Covenant of Mayors
Committed to local sustainable energy

How to develop a Sustainable Energy Action Plan

Part 2

HOW TO DEVELOP A SUSTAINABLE ENERGY ACTION PLAN (SEAP) – GUIDEBOOK

Part 2

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Glossary

Activity Data: Activity data quantifies the human activity occurring in the territory of the local authority.

Covenant signatory: Local authority that has signed the Covenant of Mayors.

Baseline year: Baseline year is the year against which the achievements of the emission reductions in 2020 shall be compared.

Baseline Emission Inventory (BEI): Quantifies the amount of CO_2 emitted due to energy consumption in the territory of the Covenant signatory in the baseline year.

Emission factors: Emission factors are coefficients which quantify the emission per unit of activity.

Certified green electricity: Electricity that meets the criteria for guarantee of origin of electricity produced from renewable energy sources set in Directive 2001/77/EC and updated in Directive 2009/28/EC.

Heating degree days (HDD): Denote the heating demand in a specific year.

Life cycle assessment (LCA): Method that takes into account emissions over the entire life cycle of the commodity. For example, life cycle emissions of oil include emissions from oil extraction, refining, transportation, distribution and combustion.

Local heat production: Production of heat in the territory of the local authority that is sold/distributed as a commodity to end users.

Local electricity production: (Small-scale) production of electricity in the territory of the local authority.

Monitoring Emission Inventory (MEI): Emission inventory that the local authority carries out to measure the progress towards target.

Per capita target: The local authority may decide to set the target as '*per capita*'. In that case, the emissions in the baseline year are divided by the population in that year, and the target for year 2020 is calculated on that basis.

Territory of the local authority: Geographical area within the administrative boundaries of the entity governed by the local authority.

PART II
Baseline emissions inventory

Table of contents

Acronyms 4

1. Introduction 5

2. Setting up an inventory 6

2.1 Key concepts 6
2.2 Boundaries, scope and sectors 6

3. Emission factors 9

3.1 Choice of emission factors: standard (IPCC) or LCA 9
3.2 Greenhouse gases included: CO_2 or CO_2 equivalent emissions 10
3.3 Fuels and renewable heat 10
3.4 Electricity 13
3.4.1 National or European emission factor 13
3.4.2 Local electricity production 14
3.4.3 Purchases of certified green electricity by the local authority 16
3.4.4 Calculation of local emission factor for electricity 16
3.5 Heat/cold 16
3.5.1 Combined heat and power production (CHP) 17
3.6 Other sectors 17

4. Activity data collection 18

4.1 Introduction 18
4.2 Final energy consumption 18
4.2.1 Buildings, equipment/facilities and industries 19
4.2.2 Road transportation 22
4.2.3 Rail transportation 25
4.3 Local electricity production (if applicable) 25
4.4 Local heat/cold production 25
4.5 Other sectors 25

5. Reporting and documentation 26

5.1 Reporting of BEI/MEI 26
5.2 Per *capita* target 26
5.3 Temperature correction 26

6. Use of existing tools and more advanced methodologies 28

7. Recalculations 29

References 31

Annex I Conversion factor and IPCC emission factor tables 32

Annex II SEAP template tables for Baseline Emission Inventory 34

Acronyms

BEI	Baseline Emission Inventory
CCS	Carbon Capture and Storage
CH_4	methane
CHP	combined heat and power
CO	carbon monoxide
CO_2	carbon dioxide
CO2EH	CO_2 emissions related to heat that is exported outside of the territory of the local authority
CO_2-eq	CO_2-equivalents
CO2GEP	CO_2 emissions due to the production of certified green electricity purchased by the local authority
CO2IH	CO_2 emissions related to imported heat from outside the territory of the local authority
CO2LPE	CO_2 emissions due to the local production of electricity
CO2LPH	CO_2 emissions due to the local production of heat
CoM	Covenant of Mayors
$CO2_{CHPE}$	CO_2 emissions from electricity production in a CHP plant
$CO2_{CHPH}$	CO_2 emissions from heat production in a CHP plant
$CO2_{CHPT}$	total CO_2 emissions of the CHP plant
EFE	local emission factor for electricity
EFH	emission factor for heat
ELCD	European Reference Life Cycle Database
ETS	European Union Greenhouse Gas Emission Trading System
EU	European Union
GEP	green electricity purchases by the local authority
GHG	greenhouse gas
GWP	global warming potential
HDD	heating degree days
HDD_{AVG}	heating degree days in an average year
ICLEI	Local Governments for Sustainability
IEA	International Energy Agency
IEAP	International Local Government Greenhouse Gas Emissions Analysis Protocol
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre of the European Commission
LCA	life cycle assessment
LHC	local heat consumption
LHC_TC	temperature corrected local heat consumption
LPE	local electricity production
MEI	Monitoring Emission Inventory
N2O	nitrous oxide
NCV	net calorific value
NEEFE	national or European emission factor for electricity
P_{CHPH}	amount of heat produced in a CHP plant
P_{CHPE}	amount of electricity produced in a CHP plant
PV	solar photovoltaic installation
SEAP	Sustainable Energy Action Plan
TCE	total electricity consumption in the territory of the local authority
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute
□e	typical efficiency of separate electricity production
□h	typical efficiency of separate heat production

1. Introduction

The Baseline Emission Inventory (BEI) quantifies the amount of CO_2 emitted due to energy consumption in the territory of the local authority (i.e. Covenant Signatory) (1) in the baseline year. It allows to identify the principal anthropogenic sources of CO_2 emissions and to prioritise the reduction measures accordingly. The local authority may include also CH_4 and N_2O emissions in the BEI. Inclusion of CH_4 and N_2O depends on whether measures to reduce also these greenhouse gases (GHGs) are planned in the Sustainable Energy Action Plan (SEAP), and also on the emission factor approach chosen (standard or life cycle assessment (LCA)). For simplicity, we mainly refer to CO_2 in these guidelines, but it can be understood to mean also other GHGs like CH_4 and N_2O in the case that the local authority includes them in the BEI and SEAP in general.

Elaborating a BEI is of critical importance. This is because the inventory will be the instrument allowing the local authority to measure the impact of its actions related to climate change. The BEI will show where the local authority was at the beginning, and the successive monitoring emission inventories will show the progress towards the objective. Emission inventories are very important elements to maintain the motivation of all parties willing to contribute to the local authority's CO_2 reduction objective, allowing them to see the results of their efforts.

The overall CO_2 reduction target of the Covenant of Mayors Signatories is at least 20 % reduction in 2020 achieved through the implementation of the SEAP for those areas of activity relevant to the local authority's mandate. The reduction target is defined in comparison to the baseline year which is set by the local authority. The local authority can decide to set the overall CO_2 emission reduction target either as 'absolute reduction' or 'per capita reduction', as is explained in Chapter 5.2.

According to the principles laid out in the Covenant of Mayors, each signatory is responsible for the emissions occurring due to energy consumption in its territory. Therefore, emission credits bought or sold on the carbon market do not intervene in the BEI/MEI. However this does not prevent signatories to use carbon markets and related instruments to finance their SEAP measures.

The BEI quantifies the emissions that occurred in the baseline year. In addition to the inventory of the baseline year, emission inventories will be compiled in the later years to monitor the progress towards target. Such an emission inventory is called Monitoring Emission Inventory (MEI). The MEI will follow the same methods and principles as the BEI. The acronym BEI/MEI is used when describing issues which are common for both BEI and MEI. Specific guidelines for monitoring SEAP implementation will be published in 2010.

In these guidelines, advice and recommendations for compiling a BEI/MEI under the Covenant of Mayors are presented. Some of the definitions and recommendations are unique to the inventories under the Covenant of Mayors, in order to enable the inventories to demonstrate the progress towards the target of the Covenant.

However, as far as possible, the concepts, methodologies and definitions in internationally agreed standards are followed in these guidelines. For example, the local authority is encouraged to use emission factors that are in line with those of the Intergovernmental Panel on Climate Change (IPCC) or European Reference Life Cycle Database (ELCD). However, the local authority is given the flexibility to use any approach or tool that it considers appropriate for the purpose.

The results of the BEI are reported by using the SEAP template which is published online at **www.eumayors.eu**. The SEAP template tables related to the Baseline Emission Inventory are shown in Annex II of these guidelines.

(1) *'territory of the local authority' refers to the geographical area within the administrative boundaries of the entity governed by the local authority.*

2. Setting up an inventory

2.1 Key concepts

In the compilation of BEI/MEI, the following concepts are of utmost importance:

1. **Baseline year.** Baseline year is the year against which the achievements of the emission reductions in 2020 shall be compared. The EU has committed to reduce the emissions 20 % by 2020 compared to 1990, and 1990 is also the base year of the Kyoto Protocol. To be able to compare the emission reduction of the EU and the Covenant signatories, a common base year is needed, and therefore 1990 is the recommended baseline year of the BEI. However, if the local authority does not have data to compile an inventory for 1990, then it should choose the closest subsequent year for which the most comprehensive and reliable data can be collected.
2. **Activity Data.** Activity data quantifies the human activity occurring in the territory of the local authority. Examples of activity data are:
   - oil used for space heating in residential buildings [MWh_{fuel}];
   - electricity consumed in municipal buildings [MWh_e];
   - heat consumed by residential buildings [MWh_{heat}].
3. **Emission factors.** Emission factors are coefficients which quantify the emission per unit of activity. The emissions are estimated by multiplying the emission factor with corresponding activity data. Examples of emission factors are:
   - amount of CO_2 emitted per MWh of oil consumed [t CO_2/MWh_{fuel}];
   - amount of CO_2 emitted per MWh electricity consumed [t CO_2/MWh_e];
   - amount of CO_2 emitted per MWh heat consumed [t CO_2/MWh_{heat}].

2.2 Boundaries, scope and sectors

The geographical boundaries of the BEI/MEI are the administrative boundaries of the local authority.

The baseline CO_2 inventory will essentially be based on final energy consumption, including both municipal and non-municipal energy consumption in the local authority's territory. However, also those other than energy-related sources may be included in the BEI.

The BEI quantifies the following emissions that occur due to energy consumption in the territory of the local authority:

1. Direct emissions due to fuel combustion in the territory in the buildings, equipment/facilities and transportation sectors.
2. (Indirect) emissions related to production of electricity, heat, or cold that are consumed in the territory.
3. Other direct emissions that occur in the territory, depending on the choice of BEI sectors (see Table 1).

The points a) and c) above quantify the emissions that physically occur in the territory. Inclusion of these emissions follows the principles of the IPCC used in the reporting of the countries to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (2).

As explained in point b) above, the emissions due to production of electricity, heat and cold consumed in the territory are included in the inventory regardless of the location of the production (inside or outside of the territory) (3).

The definition of the scope of the BEI/MEI ensures that all the relevant emissions due to energy consumption in the territory are included, but no double counting is taking place. As illustrated in Table 1, emissions other than the ones that are related to fuel combustion can be included in the BEI/MEI. However, their inclusion is voluntary because the main focus of the Covenant is the energy sector, and the importance of other than energy-related emissions may be small in the territories of many local authorities.

Table 1 illustrates the recommendation of sectors to be included in the BEI/MEI. The following labels are used in the table

- YES: inclusion of this sector in BEI/MEI is strongly recommended.
- YES if in SEAP: this sector may be included if the SEAP includes measures for it. Even if measures are planned for a sector in SEAP, its inclusion in the BEI/MEI is not mandatory. However, it is recommended because otherwise the local authority cannot quantitatively show the emission reduction which took place as a result of such a measure.
- NO: inclusion of this sector in BEI/MEI is not recommended.

Carbon Capture and Storage (CCS) and nuclear energy are outside the scope of the Covenant, and therefore any emission reduction related to such activities should be excluded from the BEI/MEI.

