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The Covenant of Mayors in Figures and Performance Indicators: 6-year Assessment

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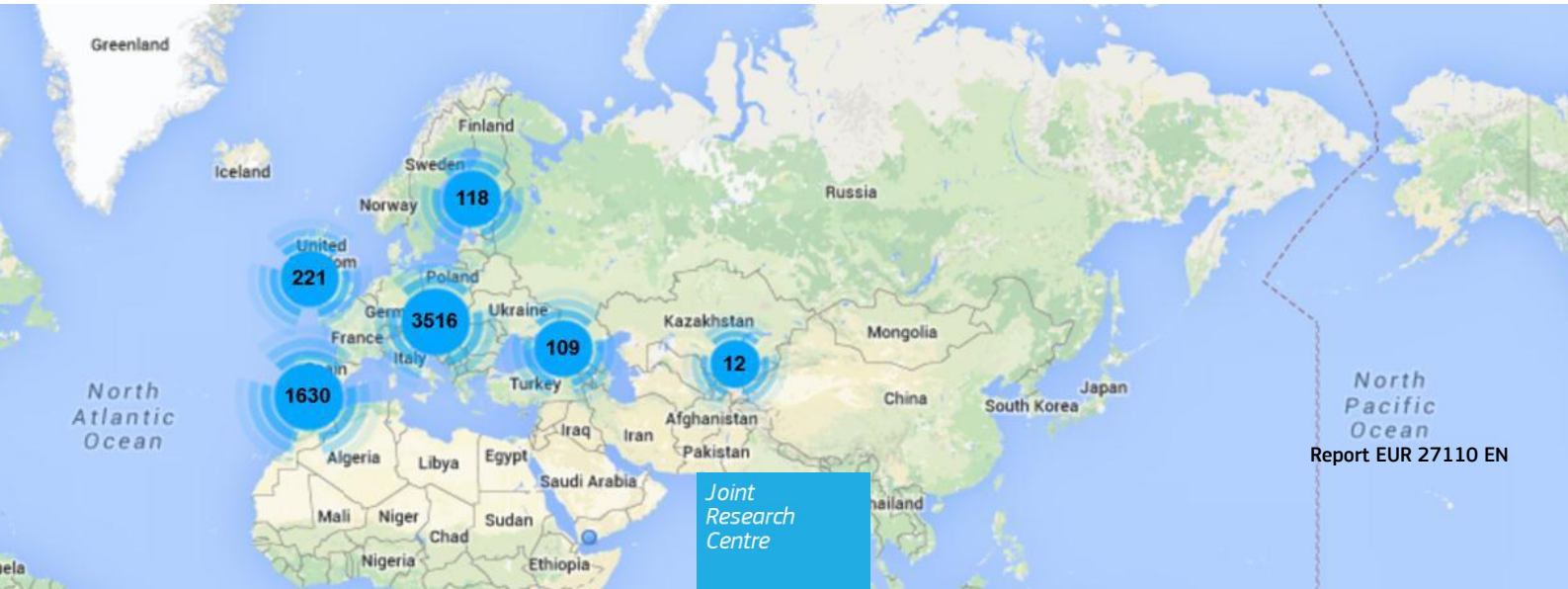

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Abstract

The main purpose of this scientific report is to provide an assessment of the Covenant of Mayors (CoM) Initiative 6 years after it has been initiated by the European Commission. By implementing the CoM Initiative, the European Commission has given visibility to the role of local authorities and their relevant contribution to EU2020 Climate and Energy targets. This is the second assessment report in a series of CoM assessment reports published by JRC.
As of mid-May 2014 5,296 local authorities signed the Covenant of Mayors (CoM), for a total of ca. 160 million inhabitants in the EU-28, and ca. 186 million inhabitants in the whole initiative.
Based on the data collected from Sustainable Energy Action Plans (SEAPs) submitted by CoM Signatories as of mid-May 2014, a statistical methodology has been developed to select a CoM data set for evaluating the real impact of the CoM initiative. The report provides main statistics of the data set in terms of GHG emission and estimated reductions, Final energy consumptions and estimated energy savings and clean energy production in the local authorities.
Ultimately, the report aims to emphasize the feature of SEAPs as a flexible common platform for achieving EU Climate and Energy targets with a bottom-up approach.

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Executive summary

The Covenant of Mayors (CoM) is the mainstream European movement involving local authorities voluntarily committing to meet and exceed the European Union 20% CO_2 reduction objective by 2020 by increasing energy efficiency and through the use of renewable energy sources on their territories. The CoM initiative was launched in 2008 by the European Commission's Climate and Energy Package to endorse and support the efforts deployed by local authorities in the implementation of sustainable energy policies.

As of mid-May 2014 5,296 local authorities signed the Covenant of Mayors (CoM), for a total of ca. 160 million inhabitants in the EU-28, and ca. 186 million inhabitants in the whole initiative.

By implementing the CoM programme, the European Commission has given visibility to the role of local authorities and their relevant contribution to EU2020 Climate and Energy targets.

Acknowledging this success, the European Commission's Energy Union Package[1] confirmed its continuous support to the Covenant of Mayors Initiative, as an important platform for achieving progress on energy efficiency in buildings.

Furthermore, the European Commission's European Energy Security Strategy[2] calls on Member States to accelerate the implementation of Sustainable Energy Action Plans (SEAPs) in the "stress test" countries as means to improve the Union's security of supply.

Lastly, the Energy Efficiency Directive (EED 2012/27/EU) specifically acknowledges the Covenant of Mayors initiative and the role of local governments in achieving significant energy savings, and calls for Member States to encourage municipalities and other public bodies to adopt integrated and sustainable energy efficiency plans (SEAPs). Exchange of experience between cities, towns and other public bodies should be encouraged with respect to the more innovative experiences (preamble 18).

The CoM has already been extended to Eastern Partnership and Central Asian countries, with specific requirement for GHG emission reduction, adapted to the characteristics of these countries. Through the CES-MED project, the European Union has opened the CoM initiative to local authorities of ten southern Mediterranean countries (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria and Tunisia).

JRC has started to publish a series of yearly assessment reports on the Initiative, which may be downloaded from the website: http://iet.jrc.ec.europa.eu. The first report on 5-year assessment of the initiative was published in 2013. This is the second assessment report which provides an overview of the Covenant of Mayors initiative as of mid-May 2014.

All the data provided in the current report are reported by the signatories in an on-line template provided on the web-site of CoM related to SEAPs submitted as of 13th of May 2014. The on-line template must reflect accurately the content of the official SEAP document, and the coherence of certain key figures is the checked by JRC. Yet, given the voluntary aspect and the difficulty of adapting sometimes local specificities into the general proposed framework, not all the data could be considered reliable, therefore a methodology has been developed to build a robust sample.

[1] Energy Union Package: COM (2015) 80

[2] European Energy Security Strategy: COM (2014)330

The results of the current assessment derive from a data set built according to a methodology developed by JRC "Methodology for Robust Data Statistics in CoM", to assess the effectiveness of the CoM initiative in terms of estimated energy savings, clean energy production and GHG emission reduction. The assessment report displays the main statistics of the sample selected from the CoM database, named "CoM data set as of 13th of May 2014".

The assessment report is structured in five paragraphs:

- *General Statistics on SEAPs*: main statistics of signatories with a submitted SEAP in terms of population coverage/region, etc;
- *Baseline Emission Inventories*: main statistics of signatories with a submitted SEAP in terms of GHG emission, Final energy consumption; Local energy production
- *Sustainable Energy Action Plans*: main statistics of signatories with a submitted SEAP in terms of Estimated GHG emission reduction, Estimated energy savings, Estimated local energy production and Estimated investments in SEAPs; contribution of local action to the achievement of European targets.
- *Performance indicators*: per capita performance indicators

The followings are reported in the annexes:

- "Signatories of CoM as of mid-May 2014 by country;
- "Methodology for Robust Data Statistics in CoM";

The peculiarity of the CoM movement, compared to other GHG mitigation networks, is the engagement of small towns in the effort to reduce greenhouse gas emissions. It is important to highlight that the majority of signatories with a submitted Sustainable Energy Action Plan are small and medium towns, representing **88%** of the total number of signatories of the sample.

One result, confirming the consistency of the "CoM data set as of 13th of May 2014" is that GHG emissions and energy consumption per capita are compatible with values from international datasets at national level (Eurostat, EEA).

Sustainable Energy Action Plans are flexible structures, with only one binding target (voluntary declared curbs on CO_2 emission). A general recommendation was made to use 1990 as the year for the BEI reference; nevertheless signatories are able to choose the closest subsequent year for which reliable data could be gathered. As a result, different years have been chosen in BEIs of the dataset. Signatories with a reference year closer to 2020 are challenged with a higher effort on meeting the target of at least 20% of emission reduction by 2020.

Although the minimum commitment was to reduce the current emissions by 20%, CoM signatories who have already submitted a SEAP as of mid-May 2014, have estimated for 2020 an overall reduction of **28%** of the overall GHG emissions in BEIs reference years.

Furthermore, the report aims to emphasize the feature of CoM as a flexible common platform for achieving EU2020 Climate and Energy targets with a bottom-up approach.

