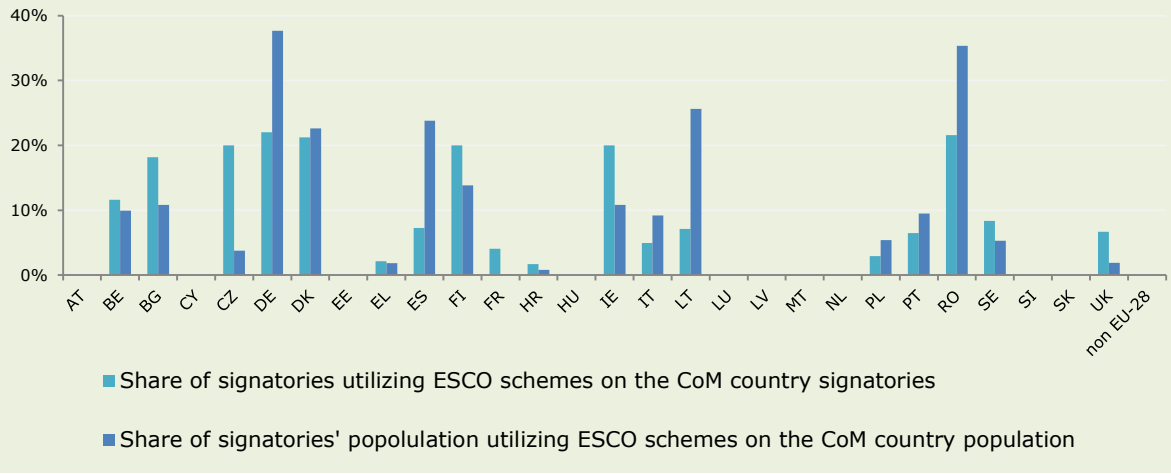
Among third party financing schemes, the **Energy Service Companies (ESCO)** schemes are most used by the CoM signatories. The ESCO usually finances the energy-saving projects without any up-front investment costs for the local authority. The investment costs are recovered and a profit is made from the energy savings achieved during the contract period. The contract guarantees a certain amount of energy savings for the local authority, and provides the possibility for the city to avoid facing investments in an unknown field. Once the contract has expired, the city owns a more efficient building with less energy costs.

Figure 9 shows at country level the shares of the number of signatories having reported measures that will deploy ESCO schemes for the implementation of the actions on the total number of the CoM country signatories and in terms of population coverage. 322 CoM signatories, representing 20.5 million of inhabitants (i.e. 6 % of total CoM

([18]) Mainly in Italy, although this policy instrument has also been adopted in Belgium (Flemish region), France and Denmark.

signatories, and 11 % of the population) have planned to implement energy saving through deployment of **ESCO schemes**.

Figure 9. Share of signatories (in terms of numbers and population coverage) deploying ESCOs schemes: CoM BEI dataset 2016



The ESCO schemes are widely used by local authorities in Germany (22 % of the CoM country signatories and 38 % of CoM country population), in Romania (22 % of CoM country signatories and 35 % of CoM country population), in Denmark (21 % of CoM country signatories and 23 % of CoM country population), in Lithuania (7 % of CoM country signatories and 26 % of CoM country population), in Spain (7 % of CoM country signatories and 24 % of CoM country population) and Italy (5 % of CoM country signatories and 9 % of CoM country population).

Box 12. Optimising the municipality's resource flows thanks to an ESCO scheme: Częstochowa, Poland

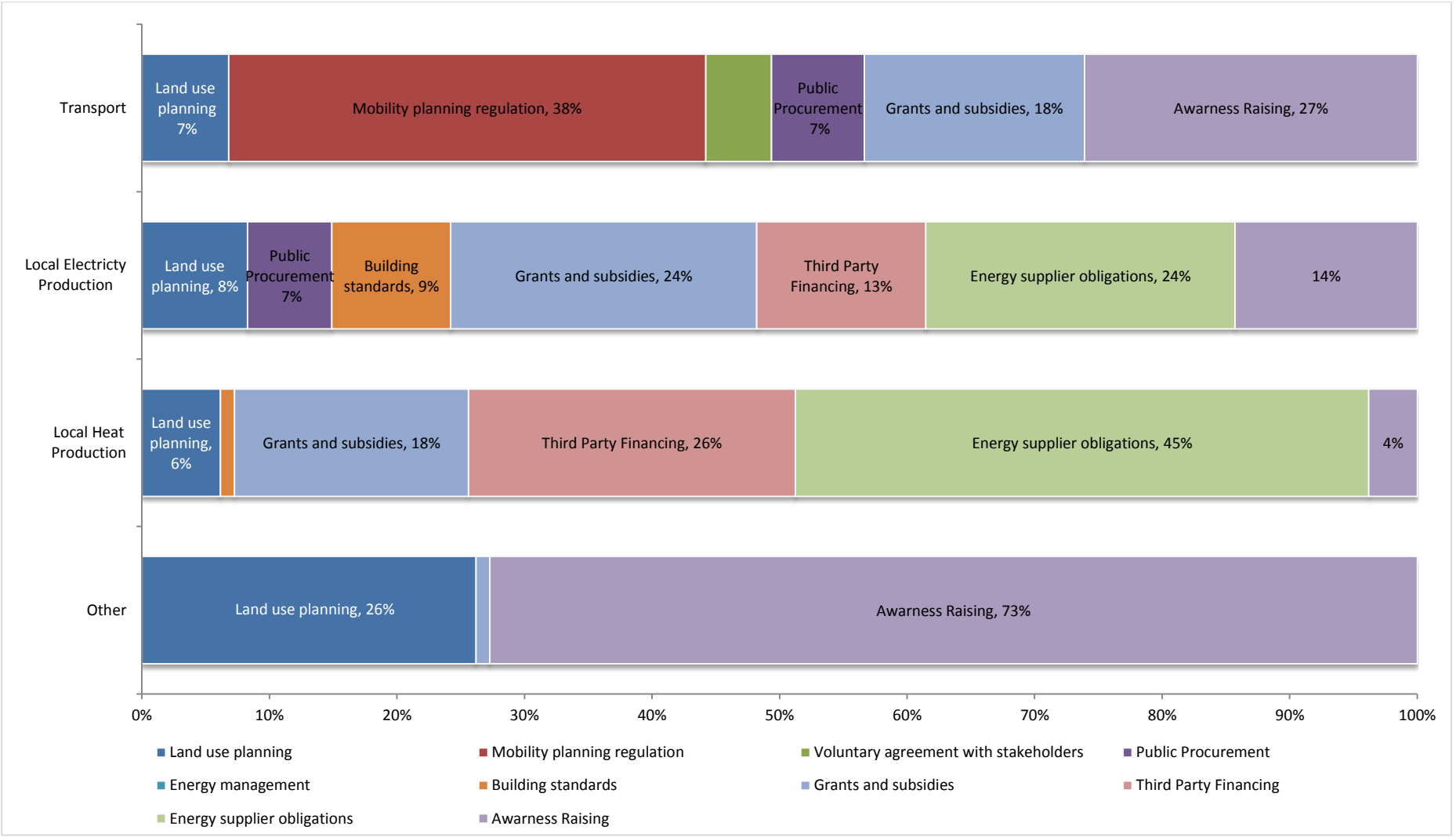
Częstochowa is located in Southern Poland on the Warta River. The municipality's efforts regarding sustainable energy management date back to 2003, when the City Engineer's Office launched a broad-scale programme on energy efficiency, including the 'Programme of Energy and Environmental Management in the public buildings in Częstochowa'. In 2012 Częstochowa launched the second phase of its zero-cost management activities and extended it to include the installation of innovative fittings offered by an Energy Service Company (ESCO) under a programme called 'Drop by Drop', that reduces water and energy consumption for heating tap water. Neither the municipality of Częstochowa nor any of the entities participating in the programme had to cover any initial costs. The company that installed the innovative fittings agreed to be paid from the savings made by the participants in the programme. The financial arrangements of the programme foresee 30 % of the savings staying with the given educational facility and 70 % going to the company to pay off modernisation costs. The pay-off period varies from 2 months to 1 year depending on the building. Additionally, the innovative water supply fittings remain installed and continue to generate savings for the municipality. The programme generates reduction in three kinds of costs: water supply, tap water heating and waste-water discharge. http://www.covenantofmayors.eu/IMG/pdf/Czestochowa_2016.pdf

Table 12. Shares of measures by area of intervention and type of policy: CoM BEI dataset 2016

Area of intervention	Awareness Raising	Urban and transport planning, regulations	Grants and subsidies	Standards monitoring management energy	Codes and regulation in buildings	Energy supplier obligations	Public Procurement	Third Party Financing
BEHAVIOURAL CHANGES	9 %							
BUILDING ENVELOPE			15 %	8 %	26 %		6 %	7 %
ENERGY EFFICIENCY IN SPACE HEATING AND HOT WATER			12 %	12 %	13 %			6 %
ENERGY EFFICIENT ELECTRICAL APPLIANCES				7 %	6 %			
ENERGY EFFICIENT LIGHTING SYSTEMS				10 %	5 %			5 %
RENEWABLE ENERGY FOR SPACEHEATING AND HOT WATER	5 %		8 %	10 %	5 %	6 %		
INTEGRATED ACTION	7 %		9 %	15 %	24 %		13 %	13 %
ICT				4 %				
URBAN REGENERATION		10 %						
WASTE AND WASTE-WATER MANAGEMENT	4 %							