(2) *They are comparable with 'scope 1 emissions', for example in the methodology of International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP) (ICLEI, 2009) and The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (WRI/WBCSD, 2004). However, a major difference is that not all emissions occurring in the territory are included, for example emissions of large power and industrial plants are excluded (see Sections 3.4 and 3.5).*

(3) *Such emissions are often referred to as 'scope 2' emissions, for example, in the methodology of ICLEI (2009) and WRI/WBCSD (2004).*

TABLE 1. SECTORS INCLUDED IN THE BEI/MEI		
SECTOR	**INCLUDED?**	**NOTE**
Final energy consumption in buildings, equipment/facilities and industries		
Municipal buildings, equipment/facilities	YES	These sectors cover all energy consuming buildings, equipment and facilities in the territory of the local authority which are not excluded below. For example, energy consumption in water and waste management facilities is included in this sector. Municipal waste incineration plants are also included here if they are not used to produce energy. For energy producing waste incineration plants, see Sections 3.4 and 3.5.
Tertiary (non-municipal) buildings, equipment/facilities	YES	
Residential buildings	YES	
Municipal public lighting	YES	
Industries involved in EU ETS	NO	
Industries not involved in EU ETS	YES if in SEAP	
Final energy consumption in transportation		
Urban road transportation: municipal fleet (e.g. municipal cars, waste transportation, police and emergency vehicles)	YES	These sectors cover all road transportation on the street network that is in the competence of the local authority.
Urban road transportation: public transportation	YES	
Urban road transportation: private and commercial transportation	YES	
Other road transportation	YES if in SEAP	This sector covers the road transportation on roads in the territory of the local authority not under its competence, for example highways.
Urban rail transportation	YES	This sector covers the urban rail transportation in the territory of the local authority, such as tram, metro and local trains.
Other rail transportation	YES if in SEAP	This sector covers the long-distance, intercity, regional and cargo rail transportation that occurs in the territory of the local authority. Other rail transportation does not only serve the territory of the local authority, but a larger area.
Aviation	NO	The energy consumption of airport and harbour buildings, equipment and facilities will be included as part of the buildings and facilities above, however excluding mobile combustion.
Shipping/fluvial transport	NO	
Local ferries	YES if in SEAP	Local ferries are the ferries that serve as urban public transportation in the territory of the local authority. These are not likely to be relevant for most of the Signatories.
Off-road transport (e.g. agricultural and construction machinery)	YES if in SEAP	

SECTOR	INCLUDED?	NOTE
Other emission sources (not related to energy consumption)		
Fugitive emissions from production, transformation and distribution of fuels	NO	
Process emissions of industrial plants involved in EU ETS	NO	
Process emissions of industrial plants not involved in EU ETS	NO	
Use of products and fluorinated gases (refrigeration, air conditioning, etc.)	NO	
Agriculture (e.g. enteric fermentation, manure management, rice cultivation, fertilizer application, open burning of agricultural waste)	NO	
Land use, land use change and forestry	NO	This refers to carbon stock changes in for example urban forests.
Wastewater treatment	YES if in SEAP	This refers to emissions not related to energy, such as to CH_4 and N_2O emissions from wastewater treatment. Energy consumption and related emissions from wastewater facilities is included in the category 'buildings, equipment/ facilities'.
Solid waste treatment	YES if in SEAP	This refers to emissions not related to energy, such as CH_4 from landfills. Energy consumption and related emissions from waste treatment facilities are included in the category 'buildings, equipment/facilities'.
Energy production		
Fuel consumption for electricity production	YES if in SEAP	In general, only in the case of plants which are <20 MW_{FUEL}, and are not part of EU ETS. See Section 3.4 for more details.
Fuel consumption for heat/ cold production	YES	Only if heat/cold is supplied as a commodity to final end-users within the territory. See Section 3.5 for more details.

3. Emission factors

3.1 Choice of emission factors: standard (IPCC) or LCA

Two different approaches may be followed when selecting the emission factors:

1. **Using 'Standard' emission factors** in line with the IPCC principles, which cover all the CO_2 emissions that occur due to energy consumption within the territory of the local authority, either directly due to fuel combustion within the local authority or indirectly via fuel combustion associated with electricity and heat/cold usage within their area. The standard emission factors are based on the carbon content of each fuel, like in national greenhouse gas inventories in the context of the UNFCCC and the Kyoto protocol. In this approach, CO_2 is the most important greenhouse gas, and the emissions of CH4 and N_2O do not need to be calculated. Furthermore, the CO_2 emissions from the sustainable use of biomass/biofuels, as well as emissions of certified green electricity, are considered to be zero. The standard emission factors given in these guidelines are based on the IPCC 2006 Guidelines (IPCC, 2006). However, the local authority may decide to use also other emission factors that are in line with the IPCC definitions.

2. **Using LCA (Life Cycle Assessment) emission factors**, which take into consideration the overall life cycle of the energy carrier. This approach includes not only the emissions of the final combustion, but also all emissions of the supply chain. It includes emissions from exploitation, transport and processing (e.g. refinery) steps in addition to the final combustion. This hence includes also emissions that take place outside the location where the fuel is used. In this approach, the GHG emissions from the use of biomass/biofuels, as well as emissions of certified green electricity, are higher than zero. In the case of this approach, other greenhouse gases than CO_2 may play an important role. Therefore, the local authority that decides to use the LCA approach can report emissions as CO_2 equivalent. However, if the methodology/tool used only counts CO_2 emissions, then emissions can be reported as CO_2 (in t).

LCA is an internationally standardised method (ISO 14040 series) and used by a large number of companies and governments, including for Carbon footprinting. LCA is the scientific basis used typically behind e.g. the Thematic Strategies on Natural Resources and Waste, the Ecodesign Directive, and Ecolabel Regulation. On EU level a series of technical guidance documents building on the ISO 14040 series is currently being developed, coordinated by the European Commission's Joint Research Centre (JRC): International Reference Life Cycle Data System (ILCD) Handbook is consulted and coordinated within the EU and also with national LCA projects outside the EU (including China, Japan and Brazil), as well as a range of European business associations. A related ILCD Data Network (JRC et al., 2009) is currently being established (launch foreseen for end of 2009), that would be open for all data providers to give access to consistent and quality-assured LCA data. The network can host cost-free data, licensed data, members-only data, etc.

The LCA emission factors given in these guidelines are based on a European Reference Life Cycle Database (ELCD) (JRC, 2009). The ELCD provides LCA data for most of the fuels and also Member State specific electricity mix data. Both the ELCD and the ILCD data sets work with the IPCC global warming factors for the individual gases.

The advantages of both approaches are summarised in Table 2.

TABLE 2. COMPARISON OF STANDARD AND LCA EMISSION FACTORS

ADVANTAGE	STANDARD	LCA
Is compatible with the national reporting to the UNFCCC	X	
Is compatible with the monitoring of progress towards EU's 20-20-20 target	X	
Is compatible with carbon footprint approaches		X
Is compatible with the Ecodesign Directive (2005/32/EC) and Ecolabel Regulation		X
All emission factors needed easily available	X	
Reflects the total environmental impact also outside the place of use		X
Tools available for local inventories	X	X

After selecting the emission factor approach, the local authority can either use the default emission factors provided in this guidebook or choose other emission factors that are considered more appropriate. The standard emission factors depend on the carbon content of the fuels and therefore do not vary significantly from case to case. In the case of LCA approach, obtaining information on the emissions upstream in the production process may be challenging and considerable differences may occur even for the same type of fuel. This is especially the case of biomass and biofuels. Local authorities using the LCA approach are recommended to consider the applicability of the emission factors presented in these guidelines before using them for BEI/MEI, and to try to obtain case-specific data where appropriate.

The choice of the emission factor is reported in the SEAP template by ticking the appropriate box.

3.2 Greenhouse gases included: CO_2 or CO_2 equivalent emissions

The greenhouse gases to be included in the BEI/MEI depend on the choice of sectors and also on the choice of emission factor approach (standard or LCA).

If the standard emission factors following the IPCC principles are chosen, it is sufficient to report only CO_2 emissions, because the importance of other greenhouse gases is small. In this case, the box 'CO_2 emissions' is ticked in the SEAP template, in point 'emission reporting unit'. However, also other greenhouse gases can be included in the baseline inventory if the standard emission factors are chosen. For example, the local authority may decide to use emission factors that take into account also CH_4 and N_2O emissions from combustion. Furthermore, if the local authority decides to include landfills and/or wastewater treatment in the inventory, then the CH_4 and N_2O emissions will also be included. In this case the emission reporting unit to be chosen is 'CO_2 equivalent emissions'.

In the case of the LCA approach, other greenhouse gases than CO_2 may play an important role. Therefore, a local authority that decides to use the LCA approach will likely include also other GHGs than CO_2 in the inventory, and select the emission reporting unit 'CO_2 equivalent emissions'. However, if the local authority uses a methodology/tool that does not include any other GHGs than CO_2, then the inventory will be based on CO_2 only, and the emission reporting unit 'CO_2 emissions' is chosen.

The emissions of other greenhouse gases than CO_2 are converted to CO_2-equivalents by using the Global Warming Potential (GWP) values. For example, one kg of CH_4 has a similar impact on global warming than 21 kg of CO_2, when considered over a time interval of 100 years, and therefore the GWP value of CH_4 is 21.

In the context of the Covenant of Mayors, it is suggested to apply the GWP values that are used in the reporting to the UNFCCC and the Kyoto Protocol. These GWP values are based on the IPCC's Second Assessment report (IPCC, 1995), and are presented in Table 3.

However, the local authority may decide to use other GWP values of the IPCC, for example depending on the tool they use. The LCA emission factors presented in these guidelines are calculated using the GWP values of the 4th Assessment report of the IPCC (IPCC, 2007).

TABLE 3. CONVERSION OF CH_4 AND N_2O TO CO_2-EQUIVALENT UNITS

MASS OF GHG AS T COMPOUND	MASS OF GHG AS T CO_2-EQUIVALENT
1 t CO_2	1 t CO_2-eq
1 t CH_4	21 t CO_2-eq
1 t N_2O	310 t CO_2-eq

3.3 Fuels and renewable heat

As explained in Section 3.1, the local authority can choose between standard emission factors in line with IPCC principles, or LCA emission factors.

The Standard emission factors following IPCC principles are based on the carbon contents of the fuels. For simplicity, the emission factors presented here assume that all carbon in the fuel forms CO_2. However, in reality a small share of carbon (usually <1 %) in the fuel forms also other compounds such as carbon monoxide (CO) and most of that carbon oxidises to CO_2 later on in the atmosphere.

The LCA emission factors include the actual emissions from all life cycle steps including final combustion, as mentioned earlier. This is of special relevance for biofuels: while the carbon stored in the biofuels themselves may be CO_2 neutral, the cropping and harvesting (fertilisers, tractors, pesticide production) and processing to the final fuel may consume a lot of energy and result in considerable CO_2 releases, as well as N_2O emissions from the field. The various biofuels differ considerably regarding the life cycle GHG emissions, and therefore the LCA approach supports the choice of the most climate-friendly biofuel and other biomass energy carriers.

Box 1 gives additional information on how to deal with biomass or biofuels (4) which are used in the territory of the local authority.

In the case of a biofuel blend, the CO_2 emission factor should reflect the non-renewable carbon content of the fuel. An example of calculation of an emission factor for a biofuel blend is presented in Box 2.

BOX 1. SUSTAINABILITY OF BIOFUELS/BIOMASS

Sustainability of biofuels and biomass is an important consideration in the preparation of the Sustainable Energy Action Plan. In general, biomass/biofuels are a form of renewable energy, the use of which does not have an impact on the CO_2 concentration in the atmosphere. However, this is the case only if biomass/biofuels are produced in a sustainable manner. Two sustainability issues should be taken into consideration when deciding on SEAP measures related to biomass/biofuels, and when accounting for them in BEI/MEI.