Energy efficiency has a fundamental role to play in the transition towards a more competitive, secure and sustainable energy system with an internal energy market at its core. In fact, the estimated energy savings by 2020 of CoM signatories amount to 479 TWh by

2020, which correspond to a reduction of **20%** of final energy consumption in BEIs reference years.

Furthermore, SEAPs may contribute to a wider vision of sustainability in urban areas. Local authorities have to find the right mixture of actions on getting local energy demand under control and increasing use of local renewable source by encouraging the integration of energy systems. Based on estimation in SEAPs of CoM signatories as of mid-May 2014, **18%** of final energy consumption by 2020 will be produced locally from renewable sources and by more efficient energy generation technologies (district heating and combined heat and power plants).

Lastly, an overall picture of estimated investment cost planned by signatories is reported. Investments in energy efficiency has the potential to contribute to economic growth, employment, innovation and a reduction in fuel poverty in households, and therefore makes a positive contribution to economic, social and territorial cohesion.

In the coming years signatories are challenged with the monitoring phase of CoM initiative. Every second year, signatories will have to submit a monitoring report of the implementation of the actions. Future studies will allow the assessment of the real progress of energy efficiency and local energy production measures planned in the SEAPs.

In this phase, bottom-up methodologies and GIS based tools may be integrated. Other regulatory frameworks and platforms (ex. Inspire) and open data sharing policies may further support the CoM signatories' efforts.

Acronyms

BEI	Baseline Emission Inventory
CH4	Methane
CHP	Combined Heat and Power
CO	Carbon monoxide
CO2	carbon dioxide
CO2–eq	CO2 – equivalents
CoM	Covenant of Mayors
CTC	Covenant Territorial Coordinators
ETS	Emission Trading System
EU	European Union
GHG	Greenhouse gases
ICLEI	Local governments for Sustainability
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment
MS	Member States
PV	photovoltaic
RES	Renewable Energy Source
SEAP	Sustainable Energy Action Plan
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme

I. General Statistics on Sustainable Energy Action Plans

The Covenant of Mayors (CoM) is the mainstream European movement involving local authorities voluntarily committing to meet and exceed the European Union 20% CO_2 reduction objective by 2020. CoM was launched in 2008 by the European Commission's Climate and Energy Package to endorse and support the efforts deployed by local authorities in the implementation of sustainable energy policies.

One of the commitments undertaken by Covenant signatories is to submit, within a year from signing up to the initiative, a Sustainable Energy Action Plan (SEAP) which is based on the results of the Baseline Emission Inventory (BEI) and includes all the planned measures to be implemented in order to achieve the 20% CO2 emission reduction target. Data from BEIs and SEAPs are transmitted by each signatory to the European Commission via an online template (Bertoldi P., et al. 2010).

As of mid-May 2014 5,296 local authorities signed the Covenant of Mayors (CoM), for a total of ca. 160 million inhabitants in the EU-28, and ca. 186 million inhabitants in the whole initiative. While in Eu-28, the urban population according to the new OECD-EC definition represents **78%** of the EU-28 signatories' population as of mid-May 2014 (see Annex I).

The CoM has already been extended to Eastern Partnership and Central Asian countries, with specific requirement for GHG emission reduction, adapted to the characteristics of these countries. Since 2010, the CoM initiative has come to involve six Eastern Partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine) and five central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) in the implementation of local sustainable energy policies (Gabrielaitiene I. 2014). Through the CES-MED project, the European Union has opened the CoM initiative to local authorities of ten southern Mediterranean countries (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria and Tunisia) (Saheb Y., et al. 2014).

Acknowledging this success, the European Commission's **European Energy Security Strategy** calls on MS to accelerate the implementation of SEAPs in the "stress test" countries. The contribution of SEAPs in Energy Security in the region has been explored in a JRC report: Covenant of Mayors: Fuel Switch and Sustainable Demand in "stress test" countries (Kona A. et al. 2014).

The diffusion of the CoM initiative in Europe is also commented by (Christoforidis G.C, et al. 2013). Most of the towns are located in Southern European countries where dedicated bodies, including Covenant Territorial Coordinators (CTCs), supported cities in the process of adhesion to the CoM. The CTCs are regional authorities which voluntarily join the movement committing to promote it within their respective territory and to offer technical and/or financial support to the signatories which choose to work under their coordination.

Based on three case studies, (Melica G. et al. 2014) indicate that the multilevel governance approach adopted within the CoM has been a key determinant to get the involvement of small towns in the movement.

The CoM movement has already been investigated for specific actions, such as achieving energy savings by retrofitting residential buildings (Dall'O', et al. 2013) increasing the energy efficiency of public lighting (Radulovic D. et al. 2011) and increasing the acceptance of renewable energy within rural communities (Doukas, et al. 2012).

Furthermore the potential of SEAPs in terms of security of supply has been investigated in signatories of CoM in Danube Region (Kona A. et al. 2014).

JRC has started to publish a series of yearly assessment reports on the Initiative, which may be downloaded from the website: http://iet.jrc.ec.europa.eu. The first report on 5-year assessment of the initiative was published in 2013 (Cerutti A.K. 2013). This is the second assessment report which provides an overview of the Covenant of Mayors initiative as of mid-May 2014.

The results of the current assessment derive from a data set built according to a methodology developed by JRC "Methodology for Robust Data Statistics in CoM", to assess the effectiveness of the CoM initiative in terms of energy savings, clean energy production and CO2 emission reduction. Further details on the methodology can be found in the Annex "Methodology for Robust Data Statistics in CoM ".

As of mid-May 2014 3,664 signatories had already submitted their SEAP. As a result of the application of the aforementioned methodology, a data set of 3,421 SEAPs was built. Along the present paper, the data set is referred to as "CoM data set as of 13th of May 2014".

Detailed data on number of signatories per country, population coverage, urban population can be found in the Annex 1 reporting statistics of the whole database of CoM.

Table 1. shows the number of signatories with a submitted SEAP with their population per region of the CoM sample 2014 "CoM data set as of 13th of May 2014".

The majority of signatories of the sample (3,361 – 98% of signatories) with a share of 90% of inhabitants are from countries of EU-28.

Table 1. Signatories with a submitted SEAP per region: CoM data set as of 13th of May 2014

Region	Nr of signatories	Population
European Union-28	3,361	114,237,208
Europe – non EU	28	6,051,021
Eastern Partnership and Central Asian Countries[3]	30	4,526,378
South Mediterranean Countries [4]	1	903,485
Rest World[5]	1	360,000
Total	3,421	126,078,092

Taken into account the harmonized definition of a 'city' for Europe based on the number of inhabitants (Dijkstra L. and Poelman 2012) by OECD – European Commission 2012, the CoM signatories in the data set were classified into categories according to those definitions. In Figure 1 are represented the shares of signatories of the data set by categories, along with the shares of inhabitants.

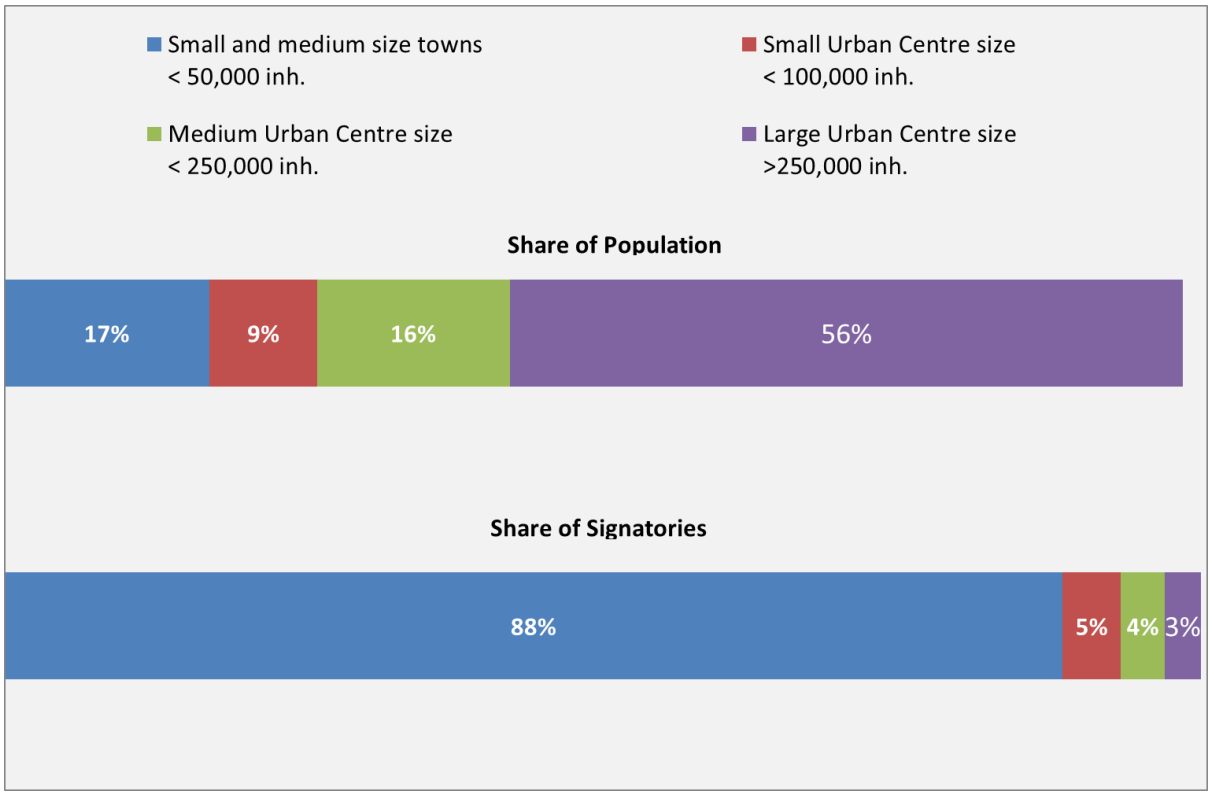
[3] Eastern Partnership: Belarus, Georgia, Moldova, Tajikistan, Ukraine

