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How to develop a Baseline Emission Inventory

Technical training on the Covenant of Mayors

JRC training for IUC contractors
and FPI Programme managers

Brussels

13-14 February 2017

Joint
Research
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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**

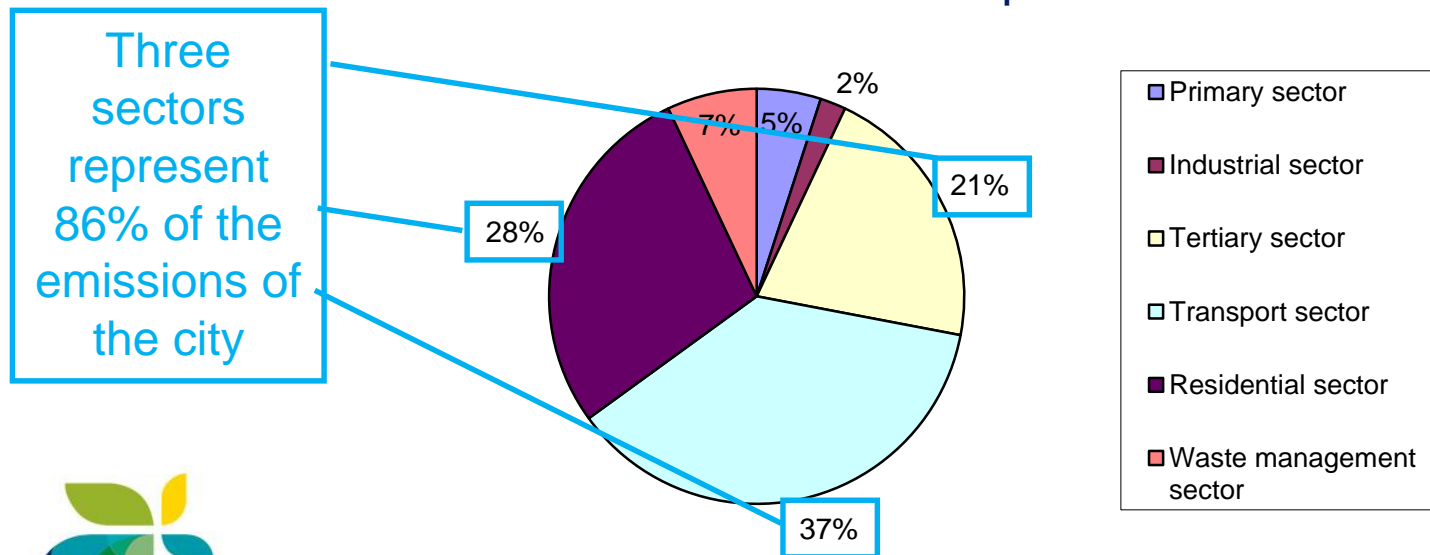


The Baseline Emission Inventory (BEI)



BEI quantifies the amount of CO₂ 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.

Share of emissions per sector



Example: Castelldefels (Spain)



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.

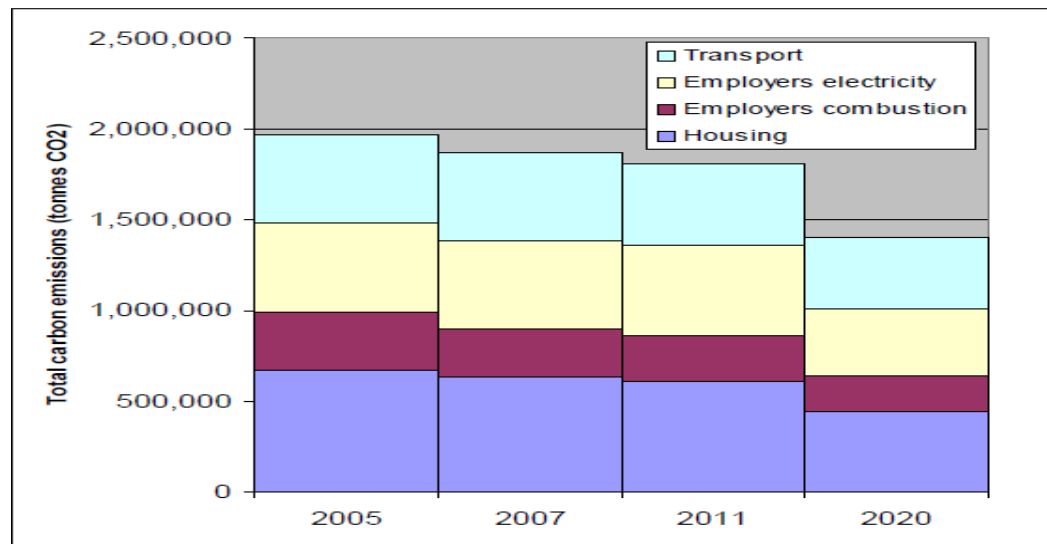
It is mandatory to cover only those sectors which are most emitting and which could be influenced by the local authority's actions (such as Municipal, Residential and Tertiary Buildings and urban Transport, further defined as **Key Sectors**). The inclusion of other sectors is optional.