1. Sustainability in relation to CO_2 concentration in the atmosphere

Combustion of carbon which is of biogenic origin, for example in wood, biowaste or transportation biofuels, forms CO_2. However, these emissions are not accounted for in the CO_2 emission inventories, if it can be assumed that the carbon released during combustion equals the carbon uptake of the biomass during re-growth within a year. In this case, the standard CO_2 emission factor for biomass/biofuel is equal to zero. This assumption is often valid in the case of crops which are used for biodiesel and bioethanol, and is valid in the case of wood if the forests are managed in a sustainable manner, meaning that on average forest growth is equal to or higher than harvesting. If wood is not harvested in a sustainable manner, then a CO_2 emission factor that is higher than zero has to be applied (see Table 4).

2. Life cycle emissions, biodiversity and other sustainability issues

Even though biofuel/biomass would represent a neutral CO_2 balance, its usage may not be considered as sustainable if its production causes high emissions of other greenhouse gases – such as N_2O from fertilizer use or CO_2 due to land use change – or has an adverse impact on biodiversity, for example.

Therefore, the local authority is recommended to check that the biomass/biofuels used meet certain sustainability criteria. The criteria (a) set in directive 2009/28/EC on the promotion of the use of energy from renewable sources may be used for this purpose. After 5 December 2010 (date by which Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive), only biomass/biofuels that meet these criteria should be considered as renewable in the context of the Covenant of Mayors.

In the case the local authority uses **standard emission factors** and uses biofuel which does not meet sustainability criteria, it is recommended to use an emission factor that is equal to that of the corresponding fossil fuel. For example, if the local authority uses biodiesel which is not produced in a sustainable manner, the emission factor of fossil diesel is to be used. Even though this rule does not follow the conventional emission estimation standards, it is applied to prevent the use of unsustainable biofuels in Covenant cities. If the local authority uses **LCA emission factors**, and uses biofuel which does not meet sustainability criteria, it is recommended to develop an emission factor, which takes into account all the emissions over the entire life cycle of the biofuel.

The emission factors for the fuels which are most commonly used in the territories of the local authorities are presented in the Table 4, based on 2006 IPCC Guidelines and European Reference Life Cycle Database (ELCD) (5). Annex I gives a more complete table of IPCC emission factors. However, the local authority can decide to use other emission factors which are considered appropriate.

(4) *In these guidelines, biofuel refers to all liquid biofuels, including transportation biofuels, vegetable oils and other fuels in liquid phase. Biomass, instead, refers to solid biomass such as wood, biowaste, etc.*

(a) *See article 17 of the directive, paragraphs 1 to 6. In very short: 'The greenhouse gas emission saving from the use of biofuels and bioliquids, [calculated in accordance with Article 19] […] shall be at least 35% […] Biofuels and bioliquids […] shall not be made from raw material obtained from land with high biodiversity value […] from land with high carbon stock […] from land that was peatland in January 2008 […]'. In addition, 'Agricultural raw materials cultivated in the Community and used for the production of biofuels and bioliquids […] shall be obtained in accordance with the requirements and standards […]' of various environmental provisions of European agricultural regulations.*

(5) *The emission factors for fuel combustion are expressed as t/MWh_{fuel}. Therefore, the corresponding activity data to be used must also be expressed as MWh_{fuel}, which corresponds with the Net Calorific Value (NCV) of the fuel.*

TABLE 4. STANDARD CO_2 EMISSION FACTORS (FROM IPCC, 2006) AND CO_2-EQUIVALENT LCA EMISSION FACTORS (FROM ELCD) FOR MOST COMMON FUEL TYPES

TYPE	STANDARD EMISSION FACTOR [t CO_2/MWh]	LCA EMISSION FACTOR [t CO_2-eq/MWh]
Motor Gasoline	0.249	0.299
Gas oil, diesel	0.267	0.305
Residual Fuel Oil	0.279	0.310
Anthracite	0.354	0.393
Other Bituminous Coal	0.341	0.380
Sub-Bituminous Coal	0.346	0.385
Lignite	0.364	0.375
Natural Gas	0.202	0.237
Municipal Wastes (non-biomass fraction)	0.330	0.330
Wood (a)	0 – 0.403	0.002 (b) – 0.405
Plant oil	0 (c)	0.182 (d)
Biodiesel	0 (c)	0.156 (e)
Bioethanol	0 (c)	0.206 (f)
Solar thermal	0	- (g)
Geothermal	0	- (g)

If local authorities prefer to use or develop emission factors that better reflect the properties of the fuels used in the territory, they are welcomed to do so. The choice of emission factor used in the BEI has to be consistent with the choice of the emission factor in the MEI.

BOX 2. HOW TO CALCULATE AN EMISSION FACTOR OF A BIOFUEL BLEND?

A biodiesel blend is used in the city, including 5 % of sustainable biodiesel, and the rest conventional diesel oil. Using the standard emission factors, the emission factor for this blend is calculated as

95 %*0.267 t CO_2/MWh + 5 %*0 t CO_2/MWh = 0.254 t CO_2/MWh

(a) *Lower value if wood is harvested in a sustainable manner, higher if harvesting is unsustainable.*

(b) *The figure reflects the production and local/regional transport of wood, representative for Germany, assuming: spruce log with bark; reforested managed forest; production mix entry to saw mill, at plant; and 44 % water content. The local authority using this emission factor is recommended to check that it is representative for the local circumstances and to develop an own emission factor if the circumstances are different.*

(c) *Zero if the biofuels meet sustainability criteria; fossil fuel emission factors to be used if biofuels are unsustainable.*

(d) *Conservative figure regarding pure plant oil from palm oil. Note that this figure represents the worst ethanol plant oil pathway and does not necessarily represent a typical pathway. This figure does not include the impacts of direct and indirect land use change. Had these been considered, the default value could be as high as 9 t CO_2-eq/MWh, in the case of conversion of forest land in the tropics.*

(e) *Conservative figure regarding biodiesel from palm oil. Note that this figure represents the worst biodiesel pathway and does not necessarily represent a typical pathway. This figure does not include the impacts of direct and indirect land use change. Had these been considered, the default value could be as high as 9 t CO_2-eq/MWh, in the case of conversion of forest land in the tropics.*

(f) *Conservative figure regarding ethanol from wheat. Note that this figure represents the worst ethanol pathway and does not necessarily represent a typical pathway. This figure does not include the impacts of direct and indirect land use change. Had these been considered, the default value could be as high as 9 t CO_2-eq/MWh, in the case of conversion of forest land in the tropics.*

(g) *Data not available, but emissions are assumed to be low (however the emissions from electricity consumption of heat pumps is to be estimated using the emission factors for electricity). Local authorities using these technologies are encouraged to try to obtain such data.*

3.4 Electricity

In order to calculate the CO_2 emissions to be attributed to electricity consumption, it is necessary to determine which emission factor is to be used. The same emission factor will be used for all electricity consumption in the territory, including that in rail transportation. The local emission factor for electricity may take the following components into consideration. The contribution of each of them in the estimation of the local emission factor is explained in more detail in the Sections below:

1. National/European emission factor.
2. Local electricity production.
3. Purchases of certified green electricity by the local authority.

Because the estimation of emissions from electricity is based on electricity consumption, the emission factors are expressed as t/MWhe. Therefore, the corresponding activity data to be used has also to be in the form of MWhe, i.e. in MWh of electricity consumed.

3.4.1 National or European emission factor

Electricity is consumed in the territory of each local authority, but the main units that produce it are only concentrated on the territory of a few of them. These major production units are often large CO_2 emitters (in the case of fossil fuel thermal plants), but their electricity production is not meant to cover only the electricity needs of the municipality on which they are built, but the needs of a larger area. In other words, the electricity that is consumed in a particular municipality generally comes from different plants either inside or outside the municipality. As a consequence, the CO_2 that is emitted due to this electricity consumption actually comes from those various plants. To quantify this for each individual municipality would be a challenging task, as the physical flows of electricity cross the borders and vary depending on several factors. In addition, the municipalities in question usually have no control on the emissions of such plants. For these reasons, and keeping in mind that the focus of the Covenant of Mayors is on the demand (consumption) side, it is recommended to use a national or European emission factor as a starting point to determine the local emission factor. This emission factor reflects the average CO_2 emissions related to the national or European electricity production.

The national and European emission factors fluctuate from year to year due to energy mix used in electricity generation. These fluctuations are caused by the heating/cooling demand, availability of renewable energies, energy market situation, import/export of energy and so on. These fluctuations occur independently of the actions taken by the local authority. Therefore, it is recommended to use the same emission factor in the BEI and in the MEI, because otherwise the result of the emission inventory could be very sensitive to factors on which the local authority has no influence.

The local authority may decide to use either a national or European emission factor. The emission factors for standard and LCA approaches are presented in Table 5 for all the Member States (except Malta and Luxembourg for which the data were not available) and the EU as a whole. The local authority is welcome to search for more up-to-date data. Note that LCA emission factors should in all the cases be higher than standard emission factors. However, due to different data sources used and different years covered by the two sets of emission factors, the standard and LCA emission factors are not necessarily comparable, which is especially visible in the cases of Poland and the Czech Republic.

TABLE 5. NATIONAL AND EUROPEAN EMISSION FACTORS FOR CONSUMED ELECTRICITY

COUNTRY	STANDARD EMISSION FACTOR (t CO_2/MWh_e)	LCA EMISSION FACTOR (t CO_2-eq/MWh_e)
Austria	0.209	0.310
Belgium	0.285	0.402
Germany	0.624	0.706
Denmark	0.461	0.760
Spain	0.440	0.639
Finland	0.216	0.418
France	0.056	0.146
United Kingdom	0.543	0.658
Greece	1.149	1.167
Ireland	0.732	0.870
Italy	0.483	0.708
Netherlands	0.435	0.716
Portugal	0.369	0.750
Sweden	0.023	0.079
Bulgaria	0.819	0.906
Cyprus	0.874	1.019
Czech Republic	0.950	0.802
Estonia	0.908	1.593
Hungary	0.566	0.678
Lithuania	0.153	0.174
Latvia	0.109	0.563
Poland	1.191	1.185
Romania	0.701	1.084
Slovenia	0.557	0.602
Slovakia	0.252	0.353
EU-27	**0.460**	**0.578**

Note that the year which the data represents varies between countries and between standard and LCA approach (6).

(6) *Sources for standard emission factors: Germany:* ***http://www.umweltbundesamt.de/energie/archiv/co2-strommix.pdf (year 2007)****; Denmark: Average of emission factors for Eastern and Western Denmark including distribution loss of 5%.* ***http://www.energinet.dk/en/menu/Climate+and+the+environment/Environmental+impact+statements+for+electricity/Environmental+impact+statements+for+electricity.htm*** *(year 2008); Estonia: personal communication with Estonian Environment Information Centre (year 2007); Portugal: personal communication with Portuguese Agency for the Environment (year 2007); Slovenia: Personal communication with Environmental Agency of the Republic of Slovenia (year 2007); Slovakia: Personal communication with Slovak Hydrometeorological Institute (year 2007); Spain: personal communication with Ministry of Environment, Spain (year 2007); United Kindom: personal communication with Department of Energy and Climate Change (year 2007); other countries and European average: Eurelectric (2005), (available years 2000-2002). Source for LCA emission factors: European Reference Life Cycle Database (ELCD),* ***http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm*** *(year 2002).*

The national or European emission factor for electricity has an acronym NEEFE in the equation in Section 3.4.4. The emission factor chosen is reported in the SEAP template as 'CO_2 emission factor for electricity not produced locally' below Table B.

