# ENERGEEWatch
# Energy & climate data online crash courses

## Course DATA COLLECTION (Aquisition and treatment)

Boštjan Krajnc, CEO Energy agency KSSENA, Slovenia

ENERGee Watch has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 892089.

# COURSE DATA COLLECTION

ENERGee Watch

✓ **Objective 1:** To understand the importance of systematic, timely and periodic gathering of energy data

✓ **Objective 2:** To understand the need for improving data sharing

✓ **Objective 3:** To be able to contribute to improving data sharing through agreements and collaborations

✓ **Objective 4:** To be able to use tools and methodologies for data retrieving, quality energy estimations and BEI calculation

Sessions

- Session 1: **SECAP – data collection for baseline review**
- Session 2: **Energy management**
- Session 3: **Energy supply and production**
- Session 4: **Transport**

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

SESSION 1

# SECAP – data collection for baseline review

ENERGee Watch has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 892089.

# Legal background

ENERGee Watch

**DIRECTIVE 2012/27/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL** of 25 October 2012 on energy efficiency.

**Directive established a set of binding measures to help the EU reach its 20% energy efficiency target:**

In the context of the Energy Efficiency Directive, several important measures have been adopted throughout the EU to improve energy efficiency in Europe, including:

- policy measures to achieve energy savings equivalent to annual reduction of 1.5% in national energy sales
- EU countries making energy efficient renovations to at least 3% per year of buildings owned and occupied by central governments
- national long-term renovation strategies for the building stock in each EU country
- mandatory energy efficiency certificates accompanying the sale and rental of buildings
- the preparation of national energy efficiency action plans (NEEAPs) every three years

KSSENA

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# Legal background

The European Climate Law writes into law the goal set out in the European Green Deal for Europe's economy and society to become climate-neutral by 2050.

The law also sets the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# EU countries obligations

ENERGee Watch

**EU countries obligations:** The National Energy Efficiency Action Plans are based on requirement laid down in Article 24(2) of Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, whereby all Member States of the European Union must submit such plans, doing so by 30 April 2014 in the first instance, and then every three years thereafter.

**Member States shall encourage public bodies, including at regional and local level, to adopt an energy efficiency plan with clear goals and objectives as well as putting in place an energy management system as part of the implementation of their plan.**

Municiplities:

- **Slovenia**: Local Energy Concepts (LEK)
- **EU Covenant of Mayors:** Sustainable Energy and Climate Action Plan (SECAP)

KSSENA

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# What is SEAP?

ENERGee Watch

- In 2008, the European Commission launched the Covenant of Mayors, to endorse and support the efforts of local authorities in the implementation of sustainable energy policies. First signatories were obliged to prepare and implement SEAP (Sustainable Energy Action Plan).

- SEAP is an action plan for sustainable energy and climate change that every municipality should have.

- The action plan is the key document which shows how the Municipality will reach its vision and target.

- **The plan includes an assessment of the current situation, i.e. a Baseline Emission Inventory** and clearly identifies goals and targets and the measures planned together with time frames, assigned responsibilities and estimated impacts.

KSSENA

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# What SECAP?

- In October 2015, following a consultation process on the future of the Covenant of Mayors, the European Commission launched the new integrated Covenant of Mayors for Climate and Energy, which goes beyond the objectives set for 2020.
- The signatories of the new Covenant commit to reduce their CO2 emissions (and possibly other GHG) and to adopt a joint approach to tackling mitigation and adaptation to climate change.
- Signatories of the Covenant of Mayors for Climate and Energy have committed to prepare and implement a Sustainable Energy and Climate Action Plan (SECAP) before 2030 (SEAP was upgraded to SECAP)

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# Difference between SEAP and SECAP

ENERGee Watch

1. Target: SECAP is aimed at defining mitigation actions that allow cutting down at least 40% of $CO_2$ emissions (SEAP – 20 %)