[4] South Mediterranean: Morocco

[5] Rest World: New Zealand

In terms of population, the highest share (56%) of CoM signatories inhabitants belongs to cities with Large-XX Large Urban centres and a Global City with a population over 250,000 inhabitants (see Figure 1). London, classified as a Global city, with a population of 7.8 million of inhabitants, represents 6% of the total population of CoM data set.

Figure 1: Shares of signatories' category and population in CoM data set as of 13th of May 2014



The majority of signatories with a submitted Sustainable Energy Action Plan are small and medium towns, representing **88%** of the total number of signatories in the CoM data set as of 13th of May 2014. This suggests that small cities can play an important role for climate change mitigation.

Nevertheless, signatories categorized as SMSTs account for a limited share of energy consumption, (16%) overall. Since the regional context appears to be the most important common factor for SMSTs, in order to maximize the potential represented by the CoM initiative, an efficient approach would be to encourage the development of Joint Action Plans and promote the rule of **Covenant Territorial Coordinators** (CTCs).

II. Baseline Emission Inventories

The BEI document reports data on: final energy consumption, local power and heat production and Green House Gas (GHG) emissions occurring in the signatories' territory.

In order to submit a SEAP for evaluation, the CoM technical team of each signatory has to compile an online template of the BEI which comprehends both mandatory and optional entries. The mandatory entries include the figure of total emissions in BEI and the subtotal emissions per macro-sector of activities:

- Buildings, equipment/facilities includes the following subsectors:
  - *Municipal buildings, equipment/ facilities*: Energy consumption and GHG Emission in buildings and facilities owned by the local authority. Facilities refer to energy consuming entities that are not buildings, such as wastewater treatment plants.
  - *Tertiary (non-municipal) buildings, equipment/ facilities*: Energy consumption and GHG Emission in buildings and facilities of the tertiary sector (services), for example offices of private companies, banks, commercial and retail activities, hospitals, etc.
  - *Residential buildings*: Energy consumption and GHG Emission in buildings that are primarily used as residential buildings. Social housing is included in this sector.
  - *Municipal public lighting*: Public lighting owned or operated by the local authority (e.g. street lighting and traffic lights). Non-municipal public lighting is included in the sector of "Tertiary buildings, equipment/facilities".
  - *Industries – small industries:* Energy consumption and GHG Emissions in manufacturing and construction industries not covered in the EU Emissions Trading Scheme (EU-ETS). Integrating ETS in emission inventories is not recommended, unless such plants were included in previous energy plans and CO2 emission inventories of the local authority
  - *Others: Agriculture/Forestry/Fisheries* : Energy consumption and GHG Emissions in buildings, facilities and machinery of the primary sector (agriculture, forestry and fisheries), for example greenhouses, livestock facilities, irrigation systems, farm machinery and fishing boats[6].

  All these subsectors, with the exception of the industry, are recommended to be included in the baseline emission inventory. The industry sector comprises only small industry, not included in the European Emissions Trading scheme and it is usually included in the BEI if the signatory has planned actions for it in the SEAP.

- Transport sector: including the following subsectors:
  - *Municipal fleet:* Energy consumption and GHG Emissions from vehicles owned and used by the local authority's administration
  - *Public transport:* Energy consumption and GHG Emissions from Bus, tramway, metro, urban rail transportation and local ferries used for passenger transport
  - *Private and commercial transport:* Energy consumption and GHG Emissions from Road, rail and boat transport in the territory of the local authority which refer to the transport of persons and goods not specified above (e.g. private passenger cars and freight transport).

[6] Included in the new template of SEAPs from mid-May 2014

These sectors cover all transportation that occurs on the territory of the signatory and that is in the competence of the local authority.

– Others, not related to energy consumption (non-mandatory sectors, that possibly may be included in one) :
  - *Waste management:* GHG Emissions not related to energy consumption, such as CH4 from landfills
  - *Wastewater management:* GHG Emissions not related to energy consumption, such as CH4 and N2O from wastewater treatment plants
  - *Other sectors:* GHG Emissions not-energy related in the territory

  The figures about emissions of each sector within each of the three macro sectors are not mandatory to be reported. Neither is the inclusion of all the mentioned sectors. As a consequence many signatories did not report disaggregated figures for all the key sectors in their template.

In order to give aggregate and robust statistics, just data for filled template entries has been considered for calculating total emissions of each macro sector and the difference with the given total emission is reported as the category 'Not-assigned in the macro-sector'.

Overall statistics have been calculated and reported in the following sections based on the analysis of the BEIs in the CoM data set as of 13th May 2014.

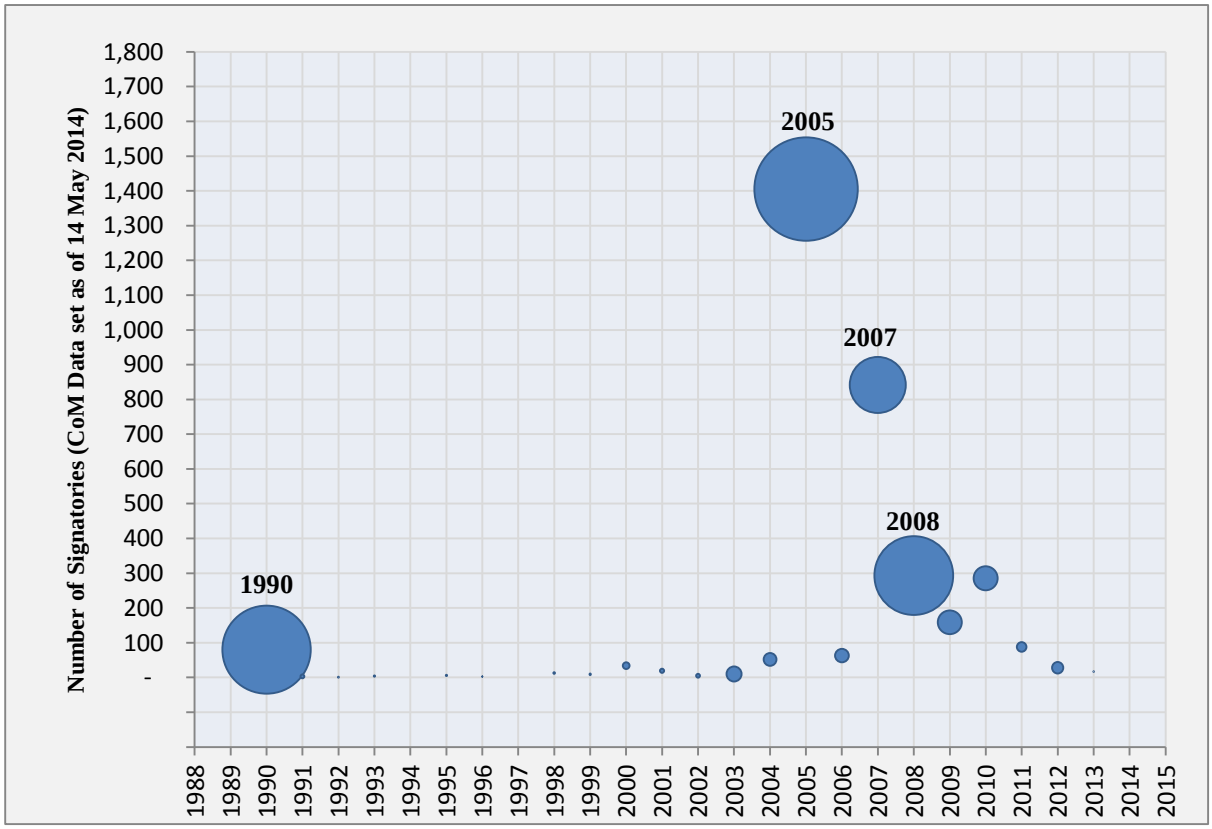
In the guidebook "How to develop a Sustainable Energy Action Plan", (Bertoldi P. 2010) a general recommendation was made to use 1990 as the year for the BEI reference; nevertheless signatories are able to choose the closest subsequent year for which reliable data could be gathered. As a result, different years have been chosen in BEIs of the dataset. Most of the Signatories (66%) decided to take 2005, or 2007, or 2008 as their reference year (see Figure 2 for details) with a share of inhabitants 34% of the total inhabitants of the dataset.