3.4.2 Local electricity production

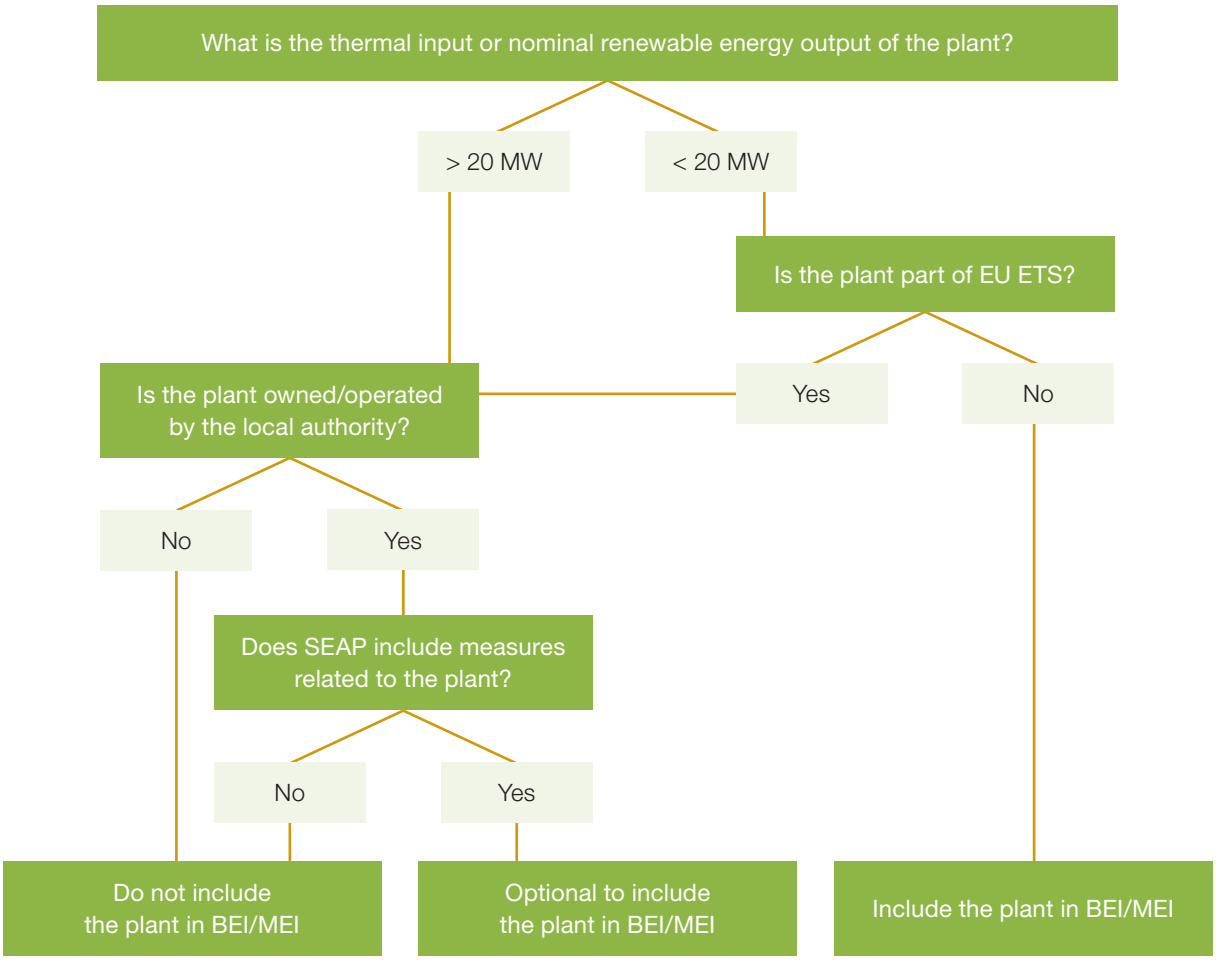
Reducing CO_2 emissions through improvement of energy efficiency and local renewable energy projects is a priority of the Covenant. However, also other actions to reduce CO_2 emissions in the supply side can be accounted for. First, the local authority has to decide whether to include local electricity production in the BEI or not. In case all the SEAP measures are focused on the demand side, inclusion of local electricity production is not needed, and the factors LPE and CO_2LPE in the equation in Section 3.4.4 below are zero.

If the local authority decides to include local electricity production in BEI, all the plants/units that meet the following criteria have to be included:

- the plant/unit is not included in the European Emissions Trading Scheme (ETS);
- the plant/unit is below or equal to 20MW_{fuel} as thermal energy input in the case of fossil fuel and biomass combustion plants (7), or below or equal to 20MW_e as nominal output in the case of other renewable energy plants (e.g. wind or solar).

The criteria above are based on the assumption that smaller plants/units primarily serve the local electricity needs, whereas larger plants primarily produce electricity to the larger grid. Usually the local authority has more control or influence on smaller plants than larger ones whose emissions are controlled by the EU ETS. However, in some cases, also larger plants or units can be included in the BEI/MEI. For example, if a local authority owns utilities or plans to develop and finance large renewable installations like wind farms in its territory, such projects may be incorporated, as long as the priority remains on the demand side (final energy consumption reductions).

BOX 3. DECISION TREE FOR INCLUSION OF LOCAL ELECTRICITY PRODUCTION



(7) *20 MW_{fuel} refers to fuel input of the plant, and corresponds to the EU ETS threshold for combustion installations. The threshold 20 MW_e set for other renewables refers to nominal electricity generation capacity, and is thus higher than the threshold for combustion installations.*

The local authority can use the decision tree of Box 3 to decide, for each of the plants/units located in the territory, whether to include them in BEI/MEI or not.

Based on the decision tree in Box 3, the local authority is recommended to fill in a table including all the electricity generation plants in the territory and determine whether they are to be included in BEI/MEI or not. An example of such a table is given in Box 4.

BOX 4. AN EXAMPLE OF IDENTIFICATION OF LOCAL ELECTRICITY GENERATION FACILITIES

The following electricity generation facilities are located in the territory of the local authority:

1. Wind power park owned by a private company
2. Solar panels on the roof of a building owned by the local authority
3. Solar panels on the roof of a building owned by a private company
4. CHP plant using natural gas
5. Gas turbine plant owned by a private company
6. A group of 3 wind turbines owned by a private company

In order to identify which plants and facilities belong to the scope of BEI/MEI, the local authority has filled in the table below.

LOCAL ELECTRICITY GENERATION IN [NAME OF THE SIGNATORY] IN [INVENTORY YEAR]

PLANT/UNIT	SIZE (THERMAL (FUEL) INPUT)	SIZE (NOMINAL RENEWABLE ELECTRICITY GENERATION CAPACITY)	INCLUDED IN ETS?	PART OF BEI?
a)	-	25 MW_e	NO	NO
b)	-	250 kW_e	NO	YES
c)	-	500 kW_e	NO	YES
d)	200 MW_{fuel}	-	YES	NO
e)	15 MW_{fuel}	-	NO	YES
f)	-	3 MW_e	NO	YES

All plants that are to be included in BEI/MEI, as per above rule, should be listed in Table C of the SEAP template (see Annex II), with corresponding quantity of locally generated electricity, energy inputs, and corresponding CO_2 emissions. For convenience, similar production units may be grouped (for example solar photovoltaic installations (PVs) or combined heat and power plants (CHPs)).

Waste incineration plants that produce electricity are treated similarly to any other power plants. Waste incinerated in plants that do not produce electricity or heat is included in Table A of the SEAP template and the related emissions in Table B.

Further guidance on activity data collection regarding local electricity production is available in Section 4.3.

The emissions from local electricity production (CO2LPE) are estimated, in the case of plants combusting fuel, by using emission factors in Table 4. In the case of the local renewable electricity production (other than biomass/biofuels), the emissions can be estimated by using the emission factors in Table 6.

TABLE 6. EMISSION FACTORS FOR LOCAL RENEWABLE ELECTRICITY PRODUCTION

ELECTRICITY SOURCE	STANDARD EMISSION FACTOR (t CO_2/MWh_e)	LCA EMISSION FACTOR (t CO_2-eq/MWh_e)
Solar PV	0	0.020-0.050 (8)
Windpower	0	0.007 (9)
Hydropower	0	0.024

(8) *Source: Vasilis et al., 2008.*

(9) *Based on results from one plant, operated in coastal areas with good wind conditions.*

3.4.3 Purchases of certified green electricity by the local authority

Instead of purchasing the 'mixed' electricity from the grid, the local authority can decide to purchase certified green electricity. Only electricity that meets the criteria for *guarantee of origin of electricity produced from renewable energy sources* set in the Directive 2001/77/EC and updated in the Directive 2009/28/EC can be sold as green electricity. The local authority will report the amount of purchased green electricity (GEP) under Table A of the SEAP template.

In the case that the standard emission factors are used, the emission factor for certified green electricity is zero. If the LCA emission factors are used, the local authority has to estimate the LCA emissions of the green electricity purchases (CO2GEP) either by requesting required information from the power provider or by using the default factors provided for local renewable electricity generation in Table 6 if they are deemed suitable.

Also other actors in the territory of the local authority may purchase green electricity. However, it may be difficult to obtain data about such purchases. In addition, green electricity purchases reduce greenhouse gas emissions only in the case that electricity production by fossil fuels is actually replaced by production from new renewable electricity installations, due to such purchases, which is not necessarily the case. For these reasons, and also because the focus of the Covenant is on the demand side, the green electricity purchases of other actors (companies, consumers, institutions, etc.) in the territory are not accounted for in the local electricity emission factor.

3.4.4 Calculation of local emission factor for electricity

Based on the information presented in the Sections above, the local emission factor for electricity (EFE) can be calculated by using the equation below (10)

EFE = [(TCE – LPE – GEP) * NEEFE + CO2LPE + CO2GEP] / (TCE)

Where

EFE = local emission factor for electricity [t/MWh$_e$]
TCE = total electricity consumption in the local authority (as per Table A of the SEAP template) [MWh$_e$]
LPE = local electricity production (as per table C of the template) [MWh$_e$]
GEP = green electricity purchases by the local authority (as per Table A) [MWh$_e$]
NEEFE = national or European emission factor for electricity [t/MWh$_e$]
CO2LPE = CO_2 emissions due to the local production of electricity (as per table C of the template) [t]
CO2GEP = CO_2 emissions due to the production of certified green electricity purchased by the local authority [t]

In the exceptional case where the local authority would be a net exporter of electricity, then the calculation formula would be:

EFE = (CO2LPE + CO2GEP) / (LPE + GEP)

These principles and rules allow rewarding the increase in local renewable energy production, or improvements of efficiency in the local energy generation, whilst still keeping the main focus on final energy (demand side).

3.5 Heat/cold

If heat or cold is sold/distributed as a commodity to end users within the territory of the local authority (see table A of the SEAP template), then it is necessary to establish the corresponding emission factor.

First, the local authority has to identify all the plants and units which provide heat/cold as a commodity to end-users in the territory (for example from district heating, or a CHP plant). All such plants should be listed in table D of the SEAP template, with the corresponding quantity of locally generated heat, energy inputs, and corresponding CO_2 emissions. For convenience, similar production units may be grouped (e.g. CHPs).

Waste incineration plants that produce heat to be sold as commodity to the end-users are treated similarly to any other heating plants. Amount of waste incinerated, and the related CO_2 emissions from plants which do not produce electricity of heat, are included in Tables A and B, respectively.

Please note that energy consumption and CO_2 emissions related to heat and cold locally produced by end-users for their own usage are already covered by tables A and B (columns for fossil fuel and renewable energy consumption). In principle, the total amount of heat/cold produced referenced in table D should be equal (or very close) to the quantity of heat/cold consumed and reported in table A, column 'Heat/cold'. Differences may occur due to:

- auto-consumption of heat/cold by the utility producing it;
- transport & distribution losses of heat/cold.

Further guidance on activity data collection regarding heat production is available in Section 4.4.

(10) *This formula neglects transport and distribution losses in the local authority's territory, as well as auto-consumption of energy producers/transformers and tends to double count local renewable production. However, at the scale of the local authority, these approximations will have a minor effect on the local CO_2 balance and the formula may be considered as robust enough to be used in the context of the Covenant of Mayors.*

If a part of the heat/cold that is produced in the territory of the local authority is exported, then the corresponding share of CO_2 emissions should be deducted when calculating the emission factor for heat/cold production (EFH), as indicated in the formula below. In a similar manner, if heat/cold is imported from a plant situated outside the local authority, then the share of CO_2 emissions of this plant that correspond to heat/cold consumed in the territory of the local authority should be accounted for when calculating the emission factor (see formula below).