Focuses mainly on GHG emissions occurring due to final energy consumption and mainly on **CO₂** emissions (**CH₄** and **N₂O** are optional).

The Baseline Emission Inventory (BEI)



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



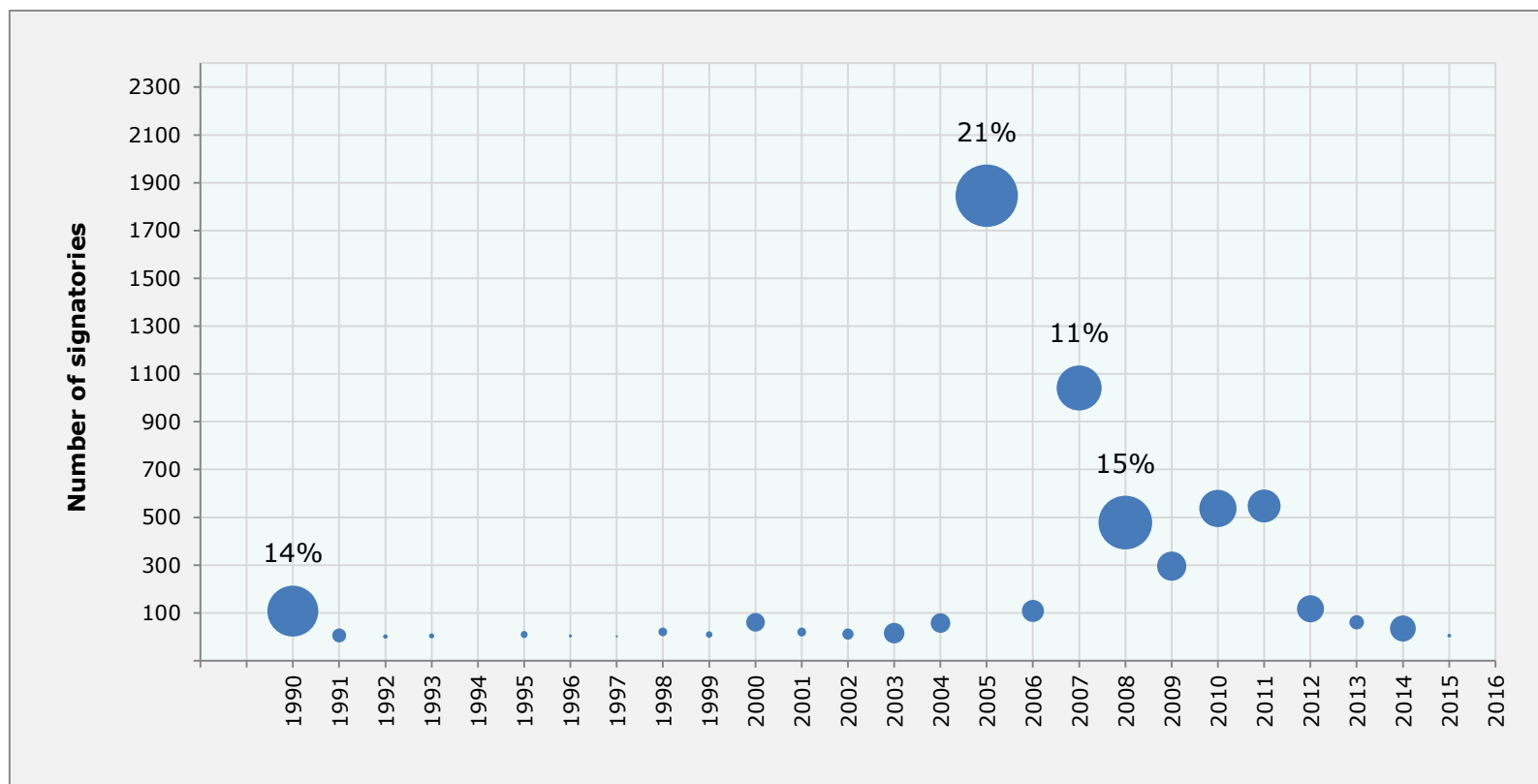
The base year



- 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.



Base years in CoM