Small and medium Urban Centers (number of inhabitants less than 250,000) 1,378 signatories have chosen 2005 as BEIs reference year and 832 signatories 2007.

Just 80 local municipalities adopted 1990 as reference year for BEIs, nevertheless these signatories include 25 Large Urban Centers (such as Berlin, Munich, Brussels-Capital, etc..) with a share of 19% of the total inhabitants of the dataset.

As the emission reduction targets are set according to the BEI, the reference year that has been chosen may play an important role in the whole project. Setting the target for 2020 on reference years closer to the actual year would mean a higher effort for emission reduction (Cerutti A.K. et al.2013).

Figure 2. Reference years in BEIs in CoM data set as of 13th of May 2014



Greenhouse Gas Emissions in BEIs

Large Urban centres are currently the focal point of research for Greenhouse-gas (GHG). Studies on the correlation between urbanization and GHG emission per capita is under research (Hoornweg D. 2011). Thus, the methodology for calculating emission inventories is crucial in deriving conclusions. In line with the established framework of the UNFCCC, project guidelines for emission inventory within the CoM broadly follow the IPCC guidelines. An effort to render the emission inventories more comparable, the emissions reported under the LCA approach were converted using a unique conversion coefficient (0.885) considered to be representative of the direct emissions embedded in LCA inventories (Cerutti A.K. 2013).

Table 2. illustrates the overall GHG emissions in CoM sectors reported in the BEIs of the CoM data set as of 13th of May 2014. The total GHG emissions are 686 Mt CO2-eq/year, where the highest values are reached in the Building sector (70%). Note that in the sector "OTHER", are grouped the emissions related to activities not energy related.

Table 2. GHG emissions in sectors reported in BEIs: CoM data set as of 13th of May 2014

	Sectors Covered	Aggregated emissions [t CO2-eq/year]	Shares
BUILDINGS, EQUIPMENT, FACILITIES & INDUSTRIES	Municipal buildings, Equipment, Facilities	11,637,975	1.7%
	Tertiary Buildings, Equipment, Facilities	84,036,975	12%
	Residential Buildings	176,319,602	26%
	Municipal Public Lighting	3,224,643	0.5%
	Industries (non ETS)	101,020,487	14.7%
	Not assigned in the macro-sector	105,614,597	15.4%
	SUBTOTAL	**481,854,280**	**70.2%**
TRANSPORT	Municipal Fleet	899,574	0.1%
	Public Transport	5,601,244	0.8%
	Private and commercial Transport	123,612,322	18%
	Not assigned in the macro-sector	57,887,788	8.4%
	SUBTOTAL	**188,000,928**	**27.4%**
OTHER	Waste Management	8,255,601	1.2%
	Water Management	1,565,407	0.2%
	Agriculture	4,984,056	0.7%
	Other Emissions	1,810,337	0.3%
	SUBTOTAL	**16,615,400**	**2.4%**
TOTAL		**686,470,608**	

Final Energy Consumption in BEIs

The Final energy Consumption in urban areas derive mainly from two macro sectors: buildings and transport (see Table 3.). The total final energy consumption is 2,358 TWh/year, where the highest values are reached in the residential sector. The table reports also the amount of electricity, heat/fuel consumptions per sectors in CoM. The highest share of electricity and heat is consumed in the Residential sector, while the highest fuel consumption in the Transport sector is consumed in the Private and commercial transportation.

Table 3. Final Energy consumption in sectors reported in BEIs: CoM data set as of 13th of May 2014

	Sectors Covered	Final Energy consumption [MWh/year]	Electricity consumption [MWh/year]	Heat/ Fuel consumption [MWh/year]
BUILDINGS, EQUIPMENT, FACILITIES & INDUSTRIES	Municipal buildings, Equipment, Facilities	43,126,872	14,811,648	25,530,504
	Tertiary Buildings, Equipment, Facilities	275,656,191	129,115,613	135,282,235
	Residential Buildings	673,142,759	154,756,416	495,561,796
	Municipal Public Lighting	6,479,090	5,884,047	-
	Industries (non ETS)	288,132,937	95,270,728	169,737,328
	Not assigned in the macro-sector	378,930,369	114,972,682	324,545,221
	SUBTOTAL	**1,665,468,219**	**514,811,134**	**1,150,657,084**
TRANSPORT	Municipal Fleet	3,833,204	952,791	2,772,621
	Public Transport	22,245,400	798,071	16,066,339
	Private and commercial Transport	454,629,318	5,846,239	411,988,873
	Not assigned in the macro-sector	211,787,277	2,506,080	250,329,897
	SUBTOTAL	**692,495,199**	**10,103,181**	**682,392,018**
	TOTAL	**2,357,963,418**	**524,914,315**	**1,833,049,102**

Local Energy Production in BEIs

The BEI document reports also data on local power and heat production and GHG emissions due to local energy production in the signatories' territory. The entries include the figure of total energy produced and emissions per macro-sector of activities:

- Local electricity production
  - *Wind:* the amount of electricity produced and GHG emissions if LCA approach

- *Hydroelectric:* the amount of electricity produced and GHG emissions if LCA approach
- *Photovoltaics:* the amount of electricity produced and GHG emissions if LCA approach
- *Geothermal:* the amount of electricity produced and GHG emissions if LCA approach
- *Combined Heat & Power:* the amount of electricity produced per fuel source, and the amount of primary energy used with GHG emissions related
- *Other:* the amount of electricity produced and GHG emissions if LCA approach

– Local heat/cold production

- *Combined Heat & Power:* the amount of heat/cold produced per fuel source, and the amount of primary energy used with GHG emissions related
- *District heating (heat-only):* the amount of heat/cold produced per fuel source, and the amount of primary energy used with GHG emissions related
- *Other:* the amount of heat/cold produced per fuel source, and the amount of primary energy used with GHG emissions

In the following section, data from the BEIs data set as of 13th of May 2014 on local electricity production and local heat production and distributed through District Heating and Cooling (DHC) networks are reported.

Table 4 reports the amount of local electricity production in CoM, classified according to the type of the conversion technology. The highest share of electricity is produced by the Combined Heat and Power plants CHP (38%).

Table 4. Local Electricity production reported in BEIs: CoM data set as of 13th of May 2014

	Technology	**Electricity production [MWh/year]**	**Shares**
Local Electricity Production [MWh/year]	Photovoltaic	733,913	2%
	Hydro Power	6,730,511	15%
	Wind Power	5,815,590	13%
	Combined Heat and Power (CHP)	17,489,132	38%
	Other(not specified)	15,237,562	33%
	TOTAL	**46,006,708**	

Table 5 displays the amount of local heat production in CoM. The share of heat derived from CHP power stations using mainly fossil fuels as primary source is 39%. While 16% of Local Heat production is a distributed generation using Renewable sources (geothermal, biomass and solar).

Table 5. Local Heat production reported in BEIs: CoM data set as of 13th of May 2014

	Technology	Local Heat production [MWh/year]	Shares
Local Heat Production [MWh/year]	District Heating with Combined Heat and Power	59,915,197	39%
	District Heating	68,920,021	45%
	Distributed Heat generation from RES	25,314,099	16%
	TOTAL	**154,149,317**	

Furthermore, the current Local Energy production (as reported in the BEIs dataset) constitutes **8.5%** of the overall Final energy consumption. This figure is calculated as the summation of two terms: energy produced locally by Renewables and thermal energy distributed through District heating Networks (table 6).

Table 6. Share of Local Energy Production: CoM data set as of 13th of May 2014

Local Energy production in BEIs	200,156,025
Share of Local Energy production	**8.5%**

III. Sustainable Energy Action Plans

The SEAP document reports the actions/measures planned by the signatories, together with relevant project management information on

- Estimated GHG emission reduction by 2020.
- Estimated energy savings by 2020;
- Estimated local energy production by 2020;
- Estimated investment costs in the SEAPs

Based on the analysis of the SEAPs data set as of 13th of May 2014, overall statistics have been calculated and reported in this section.

Estimated GHG Emission Reductions

In order to achieve the Europe 2020 Climate and Energy target of 20% reduction in greenhouse gas emissions (compared to 1990) by 2020, the main instruments under the Climate and Energy Package are 1.) the EU Emissions Trading System (EU ETS)[7] and 2.)the Effort Sharing Decision (ESD) for sectors not included under the EU emissions trading system. In the ESD, Member states committed to reach legally binding national targets by 2020 (compared to the situation in 2005) for emission not covered by the EU Emission Trading System which will commonly contribute to an overall 9%[8] reduction at EU level. The non-ETS sectors broadly include direct emissions from households and services, as well as emissions from transport, waste and agriculture. The non-ETS sectors currently represent about 60 % of total GHG emissions[9] (EEA 2014).