The following formula may be applied to calculate the emission factor for heat, taking the above mentioned issues into consideration.

EFH = (CO2LPH + CO2IH – CO2EH) / LHC

Where

EFH = emission factor for heat [t/MWh_{heat}]

CO2LPH = CO_2 emissions due to the local production of heat (as per table D of the template) [t]

CO2IH = CO_2 emissions related to any imported heat from outside the territory of the local authority [t]

CO2EH = CO_2 emissions related to any heat that is exported outside of the territory of the local authority [t]

LHC = local heat consumption (as per table A) [MWh_{heat}]

A similar formula may apply for cold.

District cooling, i.e. purchased chilled water, is in principle a similar product as purchased district heating. However, the process to produce district cooling is different from the process to produce district heating, and there is a larger variety of production methods.

If local production of district cooling occurs, or if district cooling is consumed as a commodity by end-users, the local authority is recommended to contact the district cooling provider for information on the use of fuels or electricity to provide cooling. Then the emission factors for fuels and electricity presented in the Sections above can be applied.

3.5.1 Combined heat and power production (CHP)

Part or all of the heat used in the territory of the local authority may be generated in a combined heat and power (CHP) plant. It is essential to divide the emissions of a CHP plant between heat and electricity when filling Tables C and D of the template. This is especially the case when the heat is used locally (input to the BEI), but the electricity is sold to the regional grid (no direct input to BEI).

The fuel use and emissions can be allocated between heat and electricity generation by using the following Equation:

$$CO2_{CHPH} = \frac{\frac{P_{CHPH}}{\eta_h}}{\frac{P_{CHPH}}{\eta_h} + \frac{P_{CHPE}}{\eta_e}} * CO2_{CHPT}$$

$$CO2_{CHPE} = CO2_{CHPT} - CO2_{CHPH}$$

Where

$CO2_{CHPH}$ denotes CO_2 emissions from heat production [t CO_2]

$CO2_{CHPE}$ denotes CO_2 emissions from electricity production [t CO_2]

$CO2_{CHPT}$ denotes total CO_2 emissions of the CHP plant calculated based on fuel consumption and fuel-specific emission factors [t CO_2]

P_{CHPH} denotes the amount of heat produced [MWh_{heat}]

P_{CHPE} denotes the amount of electricity produced [MWh_e]

η_h denotes the typical efficiency of separate heat production. The recommended value to be used is 90 %.

η_e denotes the typical efficiency of separate electricity production. The recommended value to be used is 40 %.

3.6 Other sectors

In the case of other sectors, the emissions of which are not related to fuel combustion, the local authority is recommended to use methodologies developed by specialised organisations.

If the local authority has chosen to use the standard emission factors in line with IPCC principles, it may consider using the methodologies of Local Governments for Sustainability (ICLEI) and Intergovernmental Panel on Climate Change (IPCC).

The ICLEI's International Local Government GHG Emissions Analysis Protocol (IEAP) also includes peer reviewed and approved Specific Country Supplements for certain countries, with country-specific emission factors. Supplements for Italy, Spain and Poland are currently under development. The activity will be extended to other European countries as resources become available.

1. The IEAP and country supplements are available at **www.iclei.org/ghgprotocol**
2. The 2006 IPCC Guidelines are available at **http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html**
3. If the local authority has chosen to use the LCA emission factors, such emission factors for landfills are available from the ELCD database: **http://lca.jrc.ec.europa.eu/lcainfohub/datasetList.vm?topCategory=End-of-life+treatment&subCategory=Landfilling**

4. Activity data collection

4.1 Introduction

The key issues in collecting activity data in the context of the CoM are:

- The data should be relevant to the particular situation of the local authority. For example, estimates based on national averages would not be appropriate, as in the future, they would only reflect trends occurring at national level, and they would not allow taking the specific efforts made by the local authority to reach its CO_2 targets into account.
- The data collection methodology should be consistent through the years: if the methodology changes, this may cause changes in the inventory which are not due to any action of the local authority to reduce its CO_2 emissions. For this reason, it is important to document very clearly the way data are collected and inventories are carried out, so that consistency can be kept in the future years. In the case of methodological changes, recalculation of the BEI may be necessary (see chapter 7).
- The data should cover at least all sectors in which the local authority intends to take action, so that the result of those actions can be reflected in the inventory.
- The sources of data used should be available in the future.
- Within the limits of possibility, the data should be accurate, or at least represent a vision of the reality.
- The collection process and data sources should be well documented and publicly available, so that the BEI elaboration process is made transparent and stakeholders can be confident with the inventory.

4.2 Final energy consumption

Reducing final energy consumption should be considered as a priority in the SEAP. The final energy consumption should be reported in Table A of the template (see annex II).

Final energy consumption is split into 2 main sectors, for both of which data are mandatory:

1. Buildings, equipment/facilities and industry.
2. Transport.

Those sectors are in turn divided into sub-sectors. See Table 1 for the details of the sectors to be covered.

Note: the term 'equipment/facilities' covers all energy consuming entities that are not buildings (e.g. water treatment units). In the case there is a waste incineration plant that does not produce electricity or heat, the fuel (waste) incinerated is included in row 'Municipal buildings, equipment/facilities' in Table A. The renewable fraction (i.e. biomass) is included in the column 'other biomass' and the non-renewable part in the column 'Other fossil fuels'.

Notes about the energy carriers referred to in Table A of the template:

- 'Electricity' refers to the total electricity consumed by end-users, whatever the production source is. If the local authority is purchasing certified green electricity, please complete also the cell below the table. In the LCA approach, also the corresponding emission factor needs to be specified. 'Certified green electricity' means electricity produced from renewable energy sources covered by Guarantee of origins as per Article 5 of Directive 2001/77/EC, Article 15 of Directive 2009/28/EC and Article 3 (6) of Directive 2003/54/EC. Electricity consumption is reported in the table as the amount of electricity consumed by end-user, MWh_e.
- 'Heat/cold' refers to heat/cold that is supplied as a commodity to end-users within the territory (for example from district heating/cooling system, a CHP plant or waste heat recovery). Heating produced by end-users for their own use should not be included here, but under the columns of the energy carriers that produce the heat (fossil fuels or renewable energies). With the exception of CHP heat: as a CHP unit also generates electricity, it is preferable to include it under production (tables C and D), especially if it concerns large units. Heat/cold consumption is reported in the table as the amount of heat/cold consumed by end-user, MWh_{heat}/MWh_{cold}.
- 'Fossil fuels' cover all fossil fuels consumed as a commodity by final end-users. It includes all fossil fuels bought by end-users for space heating, sanitary water heating, or cooking purposes. It also includes fuels consumed for transportation purposes, or as an input in industrial combustion processes (11). Fossil fuel consumption is reported in the table as the amount of fuel consumed by end-user, MWh_{fuel}.
- 'Renewable energies' covers all plant oil, biofuels, other biomass (e.g wood), solar thermal and geothermal energy consumed as a commodity by final end-users. Note: If peat is consumed within the local authority, it should be accounted for in the 'other fossil fuel' column (even if it is not strictly speaking a fossil fuel). Renewable fuel consumption is reported in the table as the amount of fuel consumed by end-user, MWh_{fuel}. Renewable heat consumption is recorded as the amount of heat consumed by the end-user, MWh_{heat}.

(11) *Only if the SEAP includes actions in this sector. However, energy use of industries involved in EU ETS is excluded.*

4.2.1 Buildings, equipment/facilities and industries

1. Municipal buildings and equipment/facilities

In principle, the local authority should be able to collect accurate and comprehensive energy consumption data related to its own buildings and facilities. Well-advanced local authorities already have a full energy accounting system in place. For other local authorities who have not yet initiated such a process, the energy data collection could require the following steps:

- Identify all buildings and facilities owned/managed by the local authority.
- Within those buildings and facilities, identify all energy delivery points (electricity, natural gas, heat from heating district network, fuel oil tanks, …).
- For all those energy delivery points, identify the person/department receiving the invoices and energy data.
- organise a centralised collection of these documents/data.
- Select an appropriate system to store and manage the data (could be a simple Excel sheet or a more elaborate software, available commercially).
- Make sure the data are collected and introduced in the system at least every year. Tele measurement is possible and can ease the process of data collection.

Note that this process of data collection may be the opportunity to deal with other important energy related issues:

- Rationalise the number of energy delivery and invoicing points.
- Renew/improve contractual arrangements with energy suppliers.
- Initiate a real energy management process within the territory of the local authority: identify buildings which consume most energy and select them for priority action, such as daily/weekly/monthly monitoring of energy consumption allowing to identify abnormalities and take immediate corrective action etc (see chapter 8.1 in Part I of this guidebook).

Regarding heating fuel oil or other energy carriers delivered periodically as bulk, it is often preferable to install a measurement device (gauge, metre, …) to help determine exactly the quantity of energy consumed during a given period. An alternative is to assume that the fuel purchased each year is equal to fuel consumed. This is a good assumption if the fuel tanks are filled at the same period each year, or if many deliveries of fuel occur each year.

Renewable heat and cold produced and consumed locally by end-users should be measured and reported separately (columns related to 'Renewable energies' in Table A of the template).

It is important that all fuel supplied for purposes of producing electricity or district heating or cooling are tracked and reported separately as fuel used for electricity or district heating/cooling generation (Tables C and D of the template).

If the local authority buys green electricity of guaranteed origin, this will not affect its energy consumption, but it may be counted as a bonus to improve the CO_2 emission factor (see Section 3.4.3). The quantity of such green electricity has to be derived from the supplier's invoices, which indicate the origin of the electricity. The amount of green electricity purchased has to be reported in Table A of the SEAP template.

2. Municipal public lighting

The local authority should be able to collect all data regarding **Municipal public lighting**. If it is not the case, an identification and data collection process similar to the one indicated in the previous paragraph may have to be initiated. In some cases, it may be necessary to place additional meters, for instance when an electricity supply point feeds both public lighting and building/facilities.

Note: any non-municipal public lighting should be referred in the category 'Tertiary (non municipal) buildings, equipment/facilities'.

3. Other buildings and facilities

This section covers:

- tertiary (non municipal) buildings, equipment/facilities;
- residential buildings;
- industries (optional, excluding industry part of EU Emission trading scheme).

Collecting information from every individual energy consumer within the territory of the local authority is not always possible or practical. Therefore, a variety of approaches are likely to be needed to develop an estimate of energy consumption. Several options are available, and often a combination of them is necessary to have an overall picture of the energy consumption within the territory of the local authority:

1. Get data from the market operators

Since the liberalisation of gas and electricity market, the number of actors has increased, and the data related to energy consumption is becoming commercially sensitive and therefore more difficult to obtain from energy suppliers. Therefore, in order to get the data from them, you have to identify which suppliers are active on the territory of the local authority and prepare a table that they would have to fill.

As several energy suppliers may be active, it may be simpler to contact grid operators (for heat, gas and electricity) whenever possible (it is not very likely that more than one of them is active on the territory of a single municipality, for each energy carrier).

Note that such data are generally considered as commercially sensitive and that in the best case you will probably be able to get only aggregated data. Ideally, a disaggregation between the residential, services and industry sectors, for the different energy carriers (electricity, natural gas…) for all the postal code(s) that relate to your municipality should be obtained.

If a greater level of disaggregation is available, then do not hesitate to ask for it (e.g. you should distinguish between the various sub-sectors for services and industry, and ask whether for private or public, individual houses or apartments…). If the NACE code (statistical classification of economic activities in the European Community) (12) is available, this could help to classify the energy consumption in the appropriate sector. However, the NACE code may be misleading: offices of an industrial company will be classified as industrial, whereas they rather belong to the tertiary sector (they do not correspond to an actual industrial activity in the local authority's territory). Some fine-tuning or questionnaires may be necessary to solve this question.

