How to develop a Baseline Emission Inventory

Technical training on the Covenant of Mayors

JRC training for IUC contractors and FPI Programme managers

Brussels

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Structure of the presentation

• What is the Baseline Emission Inventory (BEI)
• The human activity sectors used by the Covenant of Mayors
• Key concepts and calculation rules
• Greenhouse Gases (GHGs) included and Emission factors
BEI quantifies the amount of CO$_2$ emitted due to final energy consumption in given activity sectors on the municipality’s territory within a calendar year and it helps to select the appropriate actions.

Example: Castelldefelds (Spain)

Three sectors represent 86% of the emissions of the city.
The Baseline Emission Inventory (BEI)

BEI is an instrument to follow progress towards the CO₂ reduction objective taken by signatories: >20% by 2020 or >40% by 2030.

Simplicity of use and flexibility: the BEI should not be a barrier for action. Should suit very different situations, from the largest capitals to very small communities, from newcomers to very experienced cities.

It is mandatory to cover only those sectors which are most emitting and which could be influenced by the local authority’s actions (such as Municipal, Residential and Tertiary Buildings and urban Transport, further defined as Key Sectors). The inclusion of other sectors is optional.

Focuses mainly on GHG emissions occurring due to final energy consumption and mainly on CO₂ emissions (CH₄ and N₂O are optional).
The BEI shows where the local authority is at the beginning of the planning process, and the successive monitoring inventories will show the progress towards the objective.

Example: Sunderland, UK
The base year is the reference year for setting the objective.

The Covenant’s goal is to contribute to the EU commitment to reduce GHG emissions by 20% by 2020 and by 40% by 2030 compared to 1990.

The recommended baseline year is 1990.

If data availability is insufficient, then a subsequent year must be chosen.
The population covered in the corresponding SEAPs is represented in relative terms by the size of the bubble.

Data from CoM BEI dataset (N=5,403, 97% from EU28) at 4th of September 2016, Kona A. et al., 2016
For the territorial extensions of the Covenant beyond EU borders, the local economic situation was taken into account when recommending the base year.

For example for CoM East - originally covering countries from Eastern Europe and Central Asia - the recommendation is to use a more recent year which is representative of the current economic situation.
Definition of the boundary of the inventory

It is set by the administrative boundaries of the local authority signatory of the Covenant.

*The majority of CoM signatories are municipalities, but there are also higher administrative units (e.g. provinces, regions, counties).*

It coincides with the territory where the final energy is consumed and the one tackled by the SE(C)AP measures.

*The signatory might choose not to tackle through any measures, sectors which are otherwise included in the inventory (not recommended).*

*Nevertheless the target applies to all emissions included in BEI.*
Two key principles

1) The Covenant follows essentially (but not exclusively) a territorial approach, looking at the GHG emissions on the territory of the local authority.

2) The focus of the Covenant is on Final Energy Consumption and promoting distributed generation from renewable sources.
Targeted emissions

Only the part related to the consumption of key sectors

Not exhaustive inventory
1.) Identifying the emission sources and collect activity data:

- Final energy consumption:
  - in buildings, equipment/facilities and industries
  - in transport

- Local generation of grid distributed energy (electricity, heat, cold)
  
  Considered indirectly, via emission factors, if included in SECAP

- Other emission sources (not related to energy consumption) (e.g. waste ...)

2.) Choosing the emission factors

3.) Calculating the GHG Emissions

Only emissions reported, no activity data required
CoM activity sectors

Focus on sectors that can be directly influenced by local policies

Buildings, equipment/facilities
- Municipal
- Tertiary (commercial & non-municipal services)
- Residential

Urban transport (municipal, public, private)

Local production of grid distributed energy:
- Electricity
- Heat/Cold

Other energy related sectors:
- Industries not involved in the EU ETS*
- Agriculture, Forestry, Fisheries (only energy consumption)
- Other road transportation (e.g. highways)

Non energy related sectors:
- Wastewater and/or solid waste treatment (non energy related)

STRONGLY RECOMMENDED = the CoM EU key sectors

RECOMMENDED IF IN SEAP

* European Union Emissions Trading System (EU ETS)
Focus on sectors that can be directly influenced by local policies

CoM activity sectors

A more comprehensive list of sectors to be included in the BEI is provided in the CoM Guidebook (JRC, 2010).

Industries involved in the EU ETS

Aviation, Shipping, Agriculture

(non energy related: enteric fermentation, fertilizer application, etc...)

EXCLUDED
Activity data (AD)

AD quantifies the human activity occurring in the territory of the local authority.

Examples of activity data are:

- oil used for heating in residential buildings \[\text{MWh}_{\text{fuel}}\]
- electricity consumed in municipal buildings \[\text{MWh}_{\text{electricity}}\]
- heat consumed by residential buildings \[\text{MWh}_{\text{heat}}\]

It is strongly recommended to use data relevant for the local territory! If the inventory is built with national averages, the subsequent inventories will not show the effect of the actions implemented at local level!
Emission factors (EFs)

EFs are coefficients which quantify the emission per unit of activity. The emissions are estimated by multiplying the EF with the corresponding activity data.