The focus of the Covenant of Mayors inventories are the main non ETS sectors under the direct influence of the local authority (such as households, transport, services). Additional sectors which are optionally included in the inventories are: Agriculture (only energy-related emissions associated with buildings, facilities and machinery of the primary sector), Industry (small non-ETS installations) and other emissions not related to the energy consumption such as those associated with waste and waste water. In addition to the non-ETS sectors, the CoM inventories also account for indirect emissions associated with consumption of electricity and heat/cold (as final product delivered to the final consumer). As a consequence, a certain share of emissions arising from power generation by plants included in the EU ETS scheme are computed in the inventories and addressed via the SEAPs.

The estimations on GHG emission reduction per sector as reported in SEAPs as of mid-May 2014, are reported in Table 7. It is important to highlight that the biggest reduction of GHG emissions (44%) is estimated to take place in the Building sector, followed by the transport sector with a share of 19%. Other sectors comprehend measures planned in areas of Public procurement, in Land Use Planning, Working with citizens.

7 See http://ec.europa.eu/clima/policies/ets/index_en.htm

8 Effort Sharing Decision : http://ec.europa.eu/clima/policies/effort/index_en.htm

9 Using official statistics to calculate greenhouse gas emissions 2010 edition A statistical guide

Table 7. Estimation on GHG Emission reduction by sectors: CoM data set as of 13th of May 2014

	Sector	Estimated GHG Emission Reductions by 2020	Shares
Estimated GHG Emission Reduction by 2020 [tCO2-eq]	Buildings, Equipment, Facilities and Industries (non ETS)	83,790,055	44%
	Transport	35,978,776	19%
	Local Electricity production	26,268,357	14%
	Local District Heating, CHPs	17,150,441	9%
	Other Sectors	25,368,527	13%
	TOTAL	**188,556,156**	

In the guidebook "How to develop a Sustainable Energy Action Plan", (Bertoldi P., et al. 2010) a general recommendation was made to use 1990 as the year for the BEI reference; nevertheless signatories are able to choose the closest subsequent year for which reliable data could be gathered. As a result, different years have been chosen in BEIs of the dataset. 26% of the GHG emissions are reported from signatories with a reference year 1990, while the majority (62%) have chosen from 2005 onward as reference years.

Although the minimum commitment was to reduce the current emissions by 20%, CoM signatories who have already submitted a SEAP and are part of the sample have estimated an overall reduction of more than **28%** (Table 8).

Table 8. Share of GHG Emission reduction: CoM data set as of 13th of May 2014

GHG Emission in BEIs [t CO2-eq/year]	686,470,608
Estimated GHG Emission reduction by 2020 [t CO2-eq/year]	188,556,156
Share of GHG Emission reduction [% by 2020]	**28%**

Taken into account the above prescriptions, an attempt has been made to assess the contribution of local action to the achievement of European 2020 Climate targets in terms of GHG emission reductions (Table 9).

EU 28 values and CoM EU-28 values on GHG emissions for 1990 and reduction target for 2020 are reported in table 9. The data of EU-28 for the all sectors are collected form EEA: http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer, while the data on CoM EU-28 are taken from the "CoM data set as of 13th of May 2014".

The EU-28 reduction target in all sectors has been calculated as the difference between the 1990 values and 2020 target. In conclusion we can affirm that CoM signatories from EU-28 may contribute to 15% of the overall reduction target of GHG emission in all the sectors.

Table 9. CoM contribution to the EU 2020 target in terms of GHG Emission reduction

EU-28 GHG Emission all sectors reference 1990 [Mt CO2-eq]	5,626
EU 28 GHG Emission Reduction Target [Mt CO2-eq]	1,125
CoM EU-28 GHG Emission Estimated reduction by 2020 [Mt CO2-eq]	170
CoM EU-28 contribution to EU2020 GHG Emission reduction target [%]	**15%**

Estimated Energy Savings

Energy efficiency has a fundamental role to play in the transition towards a more competitive, secure and sustainable energy system with an internal energy market at its core.

Member states committed to achieving the 20% European energy efficiency target at the March 2007 European Council (7224/01 2007). The new Energy Efficiency Directive (EED 2012), Article 3(1)(a), and Concil Directive 2013/12/EU defined it legally as " *Union's 2020 energy consumption of no more than 1 483 Mtoe primary energy or no more than 1 086 Mtoe of final energy*". i.e. a reduction of 370 Mtoe of primary energy or 269,5 Mtoe of final energy consumptions as compared to Primes projections Baseline 2007.

Local Authorities are putting in place with a bottom-up approach the targets of Energy Efficiency Directive. In the SEAPs signatories reports the measures with estimated energy savings by 2020. Given that it is mandatory for signatories to provide estimates on GHG emission reduction per sector, but not per measure, only 35% of the energy savings are associated with specific measures.

The estimations on Energy savings per sector by 2020 are shown in table 10. It is important to highlight that the highest share of energy savings, equivalent to ca. 252 TWh of reduction in final energy consumptions (52% of the total energy savings) are estimated to take place in the building sector. Introduction of efficiency requirements in building codes, more efficient space and water heaters are typical measures planned in the buildings by signatories in the SEAPs.

Furthermore, 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. Signatories in CoM estimates to reduce ca. 117 TWh of fuel consumptions by 2020 (25% of the total energy savings) with a more efficient local transport.

Lastly, the Energy Efficiency Directive asks Member States to support cogeneration of electricity produced originating from high-efficiency cogeneration and the waste heat being effectively used to achieve primary energy savings. Utilities working closely with local governments for sustainable energy systems in their territories have reported in the SEAPs measures related to energy efficiency in CHP power plans and District Heating networks of ca. 38 TWh, corresponding to 8% of the total energy savings in CoM.

Other sectors comprehend measures planned in areas of public procurement, in land use planning, working with citizens. These measures are accompanied by more efficient urban and land use policies at local level, which will generate ca. 72 TWh of energy savings by 2020 (15% of the total energy savings).

Table 10. Estimated Energy savings as reported in SEAPs: CoM data set as of 13th of May 2014

Sector	Estimated Energy savings in 2020 [MWh/year]	associated with specific measure	Share
Buildings, Equipment, Facilities and Industries (non ETS)	251,913,287	79,352,047	53%
Transport	116,515,306	41,571,880	24%
Local Electricity production	17,606,006	2,304,802	4%
Local District Heating, CHPs	20,993,479	9,933,109	4%
Other Sectors	71,535,147	33,087,870	15%
TOTAL	**478,563,225**		

The reduction target will be achieved through energy efficiency measures in the municipal territories along with energy production from renewables and more efficient energy conversion technologies like CHPs. In fact, the estimated energy savings by 2020 amount to 479 TWh, which correspond to a reduction of **20%** of final energy consumption in the CoM signatories' (Table 11).

Table 11. Share of Energy savings: CoM data set as of 13th of May 2014

Final Energy Consumption in BEIs [MWh/year]	2,357,963,418
Estimated Energy Savings by 2020 [MWh/year]	478,563,225
Share of Estimated Energy savings [% by 2020]	**20%**

In conclusion, the recent European Energy Security Strategy points to the role of energy efficiency as means to improve the Union's security of supply - every additional 1% in energy savings cuts gas imports by 2.6% (EC COM(2014) 520 final). In CoM signatories from EU-28, measures planned in the SEAPs, will reduce the final energy consumption by 2020 by 37 Mtoe.

The difference in methodologies for calculating the energy savings between CoM and the Energy Efficiency Directive has prevented from assessing the potential contribution of SEAPs to the achievement of EU-28 targets to 2020 with respect to energy savings.

Estimated Local Energy Production

Besides reducing their emissions associated with energy consumption, local authorities can also decide to take action on the supply side, for example by fostering the deployment of locally available renewable energy sources (RES) to produce electricity (Cerutti A.K. et al. 2013). The CoM methodology for the elaboration of emission inventories sets clear rules for considering a production plant as local, therefore not all the production plants within the boundaries of the local authority are necessary included.

Table 12 reports the estimations on local energy production per sector by 2020. Signatories in CoM as of mid-May 2014, will increase the local energy production by 133 TWh in 2020. The highest share of estimated local energy production refers to electricity (43%), followed by heat distributed with district heating networks with a share of 32%.

The Energy Efficiency Directive asks Member States to support cogeneration of electricity produced originating from high-efficiency cogeneration and the waste heat being effectively used to achieve primary energy savings. Utilities working closely with local governments for sustainable energy systems in their territories have reported in the SEAPs measures related to energy production in CHP power plans and District Heating networks of ca. 99 TWh, corresponding to 75% of the total estimated local energy production in CoM by 2020.

Other sectors comprehend fuel switch measures planned in areas of public procurement; in land use planning; working with citizens and in the transport sector.

Table 12. Estimated Local Energy production as reported in SEAPs: CoM data set as of 13th of May 2014

Sector	Estimated Local Energy production by 2020 [MWh/year]	associated with specific measure	Share
Buildings, Equipment, Facilities and Industries (non ETS)	11,978,373	8,903,217	9%
Local Electricity production	56,763,237	26,297,090	43%
Local District Heating	42,032,750	21,672,044	32%
Other Sectors	21,972,310	12,132,704	17%
TOTAL	**132,746,670**		

Other analysis has been conducted on the data, in order to understand the most important technologies used for energy production at local level. Table 13. shows the estimations on Energy production per type of technology. It is important to highlight that the electricity production from renewables will increase by 130% in 2020, in comparison to the BEIs years.