PUBLIC LIGHTING ENERGY EFFICIENCY				18 %		9 %	12 %	21 %
CLEANER EFFICIENT VEHICLES	6 %	9 %	9 %				14 %	
ECO DRIVING	5 %							
ELECTRIC VEHICLES		5 %						
MODAL SHIFT TO_PUBLIC TRANSPORT		7 %						
MODAL SHIFT TO WALKING AND CYCLING		14 %						
ROAD NETWORK OPTIMISATION		6 %						
PHOTOVOLTAICS			21 %		8 %	17 %	10 %	17 %
LOCAL PRODUCTION OTHER			4 %			21 %		
OTHERS	63 %	49 %	22 %	16 %	14 %	47 %	45 %	30 %

Figure 10. Share of estimated GHG emission reduction per type of policy and by subsector: CoM BEI dataset 2016

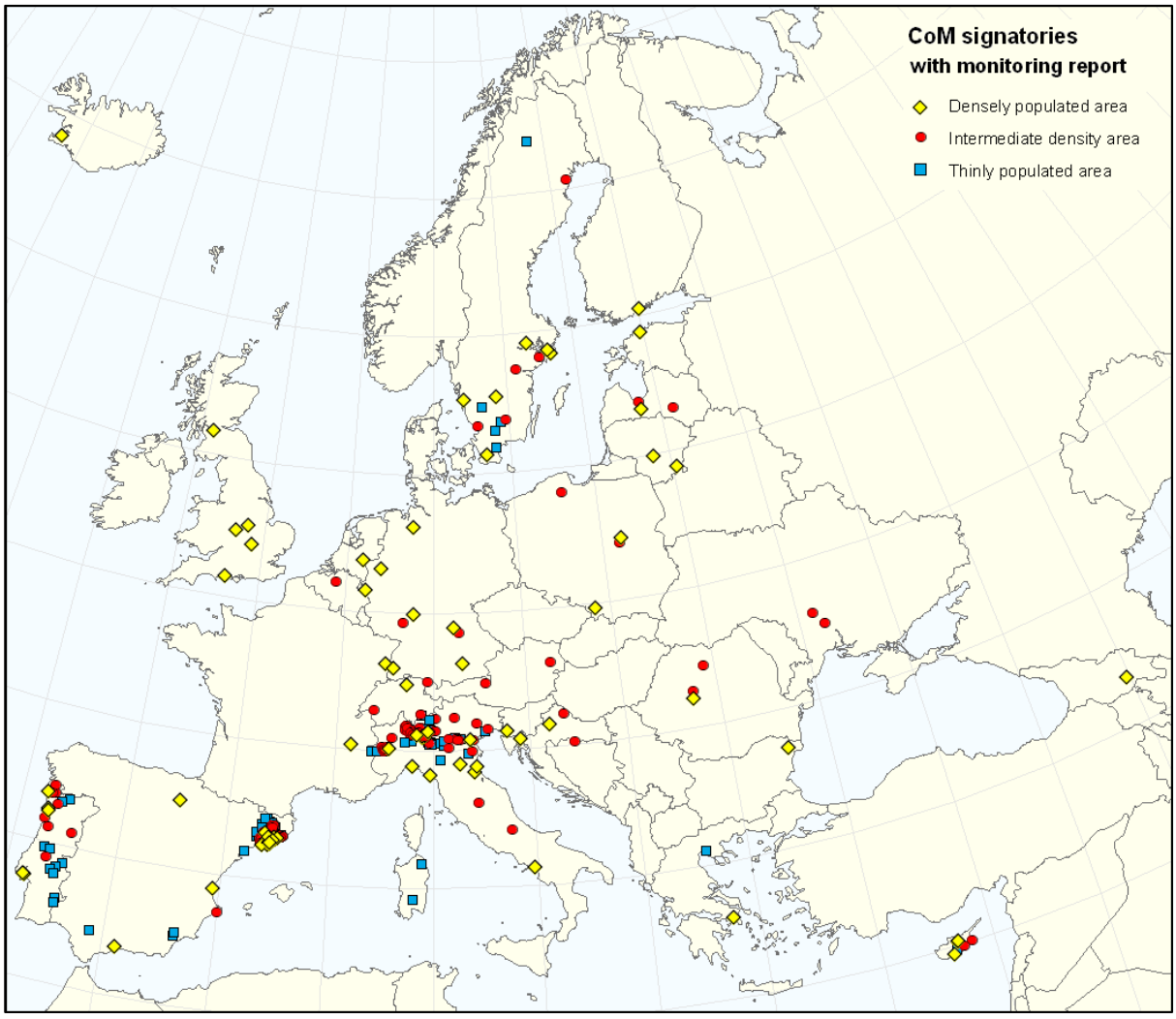

Transport
Land use planning 7%
Mobility planning regulation, 38%
Public Procurement 7%
Grants and subsidies, 18%
Awarness Raising, 27%
Local Electricty Production
Land use planning, 8%
Public Procurement 7%
Building standards, 9%
Grants and subsidies, 24%
Third Party Financing, 13%
Energy supplier obligations, 24%
14%
Local Heat Production
Land use planning, 6%
Grants and subsidies, 18%
Third Party Financing, 26%
Energy supplier obligations, 45%
4%
Other
Land use planning, 26%
Awarness Raising, 73%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Land use planning
Mobility planning regulation
Voluntary agreement with stakeholders
Public Procurement
Energy management
Building standards
Grants and subsidies
Third Party Financing
Energy supplier obligations
Awarness Raising

3.3. Monitoring and implementation

This chapter presents the progress made by the signatories on emissions reductions, on energy savings and on implementing local renewable energy production, as reported during the monitoring phase in their emission inventories based on currently available data from 315 signatories of the CoM MEI dataset 2016.

It presents the progress on monitoring reporting (3.3.1), the reported progress on GHG emission reduction (3.3.2), the reported progress on energy savings (3.3.3), the reported progress on renewable energy deployment (3.3.4) and finally the main policies adopted during the implementation phase (3.3.5). Figure 11 shows the map localisation of the 315 signatories and with their degree of urbanisation as defined in section 3.1 (Kona *et al.*, 2016).

Figure 11. CoM signatories having provided monitoring inventories: CoM MEI dataset 2016 — monitoring subset



3.3.1. Progress on implementation reporting

Up to September 2016, 315 signatories (6 % of signatories with a submitted SEAP) had reported on the implementation of their SEAP by presenting a so-called full report, i.e. a monitoring report including a monitoring emission inventory (MEI). This monitoring subset covers a population of 25.5 million inhabitants (i.e. 14 % of the population of the CoM signatories with a submitted SEAP).

Figure 12 shows the baseline and monitoring years chosen by these signatories, together with their respective populations (bubble size) (Kona *et al.*, 2016). The 1990 and 2005 BEI years have been preferentially selected by the CoM signatories, covering 25 % and 27 % of the BEI population (blue bubbles), respectively.

The MEIs already provided (red bubbles) refer mainly to the years 2012, 2013 and 2014, which represent 41 %, 33 % and 16 % of the total population in the monitoring subset, respectively. The mean reduction target of these signatories is 30 % by 2020, which is 10 % above the minimum reduction required within the frame of the CoM protocol.

Figure 12. BEI and MEI years in CoM MEI dataset 2016: CoM MEI dataset 2016 — monitoring subset