Other interesting information relates to the names and addresses of the largest energy consumers within the territory of the local authority, and their overall energy consumption (individual energy consumption is not likely to be available as it would be commercially too sensitive). This may be useful for targeted actions and questionnaires (see further).

2. Get data from other entities

Energy suppliers and grid operators may be reluctant to provide consumption data to the local authority (for reasons related to confidentiality, commercial secrecy, and administrative burden especially in the case where many local authorities would ask similar data from the same operators).

However, valuable data may be available at regional or national level (from statistical, energy, environmental, or economic ministries or agencies, supporting structures of the Covenant of Mayors, or from regulatory authorities for gas and electricity).

In addition, energy market operators have the obligation to 'provide on request, but not more than once a year, aggregated statistical information on their final customers' to an agency assigned by the Government (Directive 2006/32/EC on energy end-use efficiency and energy services, article 6). Thus the data should be available somewhere and you should contact the energy ministry of your country to know what data are available from this channel and how to obtain it.

3. Inquiries addressed to energy consumers

If all data cannot be obtained in the desired format from the market operators or from other entities, it may be necessary to make some inquiries directly to the energy consumers, in order to obtain the missing data.

This is especially the case for energy carriers which do not pass through a centralised grid (fuel oil, wood, natural gas supplied in bulk, etc). If it is not possible to identify all suppliers active in the territory of the local authority and to get data from them, it may be necessary to ask the consumers themselves.

It is worth bearing in mind that energy or statistical agencies may already be collecting such data, so make sure that data are not available elsewhere before considering sending a questionnaire.
Several options are possible:

- For sectors where there is a large number of small consumers (like the residential sector), we recommend addressing a questionnaire to a representative sample of the population (for example 1 000 households), spread over all districts of the local authority. The questionnaire may be on-line, but in this case make sure that this does not prevent some categories of customers from providing data, otherwise the results will be biased.
- For sectors where the number of players is limited, it may be worthwhile addressing the questionnaire to all energy consumers (this may be the case for example for the industrial sector).
- For sectors where there is a great number of players, but where there are some large ones (e.g. tertiary sector), it may be worthwhile making sure to address the questionnaire at least to all large players (e.g. all supermarkets, hospitals, universities, housing companies, large office buildings, etc). Their identification can be done through knowledge, statistical or commercial data (such as telephone directories) inquiry to the grid operator (ask who are the 1 000 largest electricity/gas consumers in the territory of the local authority). Another option to identify large electricity consumers is to ask grid operators the identity of all consumers connected to the middle and high voltage distribution networks (or even to the transmission network in some extreme cases).

(12) *See REGULATION (EC) No 1893/2006 of 20 December 2006 establishing the statistical classification of economic activities NACE Revision 2 and amending Council Regulation (EEC) No 3037/90 as well as certain EC Regulations on specific statistical domains.*

What to ask?

It may be tempting to ask a lot of questions in the questionnaire (e.g. is your building insulated, do you have solar panels, have you recently done energy efficiency improvements, do you have air conditioning, etc.?). However, it should be kept in mind that it is very important to keep the questionnaire simple and short (ideally not more than 1 page), in order to obtain a satisfactory rate of answers. Besides the type and quantity of energy consumed and eventual local energy production (renewable, CHP…), we recommend to ask at least 1 or 2 questions related to variables that can explain the energy consumption (for comparison or extrapolation purposes), for example floor space (m^2) of a building, and/or number of inhabitants, or number of pupils in a school, etc. For industry or services, ask the branch they belong to (propose some categories, if possible). For the residential sector, it is useful to ask questions that would allow extrapolation of the collected data. This depends on what kind of statistical information is available at the municipal level. It could be for example: household size (number of occupants), class of revenue, location (postal code and/or rural/urban area), dwelling type (detached house, semi-detached house, apartment), size of the dwelling (m^2), etc.

Tips:

- Make sure the questions are clear and precise so that they will be understood by all in the same manner. Provide some short instructions if necessary.
- To increase the amount and quality of answers, inform clearly about the purpose of the questionnaire (energy statistics and not tax purpose for example). Motivate people to answer (for example, inform that the questionnaire allows to measure progress in reaching the CO_2 reduction objectives of the local authority, or provide any other incentive you find relevant).
- Make the inquiries anonymous (especially in the residential sector) and explain that the data will be kept confidential.
- Do not hesitate to send reminders to those who do not reply on time, in order to increase the rate of answers; and to call directly the largest energy consumers to make sure they reply.
- Make sure that the collected data sample is representative of the population. You should be aware that the response rate is generally low and those who respond are generally the most educated and climate-aware, and therefore there is the risk that the data collected is strongly biased, even if the questionnaire was addressed to a representative sample of the population. To avoid this, it may be advisable to organise data collection via face-to-face or phone interviews, especially in the residential sector.
- Decide in advance what you want to do with the data collected, to make sure that you really ask the useful and necessary questions.
- Do not hesitate to get the help of specialists (statisticians) to design your inquiry.
- It is advisable to communicate in advance your aims (SEAP development) through the local media, explaining the context and expected benefits for your local community.

What to do with the data?

Generally speaking, data collected via inquiries should help you to construct the energy and CO_2 data related to the territory of the local authority. Here are a few examples of possible usages:

- Aggregated data should be broken down into sectors and sub-sectors, in order to target your actions and measure the results achieved by different target groups.
- Extrapolate some ratios obtained from the sample to the overall energy consumption. For example if you know the overall energy and gas consumption of a given sector, but you do not know its heating fuel oil consumption, you could extrapolate the electricity/fuel oil ratio or natural gas/fuel oil ratio of your sample to the whole population, provided your sample is representative.

4. Making estimates

From data collected via a sample of the population (see above), you could estimate the overall consumption. For example, from the sample data you could calculate the energy consumption per square metre or per inhabitant in the household sector for different types of buildings and different classes of revenues, and extrapolate to the entire sector using statistical data related to the territory of the local authority.

Ideally, this kind of exercise should be done with the help of statisticians to make sure the data collected and method of extrapolation provide results that are statistically meaningful.

In addition, checks should be carried out to make sure that the overall results are compatible with the data available at a more aggregate level.

Notes

- If energy consumption data cannot be disaggregated between individual sectors (i.e. residential, services and industry), then report the total consumption in the template and do not fill in the data at the sector level.
- If the data collected do not allow the possibility to distinguish the municipal consumption from other usages, then there is a risk of double counting. To avoid this, subtract the municipal usage (calculated separately, see above) from the overall energy consumption of each sector and report each of them in the relevant section of the template.

4.2.2 Road transportation

Road transportation in the territory of the local authority can be divided into two parts:

1. Urban road transportation, which includes road transportation on the local street network that is usually in the competence of the local authority. The inclusion of this sector in the BEI is strongly recommended.
2. Other road transportation, which includes road transportation in the territory of the local authority on the roads that are not in the competence of the local authority. An example of such road transportation is transportation on a highway that goes through the territory of the local authority. These emissions can be included in the BEI if the local authority intends to include measures to reduce these emissions in the SEAP.

The same methods can be used to estimate emissions of both urban and other road transportation.

The activity data for the road transportation sector is the amount of fuel consumed in the territory. Usually the amount of fuel used is not equal to the amount of fuel sold (see Box 5). Therefore, the estimate of the fuel used has to be based on estimates of:

- mileage driven in the territory of the local authority [km];
- vehicle fleet in the territory of the local authority (cars, buses, two-wheelers, heavy and light-duty vehicles);
- average fuel consumption of each vehicle type [l fuel/km].

BOX 5. USE OF FUEL SALES DATA TO ESTIMATE EMISSIONS FROM TRANSPORTATION

The local authority may consider that it is easier to collect data on local fuel sales than to estimate fuel use based on estimates of mileage driven. The study of Kennedy et al. (2009) concluded, that use of fuel sales data is appropriate for cities for which the number of vehicle trips over the border of the city is small relative to the number of trips within the city. They compared the results of using fuel sales data, scaling down from wider regions, and estimating emissions based on mileage for three megacities: Toronto, New York City and Bangkok, and concluded that the differences between the methods may be less than 5 %.

However, fuel sold in the territory of the local authority may not in all the cases correctly reflect the fuel used in the territory. The amount of fuel sold and fuel consumed may be different for various reasons (comfort of fuelling, availability of filling stations, prices etc). This is the case especially for smaller cities in which the number of filling stations is small. In addition, the factors having an impact on fuel sales may change in time (for example opening/closing of filling stations) and therefore the changes in fuel sales data may not correctly reflect the changes in traffic (fuel use).

The EMEP/EEA Guidebook (2009) and the 2006 IPCC Guidelines provide detailed guidance on the estimation of activity data for the road transportation sector. Even though the focus of these guidelines is on the national level, the information can be useful also to understand the principles for calculation of emissions at local level.

Mileage driven

The mileage driven on the street network of the local authority can be estimated based on information on traffic flows and length of the street network. As the first step, the local authority is recommended to search for information from one of the potential data sources listed below.

- The transport department of the local authority may have estimated vehicle flows and mileage driven for transport planning purposes.
- National or local street administration often carries out sample surveys, either automatic or manual. In these surveys, the numbers of vehicles passing fixed points are counted. Some surveys count vehicle numbers by type of vehicle, but information on the fuel (e.g. diesel or gasoline) is usually not available.
- Household transport surveys (origin and destination surveys).
- Mobility in cities database contains information on transportation in selected cities for the year 2001. The data are not available free of charge, but can be purchased at
  http://www.uitp.org/publications/index2.cfm?id=5#MCDBIS

In the case of the local authority's own fleet and public transportation fleet the mileage driven can be estimated using the information in the odometers of the vehicles. However, attention has to be paid to the fact that the BEI/MEI should consider only mileage driven in the territory of the local authority.

In the case of contracted services for public transport or other services, the information should be available from the operator.

The local authority may find it difficult to collect mileage data. However, data collection is of great importance, because without such information the actual impact of the measures taken cannot be estimated.

Vehicle fleet distribution

The vehicle fleet distribution indicates the share of each vehicle type of the mileage. At minimum, the fleet distribution should distinguish between:

- passenger cars and taxis;
- heavy and light-duty vehicles;
- buses and other vehicles used for public transport services;
- two-wheelers.

The fleet distribution can be estimated based on one of the following sources:

- traffic counts as discussed above;
- vehicles registered in the municipality;
- national statistics;
- Eurostat statistics at national or regional level.

Use of any of the data sources above should be accompanied with a consideration on whether it represents an appropriate estimate of the distribution of mileage driven in the territory of the local authority. The data can be adjusted to better suit to the local authority's territory if needed. For instance, the share of mileage driven in a city by heavy-duty vehicles may be lower than the share of heavy duty vehicles registered at national level.

Some of the existing tools for local emission inventories may include default fleet distributions for different regions. These can be used if they are considered appropriate by the local authority.

Average fuel consumption per km

Average fuel consumption of each vehicle category depends on the types of vehicles in the category, their age and also on a number of other factors, such as the driving cycle. The local authority is recommended to estimate average fuel consumption of vehicles driving on the street network based on polls, information from inspection agencies or information on vehicles registered in the municipality or in the region. Auto clubs and national transport associations are also sources of useful information.

Use of national level average fuel consumption for each vehicle category may produce biased estimates, in particular for urban areas. This might occur especially in countries with a dense motorway network linking cities and where a high number of rural trips are made, as the figures for fuel consumption would not be representative for urban areas.

Especially if the local authority is planning measures to reduce the average fuel consumption of vehicles, for instance by promoting the use of electric or hybrid vehicles, it is recommended not to use national or European average fuel consumption figures, but to make a more detailed estimate (as explained above) including hybrid and electric cars separately. This is because if averages are used, the reduction in fuel consumption due to measures will not be visible when comparing the BEI and MEI.