2. Timeframe: SECAP is expected to achieve the objective of 40% reduction by the year 2030 (SEAP by 2020, later 2030)

3. Development time: SECAP must be submitted within two years of joining the Covenant

4. Format: The SECAP format consists of two parts, "Mitigation" and "Adaptation"(SEAP – only „Mitigation")

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# Difference between SEAP and SECAP

ENERGee Watch

## What is adaptation to climate change (in SECAP)?

- In SECAP adaptation to climate change is required (main difference with SEAP). The task is to anticipate the adverse effects of climate change and to take appropriate action to prevent or minimize the damage it can cause. Therefore in SECAP members must develop a Risk and Vulnerability Assessment of the effects of climate change, in order to highlight strengths and weaknesses of a territory.

- This is to determine the nature and extent of risk by analysing potential hazards and assessing vulnerability that could pose a potential threat or harm to people, property, livelihoods and to the environment on which they depend. This will allow the definition of appropriate adaptation strategies, which will translate into the SECAP's actions and contribute to improve the resilience of the territory.

KSSENA

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# What is SECAP?

ENERGee Watch

SECAP is divided into two distinct parts:

1. **Analysing the territory and the climate (at the most local scale possible):** developing Baseline Emission Inventory (BEI) and the Climate Change Risk and Vulnerability Assessment (RVA). Through the development of the BEI, the signatory is able to develop an overview of its greenhouse gas (GHG) emissions. Similarly, the RVA identifies the most relevant climate hazards and vulnerabilities affecting the local authority, facilitating the process of addressing such risks through the development of an adaptation strategy and identification of appropriate adaptation actions.
2. **Defining concrete measures:** developing Action Plan. Drawing from the findings of the BEI and RVA, SECAP defines concrete measures for both climate mitigation and adaptation, with timeframes and assigned responsibilities. This permits emissions reduction of at least 40% in 2030 and prioritizing actions based on climate urgency and the severity of the impacts caused by climate change in the territory

**The reference methodology for the development of SECAP is based on the European Climate Adaptation Platform (Climate-ADAPT)2 and the UKCIP Adaptation Wizard3 tool, adopted by the Covenant of Mayors for Climate and energy.**

To ensure that adequate action is taken to mitigate and adapt to Climate Change, the SECAP should not be regarded as a fixed and rigid document. Since circumstances can change and the ongoing actions provide results and generate local experience, it may be useful or necessary to revise the plan on a regular basis.

KSSENA

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# Target sectors of SECAP

ENERGee Watch

- The main target sectors for climate MITIGATION are:
  BUILDINGS, EQUIPMENT/FACILITIES, URBAN TRANSPORT

- The SECAP may also include actions related to local electricity production (development of solar photovoltaic (PV), wind power, combined heat power (CHP), improvement of local power generation), and local heating/cooling generation).

- The SECAP should cover areas where local authorities can influence energy consumption on the long term (as land use planning)

- Industrial sector is not a key target of the SECAP for achieving reduction goals, so the local authority can decide if they want to include it or not.

- The main target sectors for climate ADAPTATION:
  VULNERABLE SECTORS AND AREAS (HOTSPOTS)

- e.g. buildings, transport, energy, water, waste, land use planning, environment & biodiversity, agriculture & forestry, health, civil protection & emergency, tourism)

KSSENA

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# SECAP - Methodology

ENERGee Watch

**Methodology used must be in-line with the guidelines of:**

- Directorate-General for Climate Action (DG CLIMA),
- EC Joint Research Centre (JRC),
- Covenant of Mayors for Climate and Energy;
- Intergovernmental Panel on Climate Change (IPCC) and others

**Useful materials:**

- Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)' by JRC
- GUIDE FOR THE ELABORATION OF SUSTAINABLE ENERGY AND CLIMATE ACTION PLANS (SECAP) LIFE-Adaptate-SECAP-Guide.pdf (lifeadaptate.eu)