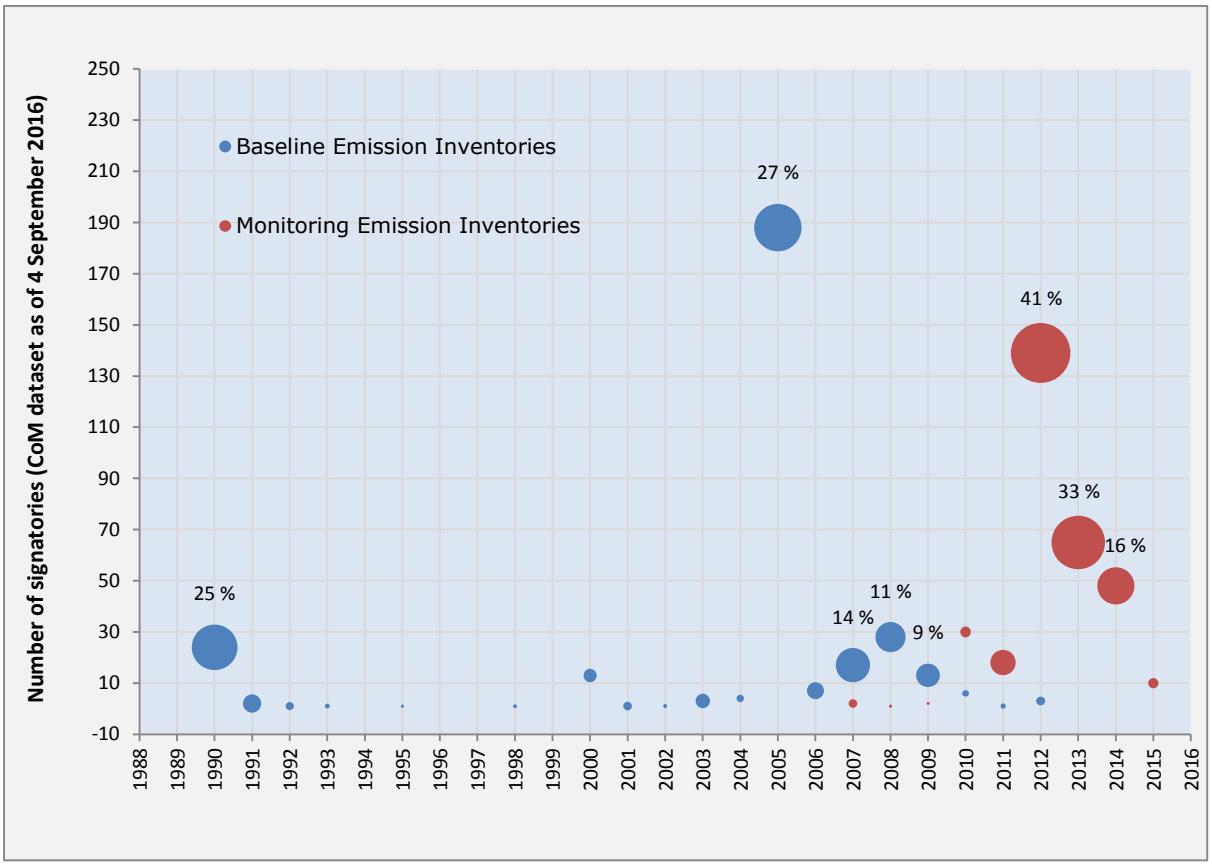
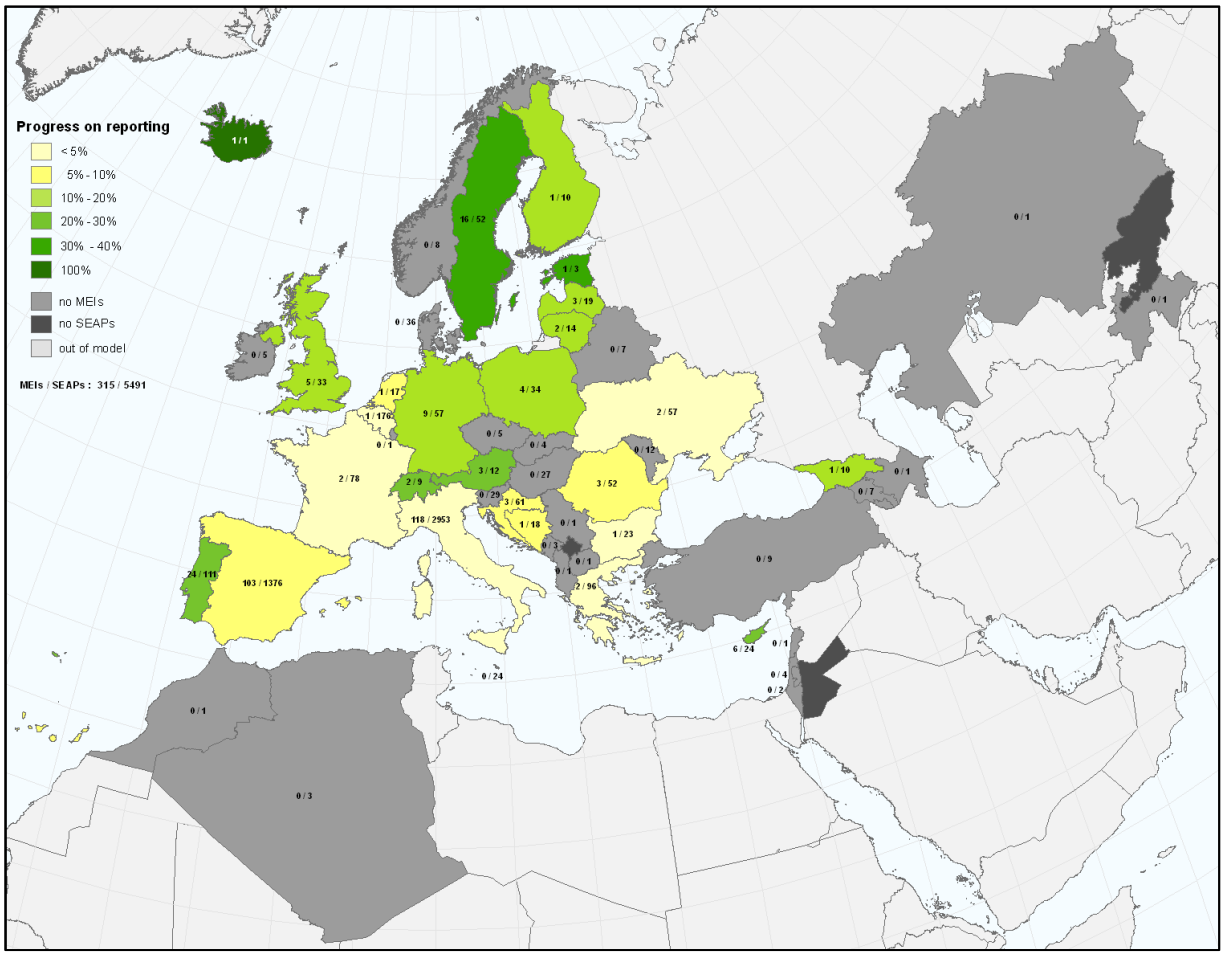


Figure 13 shows the MEIs already provided by each country in terms of percentage of SEAPs submitted (i.e. compared to CoM BEI dataset 2016) (Kona *et al.*, 2016). It suggests that local authorities in some countries (e.g. Spain and Italy) that have enthusiastically joined the initiative and submitted their SEAPs (thanks also to the support provided by regional authorities acting as CTCs), might now be facing some challenges in monitoring and/or reporting data to the Covenant of Mayors (due to lack of resources for instance) or in the implementation phase. The reasons for this should be further investigated in order to provide a definitive answer and identify potential venues to ensure targeted support for local authorities facing such a situation.

Figure 13. Share of monitoring reports on number of SEAPs per country in CoM dataset 2016



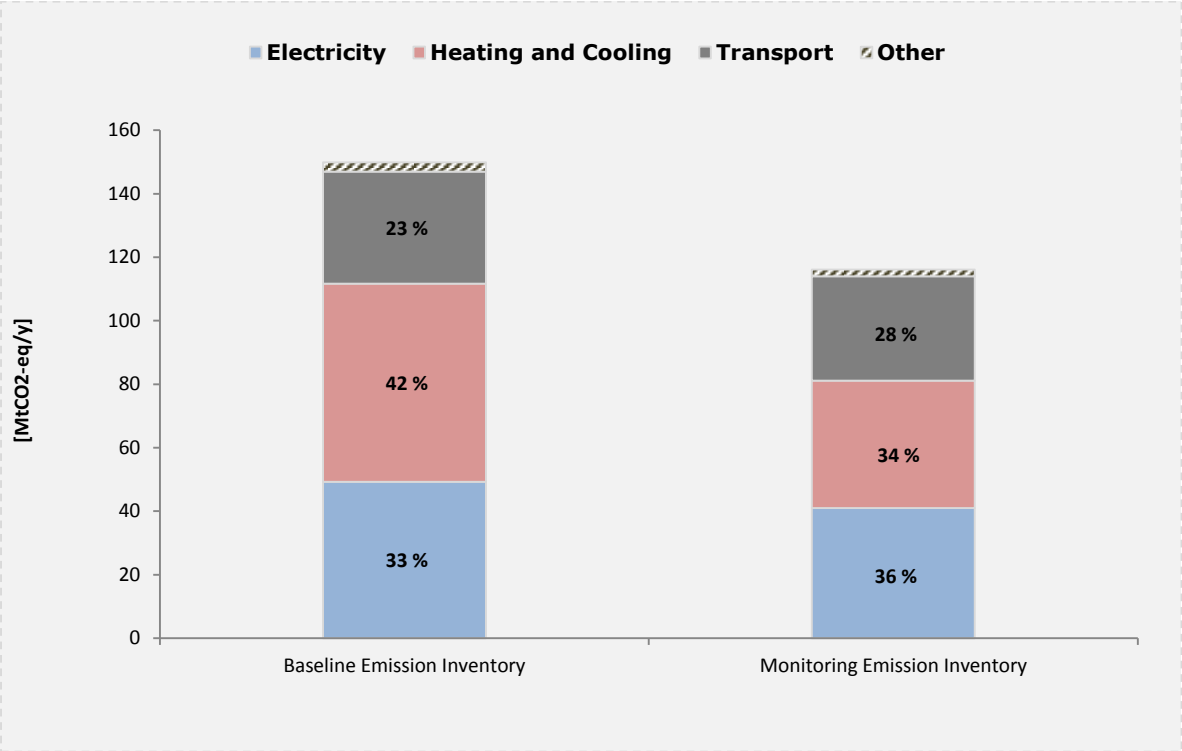
3.3.2. Reported progress on GHG emission reduction

An **overall reduction by 23 %** in GHG emissions is reported between the baseline and monitoring years (Figure 14), as the result of:

- 17 % reduction of GHG emissions thanks to improvement in the electricity consumption, driven by a less-carbon-intensive fuel mix and more efficient electricity generation power plants (EEA, 2014);
- 36 % reduction of GHG emissions from buildings' heating and cooling, driven by improved energy efficiency in buildings and subsequent lower energy generation levels, more efficient local heat production from district heating networks, and by increasing the share of renewable sources in decentralised local heating production.
- 7 % reduction of GHG emissions in the transport sector, driven by lower energy consumption from fossil fuels and an increase in the share of biofuels, and a shift towards public transportation and electric mobility.