Calculation of activity data

The activity data for each fuel and vehicle type will be calculated by the following equation:

Fuel used in road transportation [kWh] = mileage [km] x average consumption [l/km] x conversion factor [kWh/l]

The most typical conversion factors are presented in Table 7. A full list of conversion factors (net calorific values) is presented in Annex I. An example of the use of the Equation is given in Box 6.

TABLE 7. CONVERSION FACTORS FOR THE MOST TYPICAL TRANSPORTATION FUELS (EMEP/EEA 2009; IPCC, 2006)

FUEL	CONVERSION FACTOR (KWH/L)
Gasoline	9.2
Diesel	10.0

BOX 6. EXAMPLE OF CALCULATION OF ACTIVITY DATA FOR ROAD TRANSPORTATION

	PASSENGER CARS	LIGHT DUTY VEHICLES	HEAVY DUTY VEHICLES	BUSSES	TWO WHEELERS	TOTAL
Mileage (million km) from activity data collection						
Total						**2100**
Fleet distribution from activity data collection (as % of mileage)						
Total mileage	**80 %**	**10 %**	**2 %**	**4 %**	**4 %**	**100 %**
Gasoline	50 %	3 %			4 %	57 %
Diesel	30 %	7 %	2 %	4 %		43 %
Average fuel consumption from activity data collection (l/km)						
Gasoline	**0.096**	**0.130**			**0.040**	
Diesel	**0.069**	**0.098**	**0.298**	**0.292**		
Calculated mileage (million km)						
Gasoline	1 050	63			84	1 197
Diesel	630	147	42	84		903
Calculated consumption (million l fuel)						
Gasoline	100.8	8.19	0	0	3.36	
Diesel	43.47	14.406	12.516	24.528	0	
Calculated consumption (GWh)						
Gasoline	927	75	0	0	31	1 034
Diesel	435	144	125	245	0	949

Share of biofuels

If the local authority plans to promote the use of biofuels, produced in a sustainable manner, in the SEAP, it is important to estimate the share of biofuels in the fuel used in the territory of the local authority. This can be done, for instance, by making polls to the most important fuel distributors in the territory of the local authority and surrounding areas.

In the case of the use of biofuels in the municipal fleet (beyond the average use in the territory), the local authority is likely to have access to the amount of biofuel consumed, especially if special filling stations are used for municipal fleet.

If the local authority does not intend to promote biofuels in the SEAP, a national average share of biofuels can be used. This information can be found from the reports of the Member States on the promotion of the use of biofuels or other renewable fuels for transport. The reports are available at:
http://ec.europa.eu/energy/renewables/biofuels/ms_reports_dir_2003_30_en.htm

4.2.3 Rail transportation

Rail transportation in the territory of the local authority can be divided into two parts:

1. Urban rail transportation, for example tram, metro and local trains. The inclusion of this sector in the BEI is strongly recommended.
2. Other rail transportation, which covers the long-distance, intercity and regional rail transportation that occurs in the territory of the local authority. Other rail transportation does not only serve the territory of the local authority, but a larger area. Other rail transportation includes also freight transport. These emissions can be included in the BEI if the local authority has included measures to reduce these emissions in the SEAP.

The same methods can be used to estimate emissions of both urban and other rail transportation.

There are two types of activity data for rail transportation: consumption of electricity and consumption of fuel in diesel locomotives. Use of diesel locomotives in urban rail transportation is less common for local services.

Number of providers of rail transport in the territory of the local authority is usually low. The local authority is recommended to ask the annual electricity and fuel use data directly from the service providers. If such data are not available, the local authority can estimate the emissions based on mileage travelled and average electricity or fuel consumption.

4.3 Local electricity production (if applicable)

Identification of local electricity production plants that are included in the BEI is explained in Section 3.4.2.

For larger plants (such as CHPs), the data should be obtained via direct contact with the plant managers. For smaller units (domestic PV installations), the data can either be obtained through questionnaires or derived from statistics related to the amount of installations present in the territory of the local authority: number of permits delivered if such installations require a permit, number of subsidies granted or regional/national statistics with a sufficient level of disaggregation.

Market operators may also have data about entities that provide electricity to the grid and may help to identify them.

All plants that are to be included in BEI/MEI should be listed in Table C of the SEAP template (see Annex II), with corresponding quantity of locally generated electricity, energy inputs, and corresponding CO_2 emissions. Make sure that all energy used as an input for plants listed here is excluded from fuel consumption in Table A, in order to avoid double counting.

4.4 Local heat/cold production

Identification of local heat/cold production plants that are included in the BEI is explained in Section 3.5.

The data should be obtained via direct contact (or questionnaires) with the plant managers, as mostly large units will be listed here. All plants that are to be included in BEI/MEI should be listed in Table D of the SEAP template (see Annex II), with the corresponding quantity of generated heat/cold, energy inputs, and corresponding CO_2 emissions. Make sure that all energy used as an input for plants listed here is excluded from fuel consumption in Table A.

Note: the case of micro cogeneration

Micro cogeneration units may be too small, too numerous and scattered to obtain individual data about them. In such a case, the energy input of those units should be reported in Table A as final energy consumption, and consequently the heat and electricity produced should not be reported in Tables C and D. In addition, the electricity produced should not be accounted for as electricity consumption in Table A.

On the contrary, if data are available (for example via support schemes, sales data from suppliers), then micro cogeneration units could be reported in Tables C and D, with the energy input and heat/electricity production data.

4.5 Other sectors

In the case of other sectors, the emissions of which are not related to fuel combustion, the local authority is recommended to use methodologies developed by specialised organisations. The local authority may consider using the methodologies of Local Governments for Sustainability (ICLEI) or Intergovernmental Panel on Climate Change (IPCC).

The ICLEI's International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP) is available at **www.iclei.org/ghgprotocol**

The 2006 IPCC Guidelines are available at **http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html**

5. Reporting and documentation

5.1 Reporting of BEI/MEI

The Covenant Signatories commit themselves to submitting their SEAP, including the BEI within the year following signing up to the Covenant of Mayors.

Furthermore, the Signatories are committed to submit an implementation report at least every second year after the submission of the SEAP for evaluation, monitoring and verification purposes. The monitoring emission inventory (MEI) is a recommended part of such an implementation report.

The local authority is encouraged to compile emission inventories on an annual basis. The advantages are:

- closer monitoring and better understanding of the various factors that influence the CO_2 emissions;
- annual input to policy-making, allowing quicker reactions;
- the specific expertise necessary for inventories can be maintained and consolidated.

However, if the local authority considers that such regular inventories put too much pressure on human or financial resources, it may decide to carry out the inventories at larger intervals. The Signatories are committed to submit an implementation report at least every second year. Consequently, an MEI should be included in at least every second implementation report. This means that an MEI is carried out and reported at least every fourth year.

The Baseline Emission Inventory will be documented by using Tables A-D in the SEAP template. The SEAP template also includes instructions on how the BEI data should be filled in.

In addition to filling in the Tables A-D in SEAP template, the local authority is encouraged to make an inventory report for each inventory. It is recommended to include the following information in the inventory report:

- information about the geographical boundaries of the local authority;
- choice of emission factor approach (standard or LCA);
- emission reporting unit (CO_2 or CO_2-equivalent);
- choices made regarding inclusion of voluntary sectors and sources;
- identification of local electricity generation plants;
- identification of local heat/cold plants;
- information on data collection methods;
- emission factors used and their sources;
- assumptions made;
- references used;
- information on any changes related to approach/methodology/data sources etc since the previous inventory;
- eventual comments that would help to understand and interpret the inventory. For example, it may be useful to provide exploitations on which factors have influenced CO_2 emissions since last inventories, such as economic conditions or demographic factors;
- names and contact information of people who provided information for the inventory.

It is in the interest of the local authority to document the inventory and to archive the files, for example spreadsheets used for the compilation of BEI. This will facilitate the compilation of the MEI in the following years.

5.2 *Per capita* target

The local authority can decide to set the overall CO_2 emission reduction target either as 'absolute reduction' or '*per capita* reduction'. The local authority is recommended to report on the choice in the inventory report.

Despite the choice, the emissions in BEI are first calculated as absolute emissions. In case the '*per capita* reduction' is chosen, the emissions of the baseline year are divided by the number of inhabitants in the same year, and these 'emissions *per capita* in the baseline year' are used as a basis for calculation of the target.

In case the '*per capita*' approach is chosen, the local authority is recommended to report the results of the BEI/MEI both as absolute emissions and *per capita*. In the SEAP template the emissions are reported as absolute emissions with no correction for population.

5.3 Temperature correction

The local authority may choose to use temperature correction for emissions from space heating when reporting the emissions and monitoring the progress towards target. Temperature corrected emissions can be calculated using the following equation:

$$LHC\_TC = LHC * HDD_{AVG} / HDD$$

LHC_TC =	temperature corrected heat consumption in year x [MWh_{heat}]
LHC =	actual heat consumption in the year x [MWh_{heat}]
HDD_{AVG} =	heating degree days in an average year (defined over a certain time period) [K • d]
HDD =	heating degree days in the year x [K • d]

Heating degree days (HDD) denote the heating demand in a specific year. HDD is derived from daily temperature observations, and defined relative to a base temperature – the outside temperature above which a building needs no heating. For each day, during which the temperature is below the base temperature, the HDD is the difference of the base temperature and actual temperature. See Box 7 for an example.

In some Member States, meteorological offices provide HDD data for different parts of the country. HDD_{AVG} denotes a long-term average of heating degree days, which may also be available from the meteorological office. If a long-term average is not available, the local authority may keep the BEI emissions uncorrected, and correct the emissions in MEI using the HDD of baseline year instead of average.

Similar approach can also be used to correct the emissions from cooling based on cooling demand.

BOX 7. CALCULATION OF HEATING DEGREE DAYS (HDD)

Heating of buildings in the territory of local authority usually begins when the outside temperature is less than 15 degrees Celsius. The local authority collects the data for each of the days of the year in the table below, and as a sum of the results, the local authority gets the annual HDD.

DAY	TEMPERATURE	DIFFERENCE TO BASE TEMPERATURE (WHEN SMALLER THAN BASE TEMPERATURE)	HDD_DAY
Day 1	12	3	3
Day 2	9	6	6
Day 3	5	10	10
Day 4	-2	17	17
…	…	…	…
…	…	…	…
Day 365	17	0	0
HDD (total of the year)			700

6. Use of existing tools and more advanced methodologies

There are a number of tools available for compilation of local emission inventories. The tools are offered by, for instance, local authorities' networks, such as Climate Alliance and ICLEI. The report 'Existing methodologies and tools for the development and implementation of SEAPs' (13) gives an overview of the most commonly used methodologies and their suitability for the compilation of BEI.

As explained in the report, none of the existing tools match completely the recommended criteria specified here for BEI/MEI. The largest differences occur in the selection of scope and sectors, especially in relation to inclusion of local energy production. In the case of transportation, many tools are in line with the specifications of BEI/MEI.

The local authority is free to choose any methodology or tool that it considers suitable for the compilation of BEI/MEI. However, the local authority is recommended to ensure that the results of the inventory are in line with the specifications given for BEI/MEI in these guidelines and in the SEAP template and accompanied instructions.

The local authority is welcome to use more advanced methods than those described in these guidelines, if the method is in line with the present specifications for BEI/MEI.

(13) *Available at* ***http://re.jrc.ec.europa.eu/energyefficiency/pdf/CoM/Methodologies_and_tools_for_the_development_of_SEAP.pdf***

7. Recalculations

In general, once the BEI is completed, there is no need to change the numbers later on. By using similar methods also in the MEI, the local authority can ensure that the results are consistent, and thus the difference between MEI and BEI correctly reflects the changes of emissions between the baseline year and the monitoring year. However, there are a few occasions when recalculation of BEI is needed to ensure consistency between the emission estimates of BEI and MEI. Examples of such occasions are:

- industry delocalisation;
- new information on emission factors;
- methodological changes;
- changes in the local authority's boundaries.