Given that it is mandatory for signatories to provide estimates on GHG emission reduction per sector, but not for energy production, only 35% of the energy production are associated with specific technology.

Table 13. Estimated Local Energy production per technology: CoM data set as of 13th of May 2014

Estimated Local Energy production by 2020 [MWh/year]		
LOCAL POWER PRODUCTION	Photovoltaic	7,754,703
	Hydro Power	912,952
	Wind Power	8,183,702
	Combined heat and Power	9,951,465
	Generation of power – technology not specified	29,960,414
	Total	**56,763,237**
LOCAL HEAT PRODUCTION	District Heating with Combined Heat Power	5,766,594
	District Heating	6,846,126
	Heat from Geothermal	5,236,829
	Heat from Biomass	1,019,984
	Solar heating	133,724
	Generation of heat - technology not specified	23,029,493
	Total	**42,032,750**
LOCAL ENERGY PRODUCTION	*Generation of heat and power technology not specified*	33,950,683
TOTAL		**132,746,670**

The Estimated Local Energy production is calculated as the summation of current Local Energy production in BEIs and the Estimated Local Energy production by 2020 in the SEAPs.

We can affirm that the share of Local Energy production on Final Energy consumption by 2020, based on the analysis of the estimation in CoM signatories for Local Energy production from Renewable sources and by more efficient energy generation technologies (CHPs connected with District Heating Networks), will be 18% (Table 14).

Table 14. Share of Local Energy Production: CoM data set as of 13th of May 2014

Local Energy production in BEIs [MWh/year]	200,156,025
Estimated Local Energy production by 2020 [MWh]	332,902,694
Share of Local Energy production [% by 2020]	**18%**

The lack of detailed data on local energy production split between renewable and non-renewable sources has prevented from assessing the potential contribution of SEAPs to the achievement of EU-28 targets to 2020 with respect to energy savings and RES.

Estimated Investments Costs in SEAPs

In order to evaluate the estimated implementation cost planned by the municipalities, an economic analysis has been carried out on the data as reported in table 15. The implementation cost refers to the capital required to implement each action as well as the operating cost required during the implementation time frame of the action. The total implementation cost also incorporates operational, maintenance costs and other costs. This amount is based on the forecasted total implementation cost municipalities have declared to invest in order to implement the measures described in the SEAP. It does not take into consideration the economic aspect of the energy savings the measure will generate. Furthermore, not all the measures are implemented during the same time period. Therefore implementation cost of the measures varies from the year 2008 to 2020.

Signatories of CoM have estimated an overall implementation cost of ca. €109 billion in Energy Efficiency and in Local Energy production. The estimated implementation cost are not discounted. It is the estimated cost reported by local authorities to implement the measures reported in their SEAP. Although municipalities are invited to provide foreseen financing sources for SEAP implementation and to distinguish between public/private such information is mot systematically reported.

Table 15. Estimated investments as reported in SEAPs: CoM dataset as of 13th of May 2014

	Estimated cost [Million €]
Buildings, Equipment, Facilities and Industries (non ETS)	39,851
Transport	8,793
Local Electricity production	15,289
Local District Heating, CHPs	36,101
Other Sectors	8,666
TOTAL	**108,701**

As it can be seen in the table 15, the highest estimated implementation cost are planned to take place in the building sector (ca. €40 billion). To reap the benefits of energy efficiency in buildings, the biggest challenge is to accelerate and finance upfront investments and speed up the renovation rate of the existing stock from 1.4% - today's average - to above 2% annually (EC COM (204) 520).

Furthermore, measures related to local heat production distributed through district heating networks are foreseen to launch investment cost of ca. €36 billion as reported in the SEAPs submitted by signatories of CoM as mid-May 2014. The Energy Efficiency Directive (EED 2012/27/EU) states that High-efficiency cogeneration and district heating and cooling has significant potential for saving primary energy, which is largely untapped in the Union.

In conclusion, investment in energy efficiency has the potential to contribute to economic growth, employment, innovation and a reduction in fuel poverty in households, and therefore makes a positive contribution to economic, social and territorial cohesion.

IV. Performance Indicators

After almost 6 years of activity, preliminary results on per capita indicators are highlighted in this chapter. The following tables report the main performance indicators of the CoM Initiative.

The average GHG emissions per capita are **5.44 [tCO2-eq/cap],** while the EU-28 average for GHG Emission in CoM sectors (Non ETS and Public electricity and heat production) is **8.7 [tCO2-eq/cap]** (EEA 2005 reference year: http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer).

The average GHG emission reduction by 2020 is **1.51 [tCO2-eq/cap]** or better expressed in terms of shares **28%** as reported in Table 16.

Table 16. Performance Indicators on GHG Emissions and Reduction: CoM dataset as of 13th of May 2014

CoM -GHG Emissions per capita [tCO2-eq/cap]	5.44
EU-28 GHG Emissions per capita in CoM sectors 2005 [tCO2-eq/cap]	**8.7**
GHG Emission reduction by 2020 [t CO2-eq/cap]	1.51
Share of GHG emission reductions by 2020 [%]	**28%**

The yearly average Final energy consumption in CoM is **18.8 [MWh/cap]** while the EU-28 yearly average is **19.2 [MWh/cap]** (Eurostat 2005 reference year: Final energy consumption in transport, residential and services sectors).The average energy savings is **3.79 [MWh/cap]** or better expressed in terms of shares **20%** as reported in Table 17.

Table 17. Performance Indicators on Final Energy consumption and Estimated Energy savings: CoM dataset as of 13th of May 2014

CoM Final Energy consumption per capita BEIs reference year [MWh/cap]	18.70
EU-28 Final Energy consumption per capita BEIs reference year [MWh/cap]	**19.22**
Estimated Energy saving by 2020 [MWh/cap]	3.79
Share of Estimated Energy savings in 2020 in comparison to BEIs reference year [%]	**20%**

In table18. are reported the details on the countries of Energy savings per capita and GHG Emissions reductions per capita.

Table 18. Performance Indicators per country

Region	Nr of signatories in CoM dataset as of 13th May 2014	Population	Yearly average Final energy consumption per capita in BEIs [MWh/cap]	Estimated Energy savings per capita by 2020 [MWh/cap]	GHG Emissions per capita in BEIs [tCO2-eq/cap]	Estimated GHG Emission Reduction per capita by 2020 [tCO2-eq/cap]
EUROPE-28	**3,361**	**114,237,208**	**19.19**	**3.51**	**5.86**	**1.54**
Belgium	47	2,582,838	22.22	5.53	5.36	1.35
Bulgaria	6	1,061,685	6.15	2.62	2.36	1.22
Czech Republic	5	331,841	12.41	0.73	5.04	0.33
Denmark	27	2,611,681	24.23	5.64	7.73	1.97
Germany	41	13,440,936	27.07	8.60	9.05	3.27
Estonia	1	413,727	23.24	1.26	9.50	2.41
Ireland	5	1,340,594	32.64	5.85	10.92	2.20
Greece	43	2,206,362	12.42	2.00	5.59	1.28
Spain	992	17,894,957	13.77	2.12	4.20	0.94
France	55	10,255,859	24.15	3.44	5.82	1.30
Croatia	37	1,583,916	13.88	3.40	3.40	1.05
Italy	1,837	23,900,769	17.50	2.91	4.68	1.06
Cyprus	14	444,853	18.48	4.11	7.82	1.66
Latvia	12	961,923	22.65	2.67	4.73	1.19
Lithuania	10	1,211,557	17.76	3.47	4.51	1.33
Luxembourg	1	2,229	25.07	2.99	8.93	3.58
Hungary	16	277,314	14.53	3.33	3.78	0.99
Malta	8	37,285	7.59	0.46	3.15	0.24
Netherlands	6	1,665,459	18.60	4.13	6.31	1.51
Austria	9	1,898,245	17.67	4.55	4.11	1.30
Poland	24	3,096,566	16.80	3.12	7.31	2.47
Portugal	52	3,487,372	15.40	3.29	4.74	1.17
Romania	37	2,409,386	11.09	1.77	3.60	0.93