While these are encouraging results, the representativeness of the sample should be considered before drawing general conclusions for the whole SEAP sample. Indeed, on average these 315 signatories are bigger cities than those in the SEAP sample. In addition, they are often more advanced cities, i.e. with greater experience in terms of local climate and energy planning.

Figure 14. Evolution of GHG emissions due to electricity, heating and cooling and transport energy consumption from baseline to monitoring years: CoM MEI dataset 2016 — monitoring subset



Note: The percentages in Figure 14 refer to the shares of electricity, heating and cooling and transport energy consumption on total final energy consumption.

3.3.3. Reported progress on energy savings

The progress made by the 315 signatories (CoM MEI dataset 2016 — monitoring subset) is assessed as follows: the final energy consumption in the baseline emission inventory is compared to the consumption reported in their latest monitoring emission inventory, aggregated by sector.

Compared to the baseline inventories, **final energy consumption has dropped by 18 %** (Table 13). Taking into account that signatories' population has changed from baseline to monitoring inventory year, the per capita final energy consumption has been reduced by 22 %.

Table 13. Evolution of final energy consumptions from baseline to monitoring years: CoM MEI dataset 2016 — monitoring subset

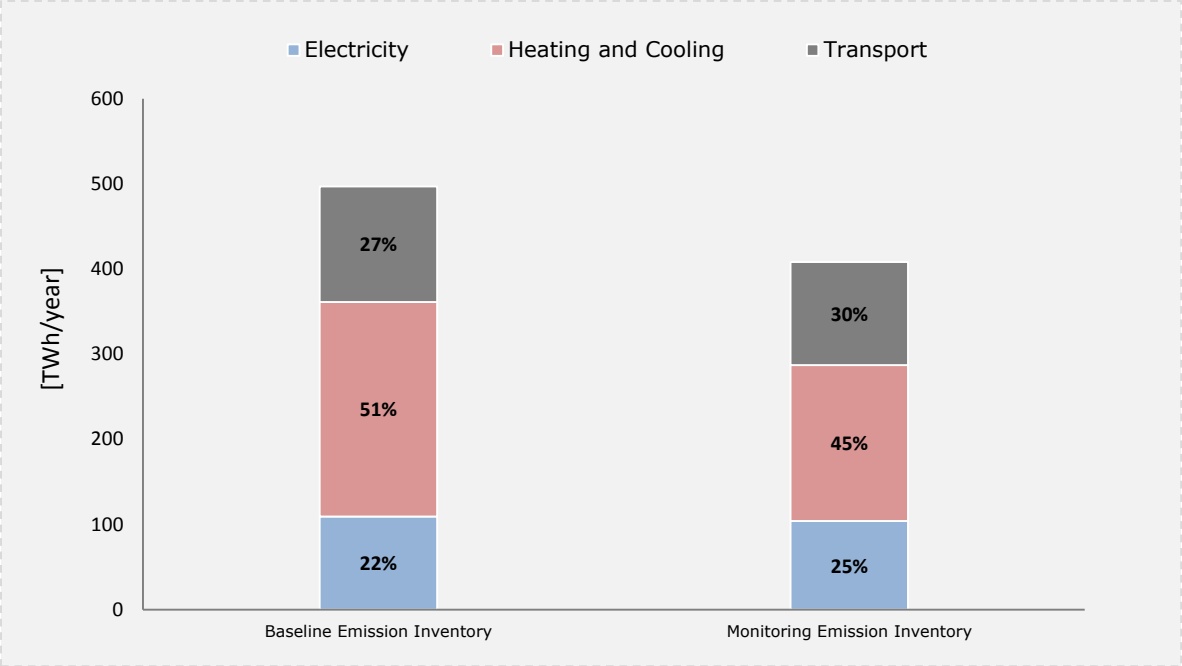
	Baseline Emission Inventory	*Monitoring Emission Inventory*	*Change [%] from baseline to monitoring years*
Final energy consumption [TWh/year]	496.8	408	– 18 %
Per capita final energy consumption [MWh/p year]	20.3	15.9	– 22 %

The 18 % decrease in final energy consumptions between baseline and monitoring years was driven by (Figure 15):

- Electricity consumption was reduced by 5 % from baseline to monitoring years (Table 14).
- Final energy consumption in buildings for heating and cooling was reduced by 27 % from baseline to monitoring years (Table 16).

- Energy consumption in the transport sector was reduced by 11 % from baseline to monitoring years driven by increased use of public transport and active mobility and by a shift towards more efficient and less polluting vehicles.

Figure 15. Evolution of final energy consumptions due to electricity, heating and cooling and transport in baseline and monitoring years: CoM MEI dataset 2016 — monitoring subset



Note: The percentages in Figure 15, refers to the shares of final energy consumption of the sector on total final energy consumption.

Electricity consumption

In CoM signatories' territories, the electricity consumption was reduced by 5 % in absolute terms (Table 14), but it grew in relative terms: in fact the share of electricity consumption in total final energy consumption increased, from 22 % to 25 % between the BEI and the MEI years.

Table 14. Evolution of electricity consumption from baseline to monitoring years: CoM MEI dataset 2016 — monitoring subset

	Baseline emission inventory	*Monitoring emission inventory*	*Change [%] from baseline to monitoring years*
Electricity consumption [TWh/year]	109.6	104	– 5 %

Local electricity production

In comparison to baseline emission inventories the reported local electricity production increased by 80 % (Table 15), it also increased in relation to electricity consumption from the BEI (14 %) to the MEI (26 %) year.

Table 15. Evolution of reported local electricity production from baseline to monitoring years: CoM MEI dataset 2016 — monitoring subset

	Baseline emission inventory	*Monitoring emission inventory*
Local electricity production [TWh/year]	14.8	26.7
Share of local electricity production in electricity consumptions [%]	14 %	26 %
Shares of local electricity production in final energy consumption [%]	3 %	7 %

The 4 percentage point increase of local electricity production in final energy consumption between baseline and monitoring years was mainly due to the increase of local production of electricity from CHP power plants. CoM signatories, in close collaboration with local utilities for sustainable energy systems in their territories, have been able to implement measures related to development of high-efficiency cogeneration power plants.

Heating and cooling consumption

Compared to the baseline inventories, heating and cooling consumption has dropped by 27 % in absolute terms, whereas in relative terms compared to the total final energy consumption, it decreased by 6 %, from 51 % to 45 % (Table 16).

Table 16. Evolution of reported final energy consumptions for heating and cooling from baseline to monitoring years: CoM MEI dataset 2016 — monitoring subset

	Baseline emission inventory	*Monitoring emission inventory*	*Change [%] from baseline to monitoring years*
Final energy consumption for heating and cooling [TWh/y]	251.8	183.3	– 27 %
Shares of heating and cooling consumption in final energy consumption	51 %	45 %	

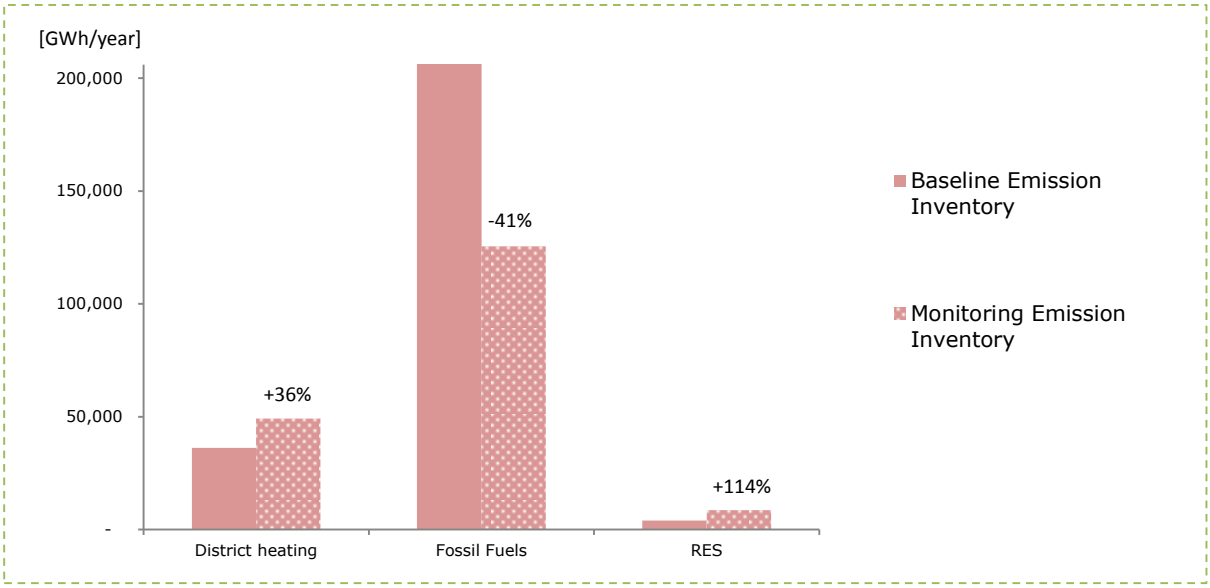
The 27 % decrease in heating and cooling consumption between baseline and monitoring years was mainly driven by energy efficiency measures in the building sector (Figure 16)

- Heating consumption using renewable sources increased by 114 % from baseline to monitoring years;
- Heating and cooling consumption using fossil fuels in buildings decreased by 41 % from baseline to monitoring years;

On the other hand:

- While heating and cooling consumption decreased by 27 %, heating consumption from district heating networks increased by 36 % from baseline to monitoring years;
- Heating consumption using renewable sources increased by 114 % from baseline to monitoring years.