Data from CoM BEI dataset (N=5,403, 97% from EU28) at 4th of September 2016, Kona A. et al., 2016

The population covered in the corresponding SEAPs is represented in relative terms by the size of the bubble.

The base year



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.

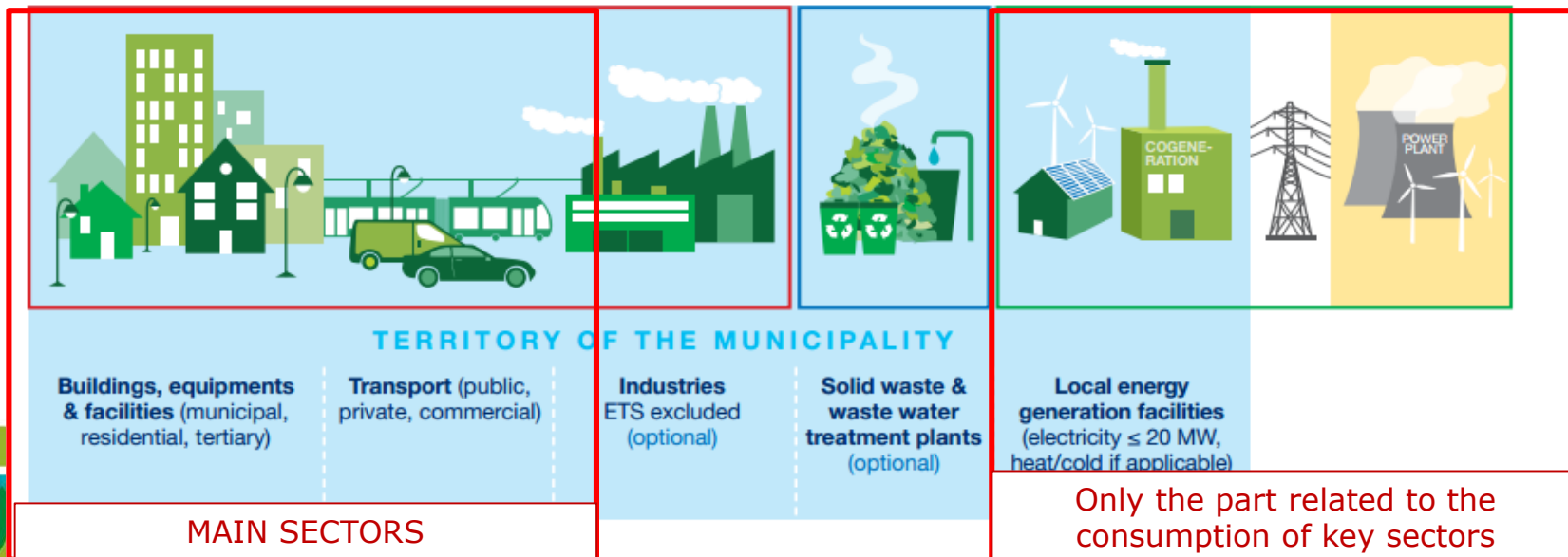
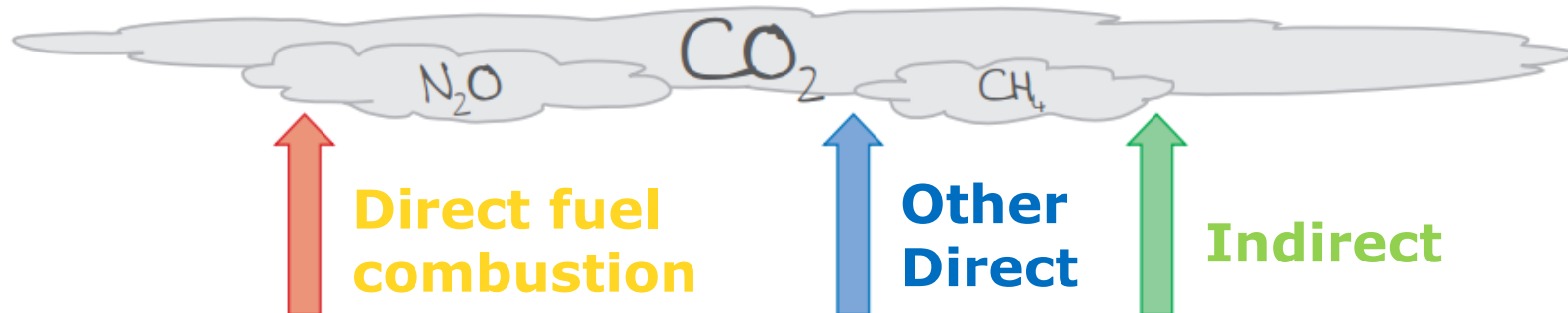