Examples of EFs are:

- amount of CO\(_2\) emitted per MWh of oil consumed \([tCO_2/MWh_{\text{fuel}}]\)
- amount of CO\(_2\) emitted per MWh electricity \([tCO_2/MWh_{\text{electricity}}]\)
- amount of CO\(_2\) emitted per MWh heat consumed \([tCO_2/MWh_{\text{heat}}]\)
electricity consumed in municipal buildings \( [\text{MWh}_{\text{electricity}}] \)

amount of \( \text{CO}_2 \) emitted per MWh electricity \( [\text{tCO}_2/\text{MWh}_{\text{electricity}}] \)

total amount of \( \text{CO}_2 \) emitted from electricity \( [\text{tCO}_2] \)

Find the proper data related to your local authority

Most emission factors can be found in the Guidebook and in technical literature
Inclusion (in CO\textsubscript{2} eq) recommended if actions are planned in related emitting sectors.
If GHG other than CO₂ are included in the BEI, then it is necessary to convert the amount of CH₄ or N₂O into CO₂ equivalents multiplying by Global Warming Potential coefficients:

<table>
<thead>
<tr>
<th>MASS OF GHG AS T COMPOUND</th>
<th>MASS OF GHG AS T CO₂-EQUIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 t CO₂</td>
<td>1 t CO₂-eq</td>
</tr>
<tr>
<td>1 t CH₄</td>
<td>21 t CO₂-eq</td>
</tr>
<tr>
<td>1 t N₂O</td>
<td>310 t CO₂-eq</td>
</tr>
</tbody>
</table>

*IPCC, Second Assessment Report*
GHGs and Emission factors

Choice of emission factors

- **Standard emission factors, according to IPCC guidelines (Intergovernmental Panel on Climate Change) approach:** Based on the Carbon content of fuels.
  
  Advantages:
  ✓ Simple;
  ✓ In line with international reporting (UNFCC, Kyoto protocol...).

- **LCA (Life Cycle Analysis) emission factors:**
  Includes embodied emissions that occur upstream (e.g. emissions required to extract, transform, transport the fuel up to the city).

  Advantages:
  ✓ Gives a better view of the global impact of the activities occurring in the territory.
**GHGs and Emission factors**

**TABLE 4. STANDARD CO₂ EMISSION FACTORS (FROM IPCC, 2006) AND CO₂-EQUIVALENT LCA EMISSION FACTORS (FROM ELCD) FOR MOST COMMON FUEL TYPES**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>STANDARD EMISSION FACTOR [t CO₂/MWh]</th>
<th>LCA EMISSION FACTOR [t CO₂-eq/MWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Gasoline</td>
<td>0.249</td>
<td>0.299</td>
</tr>
<tr>
<td>Gas oil, diesel</td>
<td>0.267</td>
<td>0.305</td>
</tr>
<tr>
<td>Residual Fuel Oil</td>
<td>0.279</td>
<td>0.310</td>
</tr>
<tr>
<td>Anthracite</td>
<td>0.354</td>
<td>0.393</td>
</tr>
<tr>
<td>Other Bituminous Coal</td>
<td>0.341</td>
<td>0.380</td>
</tr>
<tr>
<td>Sub-Bituminous Coal</td>
<td>0.346</td>
<td>0.385</td>
</tr>
<tr>
<td>Lignite</td>
<td>0.364</td>
<td>0.375</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>0.202</td>
<td>0.237</td>
</tr>
<tr>
<td>Municipal Wastes (non-biomass fraction)</td>
<td>0.330</td>
<td>0.330</td>
</tr>
<tr>
<td>Wood (¹)</td>
<td>0 – 0.403</td>
<td>0.002 (²) – 0.405</td>
</tr>
</tbody>
</table>

*(CoM West Guidebook: table 4, p. 62)*
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**.

In the absence of national regulations regarding the sustainability of biomass/biofuels, the local authority might use the criteria set in the **Directive 2009/28/EC** on the promotion of the use of energy from renewable sources. Only biomass/biofuels that meet these criteria should be considered as renewable in the context of the CoM.
In order to calculate the \( \text{CO}_2 \) emissions to be attributed to electricity consumption it is recommended to use the national emission factor or the European one (NEEFE) \([\text{tCO}_2/\text{MWh}]\).

What if there is some local electricity production AND the local authority wants to take action in this field?

The municipality can correct the national emission factor with the local production of electricity by calculating the local emission factor for electricity consumption (EFE).
Steps in calculating the Local Emission Factor for electricity

1.) Deciding which local electricity production units should be included in the inventory according to the following decision tree:

- **Large (> 20 MW) Plants** that are not operated by the local authority are not considered to be «local»

CoM West Guidebook, p. 64
2.) Calculating the Local Emission Factor for electricity:

\[
EFE = \frac{[(TCE - LPE - GEP) \times NEEFE] + CO_2LPE + CO_2GEP}{TCE}
\]

**EFE** = Local Emission Factor for Electricity  
**TCE** = Total Consumption of Electricity  
**LPE** = Local Production of Electricity  
**GEP** = Green Electricity Purchased by the local administration  
**NEEFE** = National (or European) Emission Factor for Electricity
EFs for heat

...if there is some heat sold / distributed as a commodity to end users? (e.g. district heating)

A local emission factor for heat (EFH) has to be calculated

$$\text{EFH} = \frac{\text{CO}_2\text{LPH} + \text{CO}_2\text{IH} - \text{CO}_2\text{EH}}{\text{LHC}}$$

- LPH = local heat production
- IH = imported heat
- EH = exported heat
- LHC = local heat consumption

CoM West Guidebook: p.67
As reported in the Baseline Emission Inventories; based on a sample of all Covenant signatories (N=5403) at 4th of September 2016
Kona A. et al, 2016
CoM emission inventory: Main principles

- Emission Inventories as a **tool** to support the deployment and monitoring of local energy and climate policies;

- **Bottom-up approach** in activity data collection;

- **Simplicity and flexibility:** the approach can be adapted to the specific situation of local authorities (city size, level of expertise, political mandate, etc.);

- Main focus on **CO\textsubscript{2}** emissions associated with local **energy consumption**;

- **Four key sectors** to be accounted for in the BEI and targeted by SE(C)AP measures:
  - Municipal buildings & public lighting
  - Residential buildings
  - Tertiary buildings
  - Transport
Thank you for your attention

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