Slovenia	10	387,245	33.92	3.72	10.04	2.62
Slovakia	3	556,911	20.01	3.90	4.79	1.00
Finland	6	1,539,482	20.95	3.57	5.45	1.16
Sweden	34	3,614,074	25.73	4.70	4.88	1.68
United Kingdom	23	15,022,142	21.37	4.49	6.24	1.89
EUROPE - NON EU	**28**	**6,051,021**	**18.44**	**2.40**	**3.91**	**1.09**
Bosnia and Herzegovina	12	1,432,887	8.31	1.60	2.84	0.72
former Yugoslav Republic of Macedonia	1	600,000	6.12	2.16	2.04	1.30
Montenegro	2	4,943	27.51	3.18	7.19	2.46
Norway	1	126,021	23.23	3.48	5.30	0.79
Switzerland	6	412,823	22.38	2.30	4.91	1.20
Turkey	5	3,355,920	6.85	2.19	2.50	0.82
Iceland	1	118,427	34.69	1.92	2.59	0.35
EAST PARTN. CENTR. ASIA	**30**	**4,526,378**	**12.15**	**2.12**	**2.65**	**0.81**
Belarus	3	174,372	11.98	3.10	2.20	0.90
Georgia	2	1,270,000	8.40	2.89	2.59	1.04
Moldova	2	160,100	6.80	1.76	1.89	0.44
Ukraine	22	2,901,753	14.08	2.32	3.95	0.87
Tajikistan	1	20,153	6.10	2.15	1.25	0.63
SOUTH MEDITERRANEAN COUNTRIES	**1**	**903,485**	**2.38**	**0.04**	**0.97**	**0.49**
Morocco	1	903,485	2.38	0.04	0.97	0.49
REST WORLD	**1**	**360,000**	**34.17**	**5.96**	**9.35**	**2.45**
New Zealand	1	360,000	34.17	5.96	9.35	2.45
Total	**3,421**	**126,078,092**				

Annex I: Signatories of CoM as of mid-May 2014 by country

Region	Number of Signatories	Percentage from the number of signatories of CoM	CoM Population by country (thousands)	Percentage from CoM Population	CoM Population from cities above 50.000 inhabitants (thousands)	Representativeness of population from cities above 50.000 inhabitants in CoM Signatories	Country population 2008-2012 (thousands)	UNDP Country urban population 2008-2012 (thousands)	UNDP Percentage covered by CoM from the country urban population
EUROPE-28	**5,132**	**97%**	**160,281**	**86%**	**125,559**	**78%**	505,617	370,163	43%
Belgium	104	2%	4,603	2%	3,187	69%	10,929	10,660	43%
Bulgaria	34	1%	2,652	1%	2,305	87%	7,390	5,292	50%
Czech Republic	5	0%	332	0%	307	93%	10,545	7,739	4%
Denmark	36	1%	2,786	2%	2,197	79%	5,549	4,795	58%
Germany	55	1%	17,092	9%	16,721	98%	83,055	61,390	28%
Estonia	5	0%	536	0%	511	95%	1,299	888	60%
Ireland	6	0%	1,405	1%	1,405	100%	4,466	2,738	51%
Greece	93	2%	3,529	2%	2,148	61%	11,107	8,392	42%
Spain	1,458	28%	25,486	14%	17,369	68%	46,090	35,939	71%
France	108	2%	15,749	8%	14,974	95%	63,238	49,239	32%
Croatia	59	1%	1,930	1%	1,351	70%	4,336	2,475	78%
Italy	2,731	52%	33,716	18%	16,548	49%	60,443	41,158	82%
Cyprus	22	0%	471	0%	272	58%	1,103	748	63%
Latvia	18	0%	1,078	1%	855	79%	2,095	1,421	76%
Lithuania	13	0%	1,346	1%	1,049	78%	3,077	2,053	66%
Luxembourg	1	0%	2	0%	-	0%	507	445	1%
Hungary	24	0%	2,670	1%	2,421	91%	10,013	6,794	39%
Malta	25	0%	117	0%	-	0%	425	400	29%
Netherlands	18	0%	3,804	2%	3,741	98%	16,612	14,170	27%
Austria	11	0%	1,913	1%	1,825	95%	8,403	5,532	35%
Poland	35	1%	3,596	2%	3,238	90%	38,200	23,346	15%

Portugal	92	2%	4,582	2%	3,574	78%	10,588	6,284	73%
Romania	58	1%	6,219	3%	5,792	93%	21,861	11,710	53%
Slovenia	28	1%	627	0%	324	52%	2,052	1,031	61%
Slovakia	4	0%	567	0%	550	97%	5,432	2,990	19%
Finland	7	0%	1,717	1%	1,717	100%	5,366	4,469	38%
Sweden	49	1%	4,083	2%	3,504	86%	9,378	7,949	51%
United Kingdom	33	1%	17,674	10%	17,674	100%	62,062	50,116	35%
EUROPE - NON EU	**46**	**1%**	**8,668**	**5%**	**8,121**	**94%**	**104,569**	**70,070**	-
Bosnia And Herzegovina	15	0%	1,564	1%	1,352	86%	3,847	1,509	-
Switzerland	9	0%	820	0%	711	87%	7,828	5,760	14%
Norway	7	0%	1,161	1%	1,050	90%	4,889	3,836	30%
Turkey	6	0%	3,662	2%	3,627	99%	72,160	50,197	7%
Montenegro	3	0%	141	0%	136	97%	620	389	36%
former Yugoslav Republic of Macedonia	2	0%	705	0%	705	100%	2,102	1,203	59%
Serbia	2	0%	75	0%	-	0%	9,652	5,302	1%
Albania	1	0%	421	0%	421	100%	3,155	1,577	27%
Iceland	1	0%	118	0%	118	100%	318	297	40%
EAST PARTN. CENTR. ASIA	**112**	**2%**	**15,339**	**8%**	**14,208**	**93%**	**104,422**	**61,595**	-
Ukraine	65	1%	10,343	6%	9,698	94%	46,022	31,445	33%
Moldova	18	0%	580	0%	347	60%	3,574	1,610	36%
Belarus	8	0%	317	0%	204	64%	9,486	6,991	5%
Georgia	8	0%	1,877	1%	1,855	99%	4,387	2,312	81%
Kazakhstan	6	0%	1,871	1%	1,871	100%	15,920	8,616	22%
Armenia	3	0%	50	0%	-	0%	2,968	1,895	3%
Kyrgyzstan	2	0%	267	0%	233	87%	5,335	1,883	14%
Azerbaijan	1	0%	4	0%	-	0%	9,094	4,820	0%
Tajikistan	1	0%	30	0%	-	0%	7,635	2,022	1%
SOUTH MEDITERRANEAN COUNTRIES	**5**	**0.03%**	**960**	0.2%	**903**	-	**40,086**	**24,731**	-
Lebanon	2	0.04%	12	0.01%	-	0%	4,380	3,808	0%

Palestine	2	0.04%	45	0.02%	-	0%	4,016	2,960	2%
Morocco	1	0.02%	903	0.49%	903	100%	31,691	17,962	5%
REST WORLD	**1**	**0.02%**	**360**	**0**	**360**	**-**	**4,369**	**3,762**	**10%**
New Zealand	1	0%	360	0%	360	100%	4,369	3,762	10%
TOTAL CoM	**5,296**	**100%**	**185,608**	**100%**	**149,152**	**80%**	759,063	530,321	**-**

Annex II: Methodology for Robust Data Statistics

All the data provided in the current report are reported by the signatories in an on-line template provided on the web-site of CoM. The on-line template must reflect accurately the content of the official SEAP document, and the coherence of certain key figures is the checked by JRC. For the current paper, when performing the analysis on energy consumption and emission parameters in cities, the data considered was related to the SEAPs submitted as of 13th May 2014. Yet, given the voluntary aspect and the difficulty of adapting sometimes local specificities into the general proposed framework, not all the data could be considered reliable, therefore a methodology has been developed to build a robust sample.

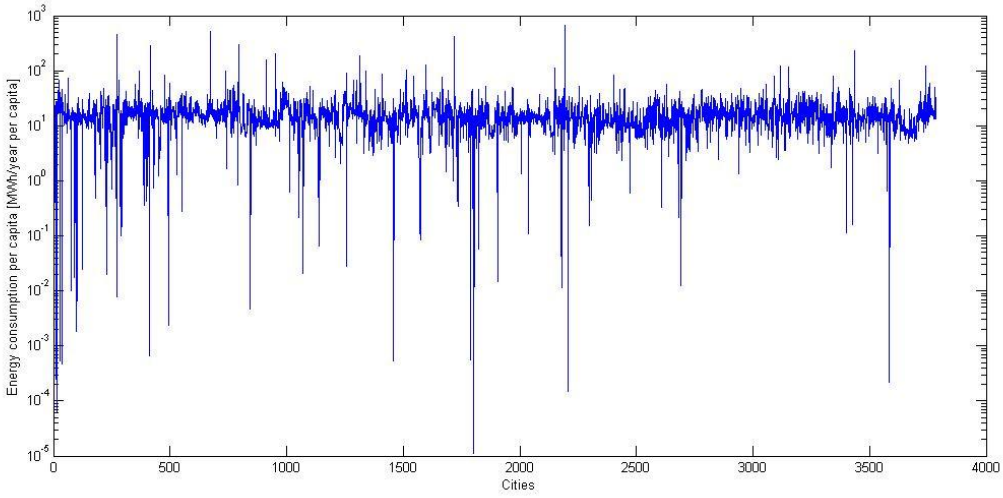
In order to describe through descriptive statistics our set of data, we need to define some parameters like the mean, the standard deviation, the Skewness and kurtosis (Foster Gant 2013). While the mean and the standard deviation are well known, in the following a brief description of the Skewness and kurtosis is reported.

The third moment about the mean gives us a special statistics called skewness, often denoted with the greek letter γ (gamma).Skewness is a god indicator of whether or not a distribution is symmetrical about its mean, with positive values indicating top-heavy values, and negative values indicating a bottom heavy one.