Two key principles

- 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



Steps in building an emission 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 ...)
 - *Only emissions reported, no activity data required*



2.) Choosing the emission factors

3.) Calculating the GHG Emissions

Buildings, equipment/ facilities

- Municipal
- Tertiary (commercial & non-municipal services)
- Residential

**STRONGLY
RECOMMENDED**

= the CoM EU key
sectors

Urban transport (municipal, public, private)

Local production of grid distributed energy:

- Electricity
- Heat/Cold

**RECOMMENDED IF
IN SEAP**

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)

* **European Union Emissions Trading System (EU ETS)**

Industries involved in the EU ETS

EXCLUDED

Aviation, Shipping,

Agriculture

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

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



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 [MWh_{fuel}]
- electricity consumed in municipal buildings [$\text{MWh}_{\text{electricity}}$]
- heat consumed by residential buildings [MWh_{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!



Key concepts and calculation rules



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 CO₂ emitted per MWh of oil consumed [tCO₂/MWh_{fuel}]
- amount of CO₂ emitted per MWh electricity [tCO₂/MWh_{electricity}]
- amount of CO₂ emitted per MWh heat consumed [tCO₂/MWh_{heat}]



Key concepts and calculation rules



Activity Data

*

Emission factors

=

Emissions

electricity consumed in
municipal buildings
[MWh_{electricity}]



Find the proper
data related to
your local
authority

amount of CO₂ emitted
per MWh electricity
[tCO₂/MWh_{electricity}]



Most emission
factors can be found
in the Guidebook and
in technical literature

total amount of CO₂
emitted from electricity
[tCO₂]



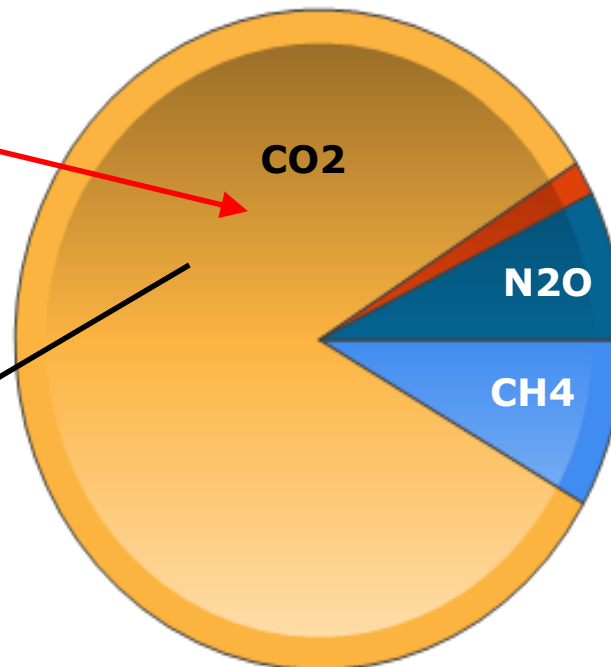
Choice of Greenhouse Gases (GHG)