Figure 16. Heating and cooling consumption in building sector per type of fuel/carrier in baseline and monitoring years: CoM MEI dataset 2016 — monitoring subset



Note: The percentages in Figure 16, refers to the variations from baseline to monitoring inventories.

Local heating and cooling production

In comparison with baseline emission inventories, the local heat production in CoM signatories' territories increased by 44 % on absolute terms (Table 17) while the share of local heat production on heating/cooling consumption has doubled (from 16 % to 32 %) from the baseline to the monitoring year.

Table 17. Evolution of reported local heating and cooling production from baseline to monitoring years: CoM MEI dataset 2016 — monitoring subset

	Baseline emission inventory	*Monitoring emission inventory*	*Change [%] from baseline to monitoring years*
Local heat production from district heating [TWh/y]	36.2	49.2	+ 36 %
Heat production from solar, geothermal and biomass [TWh/y]	4	8.6	+ 114 %
Total local heat production [TWh/y]	40.2	57.8	+ 44 %
Share of local heat production in heating and cooling consumption [%]	16 %	32 %	

The 44 % increase in local heat production between baseline and monitoring years was mainly driven by:

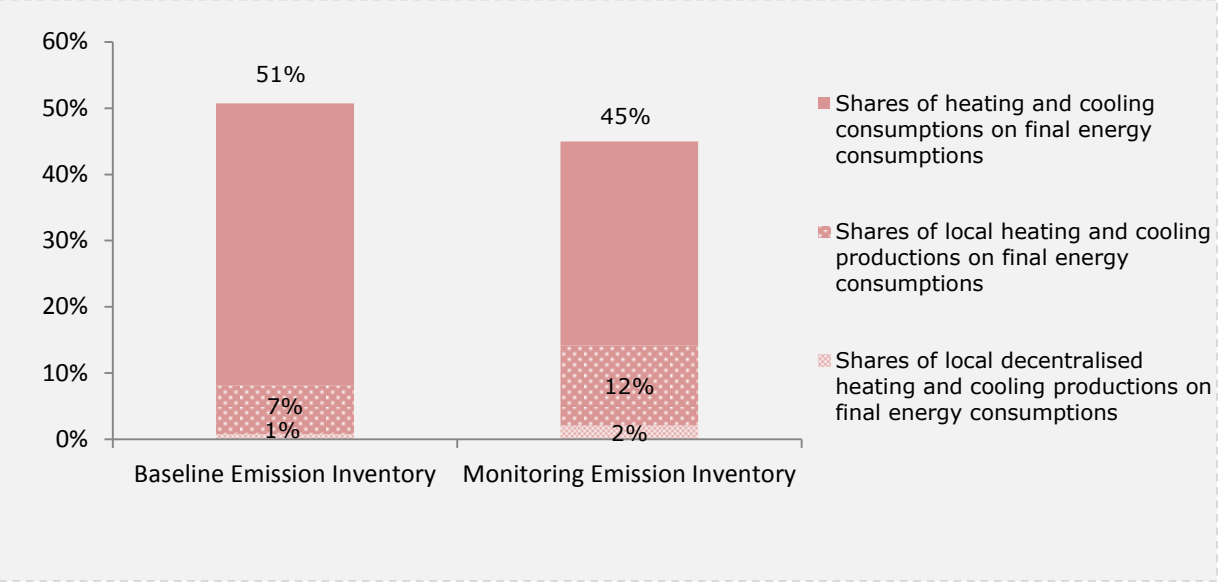
- a local district heating production increase of 36 % from baseline to monitoring years;
- local decentralised heat production from solar, geothermal and biomass which more than doubled from baseline to monitoring years.

CoM signatories, in close collaboration with local utilities for sustainable energy systems in their territories, have been able to implement measures related to efficient district heating and cooling infrastructures.

The 27 % decrease of Heating and Cooling consumption between baseline and monitoring years was mainly produced by (Figure 17):

- lower energy consumption levels in the building sector, i.e. from a share of 51 % in final energy consumption in the baseline year to 45 % in monitoring year;
- increase of the share of local district heat production, from 7 % to 12 % of the final energy consumption, between the baseline and monitoring years;
- increase of decentralised heat production from technologies such as solar thermal and geothermal, from 1 % to 2 % of the final energy consumption, between the baseline and monitoring years.

Figure 17. Shares of reported heating and cooling consumption and production in final energy consumption in baseline and monitoring years: CoM MEI dataset 2016 — monitoring subset



Transport

Energy consumption of the Transport sector is decreasing. Compared to the baseline inventories, the final energy consumption for transportation has dropped by 11 %. Overall, the energy consumption in transport decreased by 11 % between baseline and monitoring years (Table 18). More in detail, we observe:

- A decrease in energy consumption of fossil fuels (12 % of reduction in comparison to baseline consumptions);
- An increase in electricity consumption (65 % of increase in comparison to baseline consumptions);
- An increase in the consumption of renewable sources (by a factor of around 8 in comparison to baseline inventories ([19])).

To have an efficient and low-carbon transport sector, a gradual transformation of the entire system is necessary, towards modal shift from road transport to public transports and active mobility, innovation and deployment of alternative fuels, and improved management of traffic flows through intelligent transport systems.

([19]) The difference noted in the RES deployment in transportation, might not be relevant as signatories might have used the biofuel in baseline inventories but did not report it.

Table 18. Energy consumption in transport sector in baseline and monitoring years: CoM MEI dataset 2016 — monitoring subset

	Baseline emission inventory	*Monitoring emission inventory*	*Change [%] from baseline to monitoring years*
Electricity consumption in transport [TWh/y]	1.6	2.6	+ 65 %
Fossil fuels consumption in transport [TWh/y]	133.6	117	– 12 %
RES consumption in transport [TWh/y]	0.217	1.8	+ 753 %
Total energy consumption in transport [TWh/y]	135.4	120.6	– 11 %

3.3.4. Reported progress on renewable energy

In CoM local territories, the final energy consumption using renewable energy sources has increased by a factor of around 5.3 from the baseline (6.5 TWh/year) to the monitoring (34.4 TWh/year) year (Table 19).

Table 19. Progress on renewable sources from baseline to monitoring years: CoM MEI dataset 2016 — monitoring subset

	Baseline emission inventory	*Monitoring emission inventory*
Local electricity production from renewable sources [TWh/y]	1.3	10.4
Local district heat production from renewables [TWh/y]	0.53	13.6
Local decentralised heat production from renewables (solar, geoth., biomass) [TWh/y]	4	8.6
Renewable sources in transport sector [TWh/y]	0.21	1.8
Total local energy production from renewables [TWh/y]	**6.05**	**34.4**

The steady increase of the share of renewables reported by Covenant of Mayors signatories reflects the following combining trends:

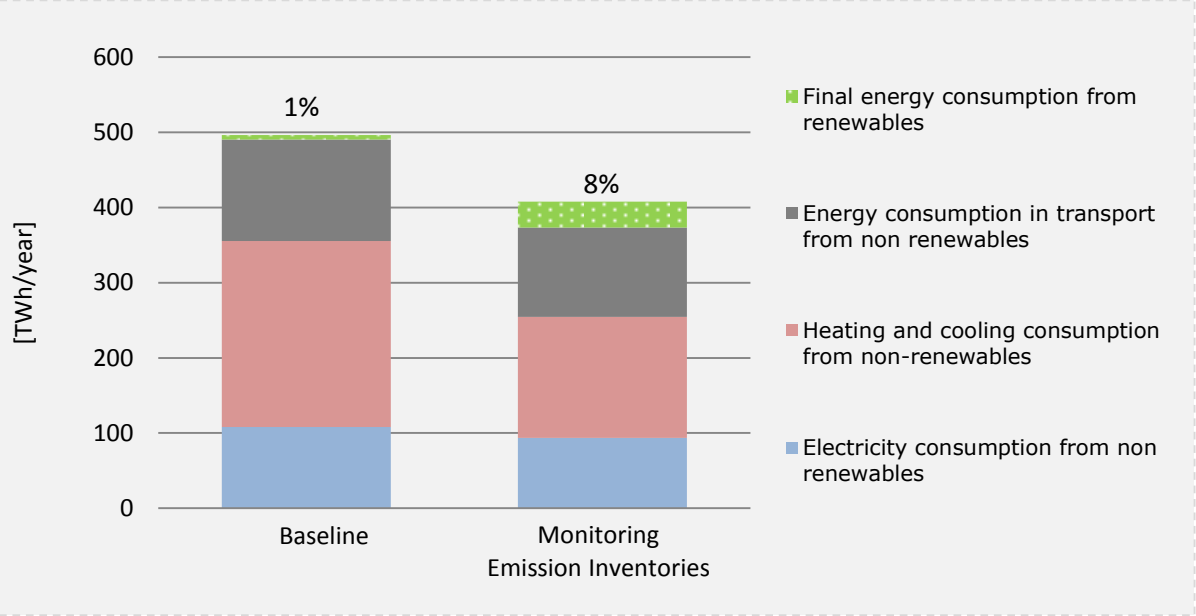
- Local electricity production from renewables increased sevenfold in monitoring years in comparison to inventory years;
- Local district heat production from renewables increased around 24 times in monitoring years in comparison to inventory years ([20]);
- Local decentralised heat production from renewables (solar, geothermal, biomass) doubled in monitoring years in comparison to inventory years;
- Renewable energy in transport sector increased around seven times ([20]).