The fourth moment about the mean is called Kurtosis, which measures how strongly extreme values are represented in the distribution. The normal (bell curve) distribution might be said to have a "normal" level of extreme –value dominance, and it has a Kurtosis equal to 3. For that reason to find out whether or not a distribution has more or less extreme dominance than the normal distribution, we simply subtract 3 from the kurtosis, often denoted with the greek letter γ_2 (gamma 2) (Foster Gant 2013).

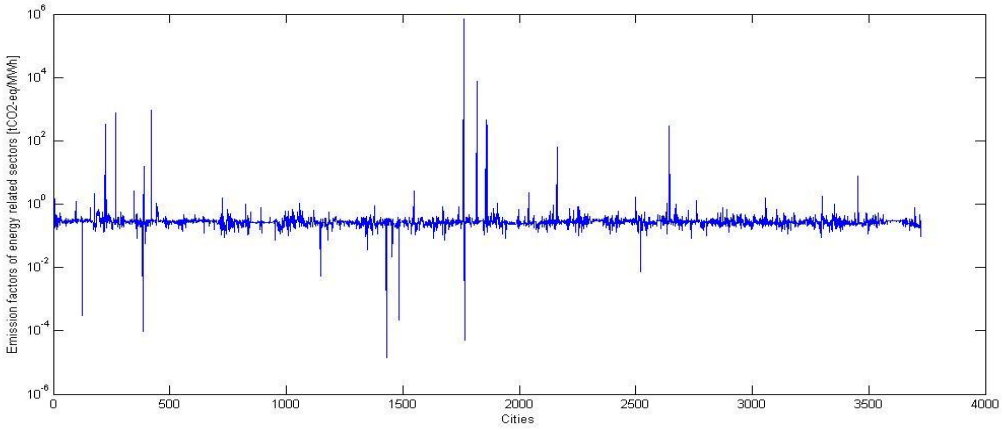
As it can be seen in Figure 3, which reports the energy consumption per capita in cities, there are many outliers and the frequency distribution is far for being normal. In statistics, an outlier is an observation point that is distant from other observations.

Figure 3. Average Final Energy Consumption per capita in cities: CoM as of 13th of May 2014



In figure 4, are reported the average Emission Factors of energy related sectors in cities.

Figure 4. Average emission factors of energy related sectors: CoM as of 13th of May 2014

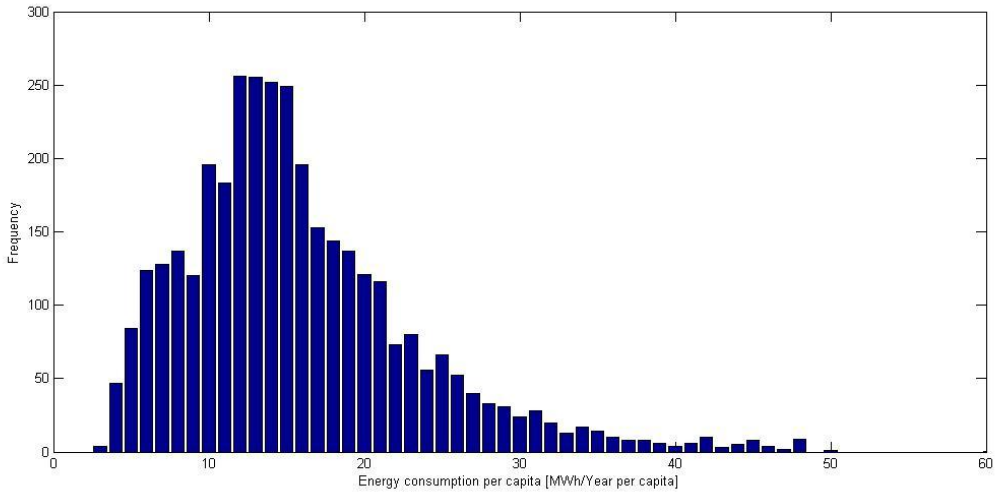


In order to remove the outliers, a methodology has been developed to select a robust data sample of cities. The methodology is based on selecting cities with reliable data on energy consumption per capita and CO2 emission factors for energy related sectors in cities.

The mean, standard deviation, skewness and kurtosis were calculated at the beginning for each set of data. Secondly a Generalised Extreme studentized method was applied for removing the outliers. Similar methodologies, in literature, have been applied to detect outliers (Kenneth L. Lange 2012) or abnormal energy consumptions in buildings (Seem 2007). As result of the applied methodology, a sample of cities were selected.

Figure 5 is represented the frequency distribution of the average Final Energy consumption per capita in cities in bins from 1-50 MWh/annual. In the vertical axes is reported the number of occurrences (cities) for each range of Final Energy consumption per capita.

Figure 5 Frequency distribution of Final Energy consumption per capita in cities: CoM dataset as of 13th of May 2014



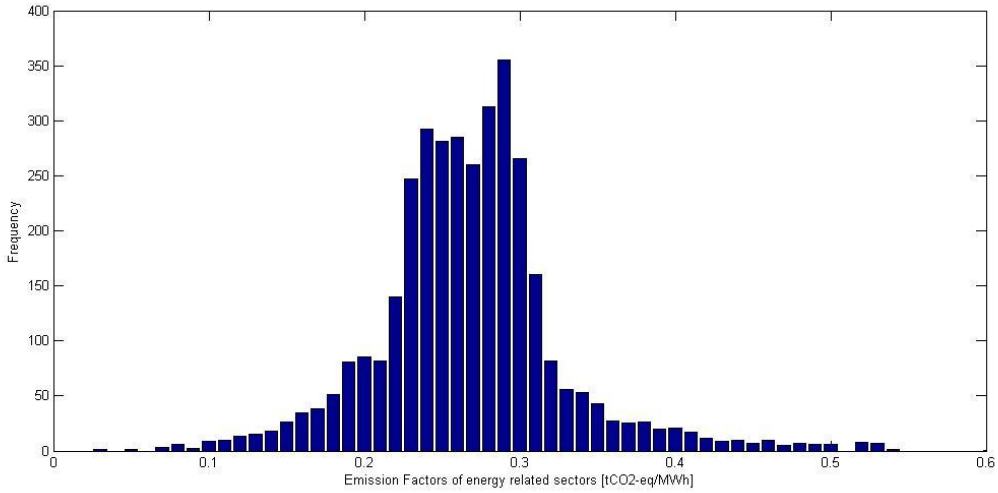
While in table 19 are reported the main parameters of the dataset on Final energy consumption per capita.

Table 19. Final Energy consumption per capita – statistical parameters: CoM dataset as of 13th of May 2014

Mean Robust	16.3
Standard Deviation Robust	7.6
Skewness	1.2
Excess Kurtosis	2.2

In Figure 6 is represented the frequency distribution of the average emission factors (energy related sectors) in cities in bins from 0.1-0.6 tCO2-eq/MWh. In the vertical axes is reported the number of occurrences (cities) for each range of Emission Factor of energy related sectors in cities.

Figure 6. Frequency distribution of Emission Factors of energy related sectors in cities: CoM dataset as of 13th of May 2014



While in Table 20 are reported the main parameters of the dataset of emission factors in cities' sample.

Table 20. Emission Factors of energy related sectors in cities – statistical parameters: CoM dataset as of 13th of May 2014

Mean	0.273
Standard Deviation	0.06
Skewness	0.65
Excess Kurtosis	2.9

Once the sample was selected in Baseline Emission Inventories database, than for these selected cities where coupled with their sustainable Energy Action plans in the SEAPs database.

In the SEAPs database, other selection criterias where applied in order to have robust data.

- in cities where there were estimated GHG emission reduction without reporting neither Energy savings nor energy production, an estimation on energy savings were made as follows:

$$Estimated\ Energy\ Savings = \frac{Estimated\ GHG\ Emission\ Reduction}{Average\ Emission\ Factor}$$

- an indicator on the emission factors of reductions due to estimated energy savings or production was calculated in order to identify outliers due to misinterpretation of the energy units reported (kWh instead of MWh)

$$Emission\ Factor\ Reduction = \frac{Estimated\ GHG\ Emission\ Reduction}{Estimated\ Energy\ (savings\ or\ production)}$$

- in the measures related to local energy production from photovoltaic an indicator on Power peak installed capacity has been calculated. By calculating this indicator, we were able to identify outliers due to the misinterpretation of the energy units reported.

$$Power\ Indicator = \frac{Estimated\ Energy\ Production}{1100\ kWh/kWp}$$

- in the measures related to local energy production from renewables such as Wind and Hydro an indicator on Power installed. This indicator has been calculated in the following formula based on literature values for the capacity factor (Gisinger S., et al. 2013). By calculating this indicator, we were able to identify outliers due to the wrong interpretation of the energy units reported.

$$Power\ Indicator = \frac{Estimated\ Energy\ Production}{(24\ hours * 365\ days * capacity\ factor)}$$

Up to mid-May 2014 5,296 local authorities and cities had signed up to participate in the CoM. Out of these 3,664 signatories had submitted a SEAP. As a result of the aforementioned methodology, the final data set was assembled resulting in 3,421 SEAPs.

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