Inclusion (in CO₂ eq)
recommended if actions
are planned in related
emitting sectors

Mandatory

**Combustion & usage of
fossil fuels**



**Share of greenhouse gases
EU27 – (EEA, 2009)**

**Agriculture (77%)
Industry (8%)**



**Agriculture (49%)
Waste (31%)**



Fugitive emissions (15%)



GHGs and Emission factors



If GHG other than CO_2 are included in the BEI, then it is necessary to convert the amount of CH_4 or N_2O into CO_2 equivalents multiplying by Global Warming Potential coefficients:

| 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 |

IPCC, Second Assessment Report



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 (UNFCCC, 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

| 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 |



(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 CO₂ 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.



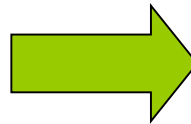
Emission Factors for electricity



In order to calculate the CO₂ emissions to be attributed to electricity consumption it is recommended to use the national emission factor or the European one (NEEFE) [tCO₂/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)**

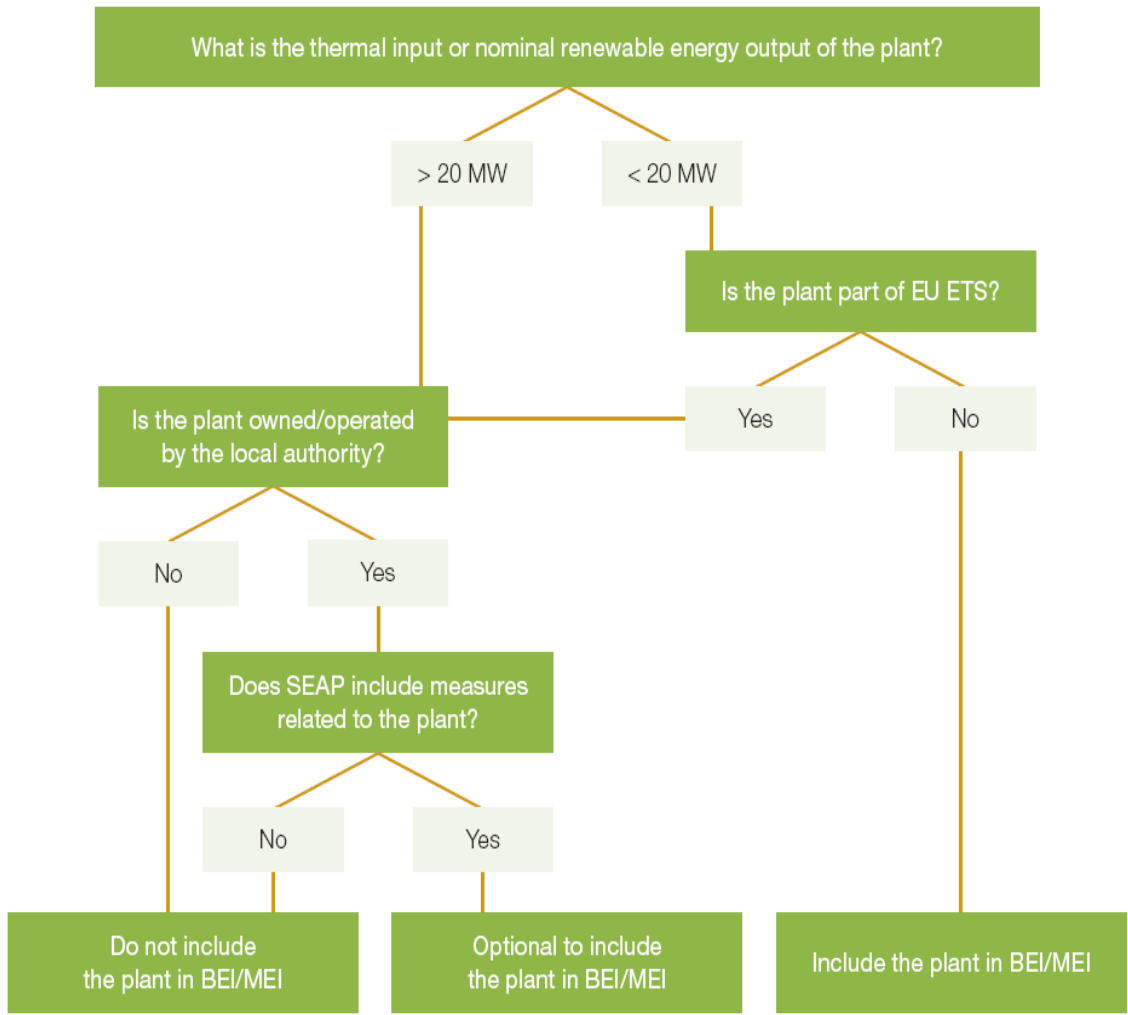


Steps in calculating the Local Emission Factor for electricity



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

Steps in calculating the Local Emission Factor for electricity



2.) Calculating the Local Emission Factor for electricity:

$$\text{EFE} = \frac{[(\text{TCE} - \text{LPE} - \text{GEP}) * \text{NEEFE}] + \text{CO}_2\text{LPE} + \text{CO}_2\text{GEP}}{\text{TCE}}$$

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

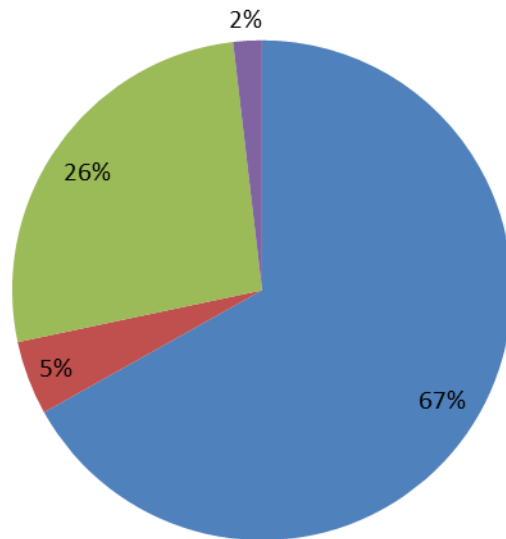
LHC = local heat consumption



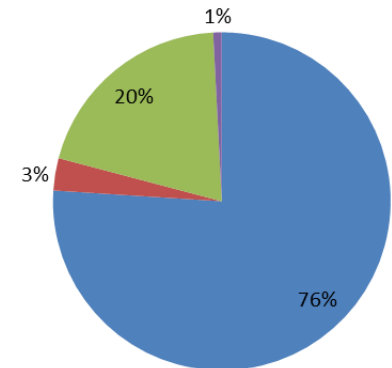
Distribution of GHG emissions by Covenant sectors



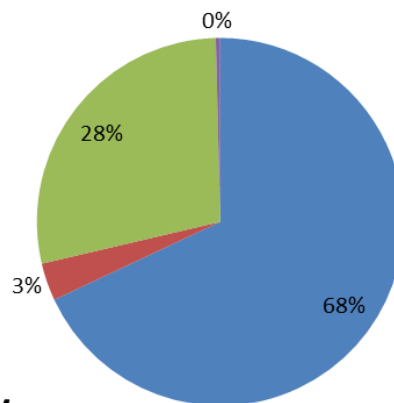
Covenant submitted SEAPs



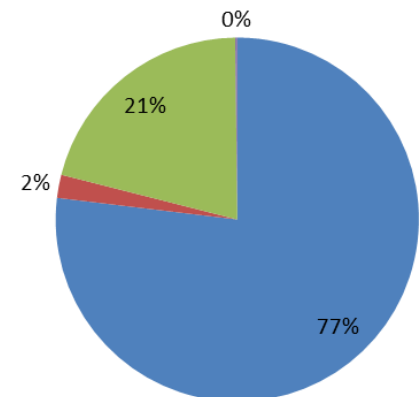
- BUILDINGS, EQUIPMENT FACILITIES AND INDUSTRIES
- OTHER
- TRANSPORT
- NON ENERGY RELATED



Ukraine



Italy



Germany



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 **CO₂** 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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<http://edgar.jrc.ec.europa.eu/>

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