([20]) The difference noted in the RES deployment might not be relevant as signatories might have used RES sources in baseline inventories but did not report it.

In the Covenant of Mayors territories, the final energy consumption using renewable sources has increased around **five times** from the baseline to the monitoring year, while the share of renewables on final energy consumption increased from 1 % to **8 %** (Figure 18).

The steady increase of the share of renewables reflects the combined effects of: increase of electricity production from renewables; increase of renewable sources in district heating doubling of local decentralised heat production from renewables (solar, geothermal, biomass); increase of biofuels in transport sector and lower final energy consumptions (by 18 % in monitoring years in comparison to inventory years).

Figure 18. Final energy consumption of renewable and non-renewable energy sources per sector in baseline and monitoring years: CoM MEI dataset 2016 — monitoring subset



3.3.5. Main policies of the monitoring reports

This chapter summarises major policies per area of intervention/subsector used by local authorities in the implementation phase of their SEAPs. Table 20 shows an overall picture of shares of action by status of the implementation:

- completed actions;
- ongoing actions;
- new actions, not started and postponed actions.

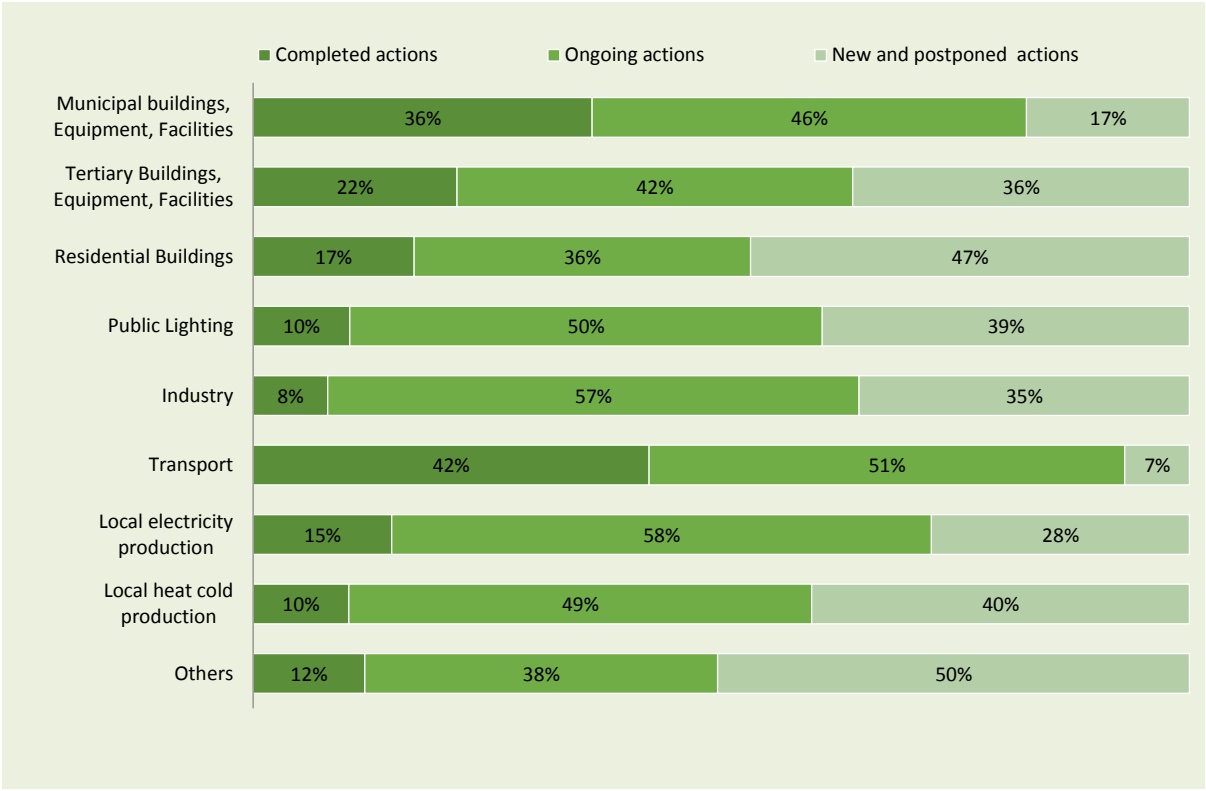
65 % of the actions are completed and ongoing, whereas the remaining 35 % of the actions are new, not started and postponed actions.

Table 20. Status of the implementation of actions in CoM MEI 2016 — monitoring subset

Status of implementation	*Number of actions*	*Percentage of the actions*
Completed actions	2 315	19 %
Ongoing actions	5 627	46 %
New actions, not started and postponed actions	4 365	35 %
Total actions	*12 307*	*100 %*

Figure 19 shows an overall picture of shares of action by status of the implementation per each CoM subsector. The majority of the completed and ongoing actions (93 %) are in the Transport sector followed by Municipal buildings and Facilities sectors (83 %). Concerning the policy instruments, Figure 20 shows an overall picture of shares of action by status of the implementation per each policy type.

Figure 19. Shares of the actions by status of the implementation per subsector: CoM MEI dataset 2016 — monitoring subset



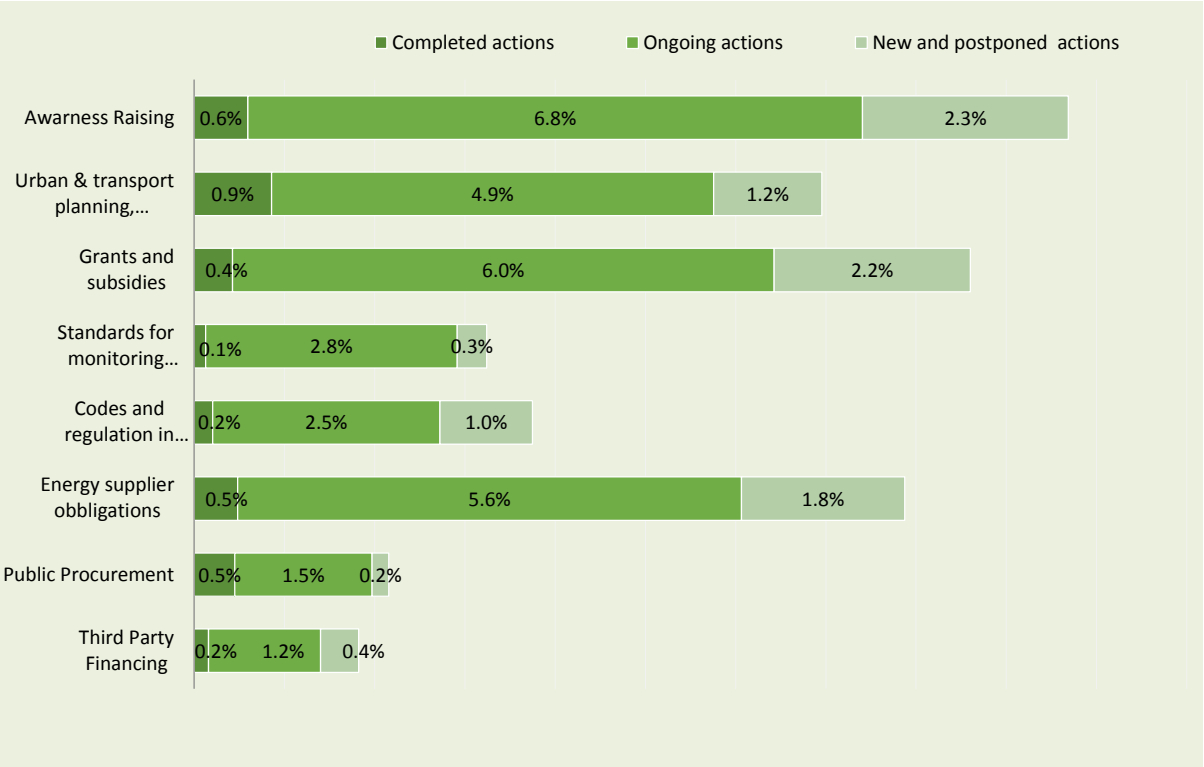
Awareness raising, as already proved in the policy analysis of the SEAP (Figure 7), is the major policy instrument implemented by local authorities to mobilise public interest in sustainable energy policies and climate change, contributing 9.7 % to the total estimate GHG emission reductions (Figure 20). The majority of actions are already completed or ongoing (contributing 7.4 % to the total estimated GHG emission reductions).

Urban and transport planning, regulations: contribute 7 % of the total estimate GHG emission reductions in the implementation phase of the SEAP (Figure 20). The majority of actions are already completed or ongoing (contributing 5.8 % to the total estimated GHG emission reductions).

Grants and subsidies: are an important policy instrument used by local authorities to promote energy efficiency and deployment of renewables, contributing 8.6 % to the total estimate GHG emission reductions (Figure 20). The majority of actions are already completed or ongoing (contributing 6.4 % of the total estimated GHG emission reductions).

Standards for monitoring and energy management: Standards for monitoring and energy management in CoM are a consolidated policy instrument, contributing 3.2 % of the total estimated GHG emission reduction by 2020 (Figure 20). The majority of the actions are already completed or ongoing (contributing 2.9 % of the total estimated GHG emission reductions).