Emission reductions due to industry delocalisation are explicitly excluded from the Covenant of Mayors. In these guidelines, industry delocalisation means a full and permanent closure of an industrial plant, the emissions of which represented more than 1 % of the baseline emissions. An example of recalculation due to industry delocalisation is presented in Box 8.

Recalculation due to new information on emission factors or methodological changes has to be carried out only in the case that the new information reflects the situation in the baseline year more accurately than the information used in compilation of BEI (see Box 9). If real changes in emission factors have occurred between the baseline year and the monitoring year – for instance due to the use of different fuel types – then different emission factors will correctly reflect the changed circumstances, and recalculation is not needed (14).

BOX 8. RECALCULATION DUE TO INDUSTRY DELOCALIZATION

The local authority decided to include emissions from industrial plants not included in EU ETS in the BEI, because the SEAP included measures to improve energy efficiency in the plants. However, one of the plants (Plant A), the emissions of which were 45 kt CO_2 in the baseline year (1.4 % of the baseline emissions), closed down before the monitoring year. Inclusion of this emission source in BEI but excluding it from MEI would mean that the local authority would gain benefit due to industry delocalisation. Therefore, the local authority has to recalculate the baseline year emissions so that the emissions of Plant A are excluded.

THE BEI OF THE LOCAL AUTHORITY, AS REPORTED IN SEAP WAS AS FOLLOWS

CATEGORY	CO_2 EMISSIONS (kt)
Residential buildings	2 000
…	…
Industries (excluding industry part of EU Emission trading scheme)	70
Subtotal buildings, facilities and industry	**2 735**
…	
Subtotal transport	**500**
Total	**3 235**

IN THE RECALCULATED BEI INVENTORY, THE EMISSIONS OF PLANT A HAVE BEEN REMOVED AND THE INVENTORY IS AS FOLLOWS

CATEGORY	CO_2 EMISSIONS (kt)
Residential buildings	2 000
…	…
Industries (excluding industry part of EU Emission trading scheme)	25
Subtotal buildings, facilities and industry	**2 690**
…	
Subtotal transport	**500**
Total	**3 190**

(14) *Extensive guidance for recalculation is given in the chapter 'Time series consistency' of IPCC (2006), available at* ***http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_5_Ch5_Timeseries.pdf***

BOX 9. RECALCULATION DUE TO NEW INFORMATION ON THE EMISSION FACTOR

The local authority had used the standard emission factor provided in Table 4 to estimate the base year emissions from coal combustion in a local district heating plant. The emission factor was 0.341 t CO_2/MWh. In the monitoring year, the local authority asked the coal provider to give information on the carbon content and thus the emission factor, of the coal type provided. The coal provider informed the local authority that the emission factor of that coal type is 0.335 t CO_2/MWh, and that the same coal type has been provided to the city since many years.

If the local authority started to use the new emission factor only since the MEI, it would gain benefit, as estimated emissions would be lower than in BEI even if the same amount of fuel would be used. Therefore, the local authority has to recalculate the BEI using the same emission factor that will be used in the MEI.

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ANNEX I
Conversion factor and IPCC emission factor tables

TABLE A. BASIC CONVERSION FACTORS				
FROM (MULTIPLY BY)	TO			
	TJ	Mtoe	GWh	MWh
TJ	1	2.388×10^{-5}	0.2778	277.8
Mtoe	4.1868×10^{4}	1	11 630	11 630 000
GWh	3.6	8.6×10^{-5}	1	1 000
MWh	0.0036	8.6×10^{-8}	0.001	1

A unit converter is available at the website of the International Energy Agency (IEA): ***http://www.iea.org/stats/unit.asp***

TABLE B. CONVERSION OF FUELS FROM MASS TO ENERGY UNITS (IPCC, 2006)		
FUEL TYPE	NET CALORIFIC VALUE (TJ/Gg)	NET CALORIFIC VALUE (MWh/t)
Crude Oil	42.3	11.8
Orimulsion	27.5	7.6
Natural Gas Liquids	44.2	12.3
Motor Gasoline	44.3	12.3
Aviation Gasoline	44.3	12.3
Jet Gasoline	44.3	12.3
Jet Kerosene	44.1	12.3
Other Kerosene	43.8	12.2
Shale Oil	38.1	10.6
Gas/Diesel Oil	43.0	11.9
Residual Fuel Oil	40.4	11.2
Liquefied Petroleum Gases	47.3	13.1
Ethane	46.4	12.9
Naphtha	44.5	12.4
Bitumen	40.2	11.2
Lubricants	40.2	11.2
Petroleum Coke	32.5	9.0
Refinery Feedstocks	43.0	11.9
Refinery Gas 2	49.5	13.8
Paraffin Waxes	40.2	11.2
White Spirit and SBP	40.2	11.2
Other Petroleum Products	40.2	11.2
Anthracite	26.7	7.4
Coking Coal	28.2	7.8
Other Bituminous Coal	25.8	7.2
Sub-Bituminous Coal	18.9	5.3
Lignite	11.9	3.3
Oil Shale and Tar Sands	8.9	2.5
Brown Coal Briquettes	20.7	5.8
Patent Fuel	20.7	5.8
Coke Oven Coke and Lignite Coke	28.2	7.8
Gas Coke	28.2	7.8
Coal Tar	28.0	7.8
Gas Works Gas	38.7	10.8
Coke Oven Gas	38.7	10.8
Blast Furnace Gas	2.47	0.7
Oxygen Steel Furnace Gas	7.06	2.0
Natural Gas	48.0	13.3
Municipal Wastes (non-biomass fraction)	10.0	2.8
Waste Oil	40.2	11.2
Peat	9.76	2.7

TABLE C. CO_2 EMISSION FACTORS FOR FUELS (IPCC, 2006)		
FUEL TYPE	CO_2 EMISSION FACTOR (Kg/ TJ)	CO_2 EMISSION FACTOR (t/MWh)
Crude Oil	73300	0.264
Orimulsion	77000	0.277
Natural Gas Liquids	64200	0.231
Motor Gasoline	69300	0.249
Aviation Gasoline	70000	0.252
Jet Gasoline	70000	0.252
Jet Kerosene	71500	0.257
Other Kerosene	71900	0.259
Shale Oil	73300	0.264
Gas oil/diesel	74100	0.267
Residual Fuel Oil	77400	0.279
Liquefied Petroleum Gases	63100	0.227
Ethane	61600	0.222
Naphtha	73300	0.264
Bitumen	80700	0.291
Lubricants	73300	0.264
Petroleum Coke	97500	0.351
Refinery Feedstocks	73300	0.264
Refinery Gas	57600	0.207
Paraffin Waxes	73300	0.264
White Spirit & SBP	73300	0.264
Other Petroleum Products	73300	0.264
Anthracite	98300	0.354
Coking Coal	94600	0.341
Other Bituminous Coal	94600	0.341
Sub-Bituminous Coal	96100	0.346
Lignite	101000	0.364
Oil Shale and Tar Sands	107000	0.385
Brown Coal Briquettes	97500	0.351
Patent Fuel	97500	0.351
Coke oven coke and lignite Coke	107000	0.385
Gas Coke	107000	0.385
Coal Tar	80700	0.291
Gas Works Gas	44400	0.160
Coke Oven Gas	44400	0.160
Blast Furnace Gas	260000	0.936
Oxygen Steel Furnace Gas	182000	0.655
Natural Gas	56100	0.202
Municipal Wastes (non-biomass fraction)	91700	0.330
Industrial Wastes	143000	0.515
Waste Oil	73300	0.264
Peat	106000	0.382

ANNEX II
SEAT template tables for baseline emission inventory

Baseline emission inventory

1. Baseline year

For Covenant signatories who calculate their CO_2 emissions *per capita*, please precise here the number of inhabitants during the Baseline year:

2. Emission factors

Please tick the corresponding box:

- ☐ Standard emission factors in the line with the IPCC principles
- ☐ LAC (Life Cycle Assessment) factors

Emission reporting unit

Please tick the corresponding box:

- ☐ CO_2 emissions
- ☐ CO_2 equivalent emissions

3. Key results of the Baseline Emission Inventory

Compulsory fields

A. FINAL ENERGY CONSUMPTION (MWh)																
CATEGORY	ELEC-TRICITY	HEAT/ COLD	FOSSIL FUELS								RENEWABLE ENERGIES					TOTAL
			Natural gas	Liquid gas	Heating oil	Diesel	Gaso-line	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geo-thermal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																
Municipal buildings, equipment/facilities																
Tertiary (non municipal) buildings, equipment/facilities																
Residential buildings																
Municipal public lighting																
Industries (excluding industries involved in the EU Emission trading scheme – ETS)																
Subtotal buildings, equipments/facilities and industries																
TRANSPORT																
Municipal fleet																
Public transport																
Private commercial transport																
Subtotal transport																
TOTAL																

MUNICIPAL PURCHASES OF CERTIFIED GREEN ELECTRICITY (IF ANY) (MWh)	
CO_2 EMISSION FACTOR FOR CERTIFIED GREEN ELECTRICITY PURCHASES (FOR LCA APPROACH)	

B. CO_2 OR CO_2 EQUIVALENT EMISSIONS (t)															
CATEGORY	ELEC-TRICITY	HEAT/ COLD	FOSSIL FUELS								RENEWABLE ENERGIES				
			Natural gas	Liquid gas	Heating oil	Diesel	Gaso-line	Lignite	Coal	Other fossil fuels	Biofuel	Plant oil	Other biomass	Solar thermal	Geo-thermal
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES															
Municipal buildings, equipment/facilities															
Tertiary (non municipal) buildings, equipment/facilities															
Residential buildings															
Municipal public lighting															
Industries (excluding industries involved in the EU Emission trading scheme – ETS)															
Subtotal buildings, equipments/facilities and industries															
TRANSPORT															
Municipal fleet															
Public transport															
Private commercial transport															
Subtotal transport															
OTHER															
Waste management															
Waste water management															
Please specify here ohter missions															
TOTAL															
CORRESPONDING CO_2-EMISSION FACTORS IN [t/MWh]															
CO_2 EMISSION FACTOR FOR ELECTRICITY NOT PRODUCED LOCALLY [t/MWh]															

C. LOCAL ELECTRICITY PRODUCTION AND CORRESPONDING CO_2 EMISSIONS

LOCALLY GENERATED ELECTRICITY (EXCLUDING ETS PLANTS, AND ALL PLANTS/ UNITS > 20MW)	LOCALLY GENERATED ELECTRICITY (MWh)	ENERGY CARRIER INPUT (MWh)										CO_2/CO_2 EQ EMISSIONS (t)	CORRESPONDING CO_2 EMISSION FACTOR FOR ELECTRICITY PRODUCTION IN (t/MWh)
		FOSSIL FUELS					WASTE	PLANT OIL	OTHER BIOMASS	OTHER RENEWABLE	OTHER		
		Natural gas	Liquid gas	Heating oil	Lignite	Coal							
Wind power													
Hydroelectric power													
Photovoltaic													
Combined Heat and Power													
Other *Please specify*													
TOTAL													

D. LOCAL HEAT/COLD PRODUCTION (DISTRICT HEATING/COOLING, CPHs...) AND CORRESPONDING CO_2 EMISSIONS

LOCALLY GENERATED HEAT/COLD	LOCALLY GENERATED HEAT/COLD (MWh)	ENERGY CARRIER INPUT (MWh)										CO_2/CO_2 EQ EMISSIONS (t)	CORRESPONDING CO_2 EMISSION FACTOR FOR HEAT/COLD PRODUCTION IN (t/MWh)
		FOSSIL FUELS					WASTE	PLANT OIL	OTHER BIOMASS	OTHER RENEWABLE	OTHER		
		Natural gas	Liquid gas	Heating oil	Lignite	Coal							
Combined Heat and Power													
District heating plant(s)													
Other *Please specify*													
TOTAL													

European Commission

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