Figure 20. Shares of the actions by status of the implementation per policy types: CoM MEI dataset 2016 — monitoring subset



Codes and regulations in building: contributing 3.7 % to the total estimated GHG emission reduction by 2020 (Figure 20). The building regulations and energy certification labelling are the major policies instruments used by local authorities in the building sector. The majority of the actions are already completed or ongoing (contributing 2.7 % to the total estimated GHG emission reductions).

Energy supplier's obligations: contributing 7.9 % to the total estimated GHG emission reduction by 2020 (Figure 20). They foster the uptake of standardised energy efficiency actions often targeting smaller energy users (residential sector). The majority of actions are already completed or ongoing actions (contributing 6.1 % of the total estimated GHG emission reductions).

Public procurement: contributing 2.2 % to the total estimated GHG emission reduction by 2020 (Figure 20). They offer a significant opportunity for local authorities to improve their overall energy consumption performance. The majority of actions are already completed or ongoing (contributing 2 % to the total estimated GHG emission reductions).

Third party financing (TPF): contributing 1.8 % to the total estimated GHG emission reduction by 2020 (Figure 20), where the majority of actions are already completed or ongoing (contributing 1.4 % to the total estimated GHG emission reductions).

4. Conclusions

As of September 2016, almost 6 200 local authorities have signed up to the CoM initiative, which corresponds to a total of ca. 213 million inhabitants. More than 5 400 local authorities have submitted a sustainable energy action plan (SEAP) accounting for a total of ca. 183 million inhabitants.

315 signatories (25.5 million inh.), representing 6 % of the signatories that have submitted an action plan, have provided a monitoring report including a monitoring emission inventory.

The main figures obtained from the data provided by Covenant of Mayors signatories in the SEAPs and in the monitoring reports submitted as of September 2016, together with the final conclusions on the main achievements are summarised hereafter.

Box 13. Covenant commitments on mitigation for 2020

- **5 403 sustainable energy action plans** in the JRC harmonised CoM dataset 2016 (98 % of the total SEAPs submitted), covering 183.8 million inhabitants.
- Covenant signatories commit to ambitious GHG emission reduction targets by 2020: **overall commitment of 27 %,** almost 7 percentage points **higher than the minimum target by**:
    - implementing **energy savings** aiming at reducing final energy consumption by **20 %** in 2020 in comparison to baseline inventories.
    - increasing the share of local energy production (i.e. renewable sources, cogeneration power plants and district heating) on final energy consumption from 10 % in the baseline inventories to **19 %** by 2020.
- **Emission reductions** of the EU Covenant signatories **may represent 31 %** of the EU-28 GHG emission reduction target by 2020 compared to 2005.

GHG emissions in the building sector are estimated to fall by 49 %: local authorities empowered with the jurisdiction to build upon national efficiency policies are implementing codes for new buildings and regulation in the existing buildings with more stringent requirements than the national ones. The application of both national and local policies would allow CoM signatories to **reduce by 28 %** their **final energy consumption** in the residential sector. In the tertiary sector, where the local authorities' influence is lower, a 5 % reduction is expected.

Local authorities often prioritise the implementation of energy management systems, public procurement and awareness raising for improving efficiency and reducing energy consumption in their buildings and facilities. The biggest share of the estimation of energy savings by 2020 on final energy consumption is expected from public lighting (34 %), followed by the municipal buildings and facilities (21 %) for the sectors under the municipal influence. Many municipalities have become active in energy saving renovation through deployment of energy performance contracting, particularly in the social housing sector where such interventions are primarily targeted at reducing energy poverty and vulnerability.

GHG emissions in the transport sector are estimated **to decline by 23 %**. In this sector, the main driver of decreasing energy demand and related GHG emissions is the modal shift (increased share of public transport and active mobility), improvement of the fuel efficiency driven policies, in particular for passenger cars, and the uptake of cleaner technologies. While fuel efficiency policies are competence of EU and national governments, local authorities' policies in transportation are related to urban transport planning, prioritising public transport modes versus private ones, and structural changes

of the sector, such as enabling the so-called 'modal shift' to cleaner/electric vehicles. Mobility and land use planning is a direct area of intervention for local authorities, which combined with cleaner and efficient vehicles, is estimated to reduce by 21 % the final energy consumption in the transport sector.

Actions in the local energy production sector would be **responsible for 20 % of the GHG emission reduction by 2020**. Local authorities in EU-28 often have jurisdiction in local energy production and distribution systems, in some case as owners of the utilities, in other cases in partnership with them (Scott and Pollitt, 2011), (Nuorkivi, 2016). The potential for improvements in energy efficiency exists in the provision of these services. Moreover, market-based instruments, such as energy efficiency obligations or white certificate schemes implemented at national/regional level, represent effective policy instruments for energy consumption making an impact at the local level. Obligation schemes for energy suppliers in the CoM municipalities are a major driver for improvements in the local heat and electricity production sectors. In the local electricity and heat production sectors, grants and subsidies are also used to support specific technologies or pilot projects which a local authority considers to be of particular relevance for the deployment of renewable energy resources, considering its own context and objectives.

An analytical method has been developed to allocate greenhouse gas emissions reduction between policies that lower final energy consumption through efficiency and those that increase the supply of renewable energy. Applying the method to CoM dataset 2016 indicates that the energy efficiency policies would be responsible for 82 % of the total GHG emission reductions planned by 2020. The 18 % remaining reduction would result from an increased use of renewable sources.

Box 14. Covenant achievements on mitigation in 2014

Based on 315 signatories with a submitted monitoring emission inventory, representing 25.5 million inhabitants, the difference between the baseline year and the last submitted monitoring report resulted in an **overall achieved GHG emission reduction of 23 %** driven by:

- The decrease of final energy consumptions of 18 %
- The increased **share of renewables** on final energy consumption from 1 % to **8 %**.

GHG emissions due to **electricity consumption** decreased by 17 % from the baseline to the monitoring years, driven by a less-carbon-intensive fuel mix and more efficient electricity generation power plants (5 % of electricity consumption decrease). CoM signatories, in close collaboration with local utilities for sustainable energy systems in their territories, have been able to implement measures related to development of high-efficiency cogeneration plants. In fact, the share of local electricity production from combined heat and power (CHP) plants on final energy consumption as reported in CoM online BEI and MEI templates increased by 4 percentage points from baseline and monitoring years.

GHG emissions due to **heating and cooling** in buildings fell by 36 % from the baseline to the monitoring years, driven by improved energy efficiency in buildings and subsequent lower energy consumption (final energy consumption decreased by 6 percentage points), increased local heat supply from district heating networks (by 5 percentage points), and an increased share of renewable sources in decentralised local heating production (1 percentage point of final energy consumption increase).

GHG emissions in the **transport** sector fell by 7 % from the baseline to the monitoring years, driven by lower energy consumption from fossil fuels (a decrease in the related energy consumption by 12 % from the baseline to the monitoring years), increased share

of biofuels (by a factor of eight in comparison to baseline inventories), and a shift towards public transportation and electric mobility (electricity consumption increase by 65 % in comparison with baseline consumptions).

The interim achievements reported in this report and summarised below (Box 14) are based on 12 307 reported actions, 65 % of which are completed or ongoing. The highest share of completed or ongoing actions is found in the Transport sector (93 %) followed by Municipal buildings and Facilities (83 %) where the municipality itself demonstrates leadership and commitment.

These main findings on CoM planned and already implemented actions underline the interconnected nature of climate and energy mitigation actions adopted at local level.

Developing a **sustainable energy and climate action plan** that requires the establishment of a baseline emission inventory, setting ambitious targets and adopting policy measures is already a tangible achievement for cities. This is the first step towards an effective, transparent system for tracking progress and demonstrating concrete results.

The Covenant of Mayors for Climate and Energy, the world's largest urban climate and energy initiative, involving thousands of local and regional authorities, shows that cities are at the centre of action to fight climate change and accelerate the energy transition. While climate change remains a global issue, the best strategies for sustainable energy systems are planned and implemented at local level.

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List of abbreviations and definitions

BEI	baseline emission inventory
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-eq	CO_2-equivalents
CoM	Covenant of Mayors
COP	Conference of the Parties
CTC	Covenant territorial coordinators
EC	European Commission
EDGAR	Emission Database for Global Atmospheric Research
EEA	European Environment Agency
ETS	emission trading system
ESD	effort sharing directive
EU	European Union
GHG	greenhouse gases
GWP	global warming potential
JRC	Joint Research Centre
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ICT	information and communication technologies
LCA	life cycle assessment
MEI	monitoring emission inventory
MS	Member States
RES	renewable energy source
RVA	risk and vulnerability assessment
SEAP	sustainable energy action plan
SECAP	sustainable energy climate action plan
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme

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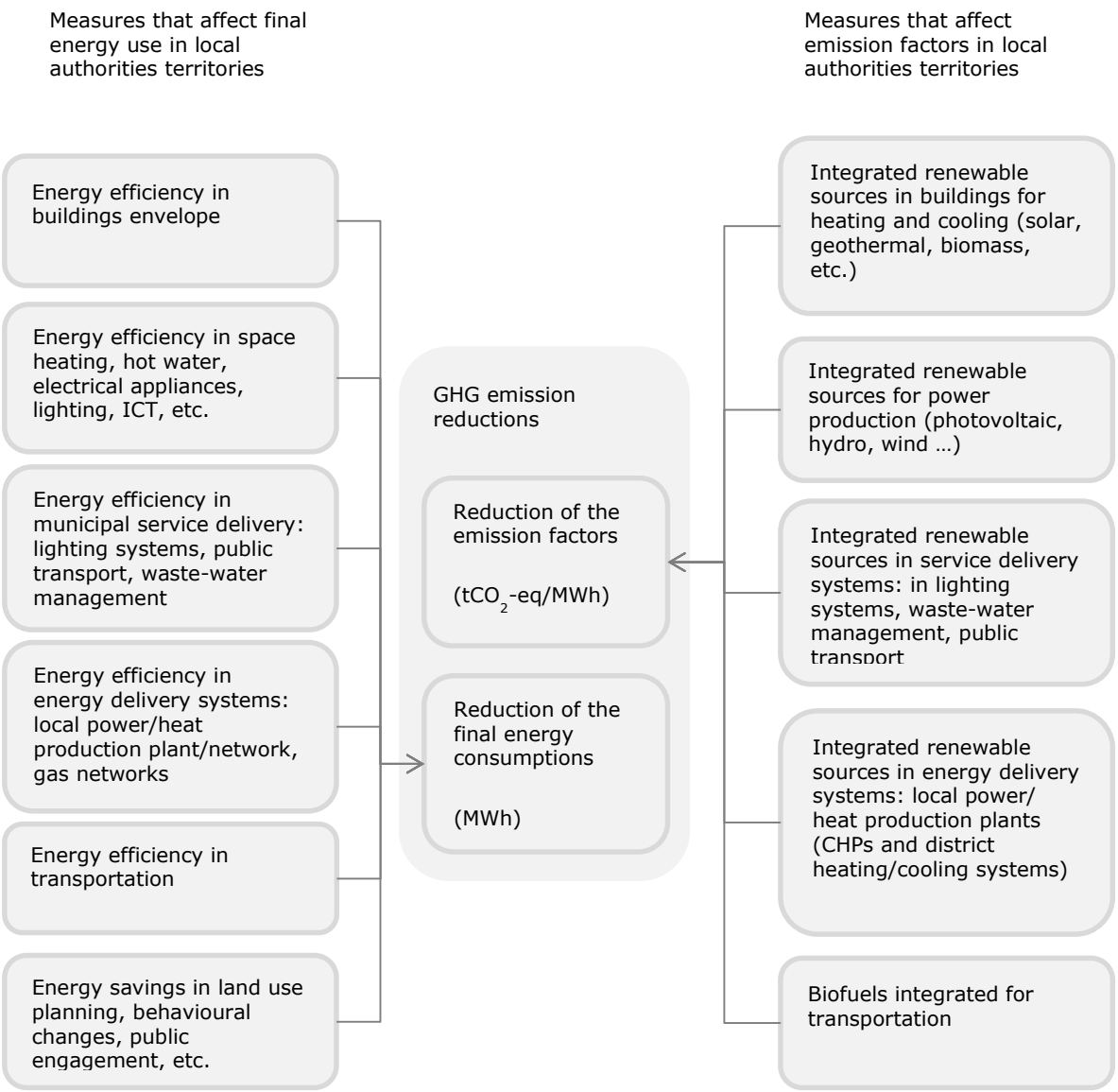
Annex 1.

When calculating the greenhouse gas impacts of policies in the local authorities' territory, an analytical challenge arises: how to allocate greenhouse gas emission impacts between policies that lower consumption through efficiency and those that increase the supply of renewable electricity (Anders *et al.*, 2015).

Figure 21 illustrates the flow diagram of the measures that affect the GHG emission reductions in local authorities' territory. On the left of the flow diagram are grouped measures that will affect the final energy consumptions, ranging for energy efficiency in buildings, equipment and appliances, in public lighting, waste-water management, in local power plant and in transportation. While on the right side of the flow diagram, are grouped the main measures that throughout the increase of the renewable sources would lower the average emission factor of the local authority, ranging from decentralised distribution of power and heat production (PV, wind, hydro, solar, biomass, geothermal, etc.) to centralised power and heat production using RES (CHPs, district heating plants, etc.) and use of biofuels in transportation.

Figure 21. Flow diagram of measures affecting the GHG emission reductions



Annex 2.

Table 21. Shares of measures by area of intervention and type of policy: CoM MEI dataset 2016 — monitoring subset

	All types of policies	Urban and transport planning, regulations	Awareness-raising	Grants and subsidies	Standards for monitoring and management of energy	Codes and regulation in buildings	Energy supplier obligations	Public procurement	Third party financing
BEHAVIOURAL CHANGES	4.0 %	1 %	9 %	0 %	2 %	1 %	3 %	2 %	0 %
BUILDING ENVELOPE	8.2 %	1 %	4 %	15 %	8 %	26 %	3 %	6 %	7 %
ENERGY EFFICIENCY IN SPACE HEATING AND HOT WATER	7.4 %	0.2 %	4 %	12 %	12 %	13 %	5 %	5 %	6 %
ENERGY EFFICIENT ELECTRICAL APPLIANCES	4.3 %	-	4 %	1.8 %	7 %	6 %	4 %	4 %	3 %
ENERGY EFFICIENT LIGHTING SYSTEMS	4.7 %	0.1 %	3 %	1.5 %	10 %	5 %	3 %	4 %	5 %
RENEWABLE ENERGY FOR SPACE HEATING AND HOT WATER	6.1 %	0.3 %	5 %	7.8 %	10 %	5 %	6 %	6 %	4 %
INTEGRATED ACTION	11.3 %	3.9 %	7 %	9.4 %	15 %	24 %	5 %	13 %	13 %
ICT	2.5 %	1.2 %	3 %	0.3 %	4 %	1 %	1 %	2 %	2 %
BUILDINGS EQUIPMENT FACILITIES OTHER	6.8 %	2.6 %	4 %	5.1 %	11 %	9 %	10 %	8 %	4 %
AGRICULTURE AND FORESTRY RELATED	1.0 %	3.1 %	2 %	0.0 %	-	-	-	-	-
TREE PLANTING IN URBAN AREAS	0.5 %	5.1 %	0.2 %	0.0 %	-	-	-	-	-
URBAN REGENERATION	1.3 %	10.0 %	1 %	0.1 %	-	-	-	-	-
WASTE AND WASTE-WATER MANAGEMENT	1.7 %	3.0 %	4 %	0.1 %	-	-	-	-	-
PUBLIC LIGHTING ENERGY EFFICIENCY	6.6 %	-	-	-	17.6 %	-	8.8 %	12 %	21 %

PUBLIC LIGHTING OTHER	0.2 %	-	-	-	0.5 %	-	0.8 %	0.41 %	0.2 %
CAR SHARING POOLING	0.6 %	2 %	1 %	0 %	-	-	-	1 %	0 %
CLEANER EFFICIENT VEHICLES	4.7 %	8.8 %	5.7 %	9.2 %	-	-	-	14 %	-
ECO DRIVING	1.9 %	1.0 %	5.5 %	0.2 %	-	-	-	0.20 %	-
ELECTRIC VEHICLES	1.4 %	5.1 %	1.1 %	1.6 %	-	-	-	4 %	-
IMPROVEMENT OF LOGISTICS AND URBAN FREIGHT TRANSPORT	0.5 %	4.2 %	0.2 %	0.2 %	-	-	-	0 %	-
MIXED USE DEVELOPMENT AND SPRAWL CONTAINMENT	0.1 %	0.8 %	0.1 %	0.0 %	-	-	-	0.03 %	-
MODAL SHIFT TO PUBLIC TRANSPORT	1.2 %	6.7 %	1.3 %	0.8 %	-	-	-	1 %	-
MODAL SHIFT TO WALKING AND CYCLING	3.0 %	14.2 %	4.1 %	0.9 %	-	-	-	3 %	-
ROAD NETWORK OPTIMISATION	0.7 %	6.0 %	0.2 %	0.2 %	-	-	-	1 %	-
TRANSPORT OTHER	1.3 %	7.66 %	1.4 %	0.41 %	-	-	-	1.56 %	-
RENEWABLE ENERGY	0.5 %	-	0.5 %	0.39 %	0.86 %	0.07 %	1.26 %	0.59 %	0.5 %
BIOMASS POWER PLANT	0.4 %	0.38 %	0.2 %	1.21 %	0.01 %	0.02 %	2.02 %	0.44 %	2 %
SOLAR	0.1 %	-	0.1 %	0.70 %	0.06 %	0.12 %	-	-	-
GEOTHERMAL	0.0 %	-	-	0.51 %	-	-	-	-	-
CHP	0.5 %	0.3 %	0.4 %	1.26 %	-	0.4 %	4.0 %	0.2 %	3.2 %
HYDRO	0.4 %	0.2 %	0.2 %	1.33 %	-	0.0 %	1.8 %	1.2 %	1.8 %
PHOTOVOLTAICS	5.7 %	0.7 %	3.4 %	21.1 %	-	7.6 %	17.1 %	10.4 %	17.5 %
SMART GRIDS	0.0 %	0.2 %	-	-	-	-	0.8 %	0.0 %	0.0 %
WIND POWER	0.4 %	0.5 %	0.2 %	0.6 %	-	0.1 %	1.0 %	0.9 %	3.1 %

LOCAL ENERGY PRODUCTION OTHER	1.1 %	0.3 %	0.9 %	3.6 %	-	1.4 %	11.3 %	0.8 %	2.5 %
DISTRICT HEATING NETWORKS	0.5 %	0.6 %	0.2 %	0.9 %	-	0.3 %	12.3 %	-	2.9 %
OTHERS	8.4 %	8.3 %	21.9 %	1.5 %	1.3 %	0.3 %	-	-	0.2 %

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