KSSENA

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# BASELINE REVIEW

ENERGee Watch

The starting point of SECAP is to assess the current situation or establishing a baseline review.
*„where we are“* - a description of the city’s current situation in terms of energy and climate change

1. Baseline emission inventory:
   > a base for „mitigation“ actions
   > mitigation is based on reduction of GHG (CO2)
   > the actions resulting from this review will define the local climate change mitigation strategy
   > mitigation is achieved through reduction of energy demand/consumption and increase of RES/RUE

2. Risk and Vulnerability Assessment
   > base for „adaptation“ measures
   > adaptation is based on designing effective actions to adapt municipality to climate change
   > adaption is achieved through collecting data on climate variables and other risk elements (such as sea level rise) assessing potential consequences and defining adaptation actions

KSSENA

ENERGee Watch has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 892089.

# BEI – BASELINE EMISSION INVENTORY

ENERGee Watch

## Definition:

A Baseline Emission Inventory (BEI) is a quantification of the amount of CO2 emitted due to energy consumption in a specified territory within a given period of time. Development of the BEI constitutes an obligatory stage of SEAP/SECAP preparation.

## Goal:

Identification of principal sources of $CO_2$ emissions and their respective reduction potentials.

## Advantages:

- closer monitoring and better understanding of the various factors that influence the CO2 emissions;
- regular input to policy-making, allowing quicker reactions;
- the specific expertise necessary for inventories can be maintained and consolidated.

# Introduction – WHAT IS BEI

ENERGee Watch

BEI reflects many factors, as energy consumption and $CO_2$ emissions are dependent on:

- economic structure
- level of economic activity
- number of inhabitants
- population density
- characteristics of the building stock
- usage and level of development of the various transport modes
- citizens' behaviour
- climate, etc.

**BEI should reflect LOCAL SITUATION!**

Assessments and estimations based on national or regional means will not reflect the real situation locally

# Recommendations

1 **As far as possible, internationally agreed standards shall be followed.** E.g. use emission factors that are in line with Intergovernmental Panel on Climate Change (IPCC) or European Reference Life Cycle Database (ELCD)

2 **Methodological approaches and sources of the data used in the estimations should not change for several years** for the sake of monitoring the progress in emission reduction.

3 **The BEI should reflect local situation –** it should be based on local data on energy consumption/production and other information necessary to prepare the inventory. Assessments and estimations based on national or regional means will not reflect the real situation.

# Recommendations

4 **The BEI should include at least the sectors where the local authorities intend to take measures** aimed at achievement of their emission reduction goals, that is the sectors that constitute important sources of $CO_2$ emission

5 **The BEI should contain reliable information** or at least common-sense vision of reality (that is, if possible, most objectively reflect the current situation).

6 **The process of input data collection, the sources of data and calculation methodology for the BEI should be duly documented** (at least the necessary data should be preserved in the local authority's documents).

# Networks and methodologies

ENERGee Watch

## Existing networks that give recommendations on the elaboration of BEI:

- Covenant of Mayors (CoM) Provides methodology: Guidebook „How to develop a Sustainable Energy and Climate Action Plan (SECAP) – Part 2 – Baseline Emission Inventory“
- Climate Alliance Developed guidelines, methodologies and tools for different regions during the years. They developed online calculation tools, such as Climate Protection Planner (Germany) and ECORegion (Germany, Luxemburg, Switzerland, Italy, Austria), and guidelines such as „Klimaschutz in Kommunen – Praxisleitfaden“
- Greenhouse Gas Protocol Provides methodology in „Global Protocol for Community-Scale Greenhouse Gas Emission Inventories - An Accounting and Reporting Standard for Cities“
- European Investment Bank (EIB) Provides methodology: „EIB Project Carbon Footprint Methodology – Methodologies for the Assesment of Project GHG Emissions and Emission Variations
- ICLEI Provides methodology „Local Government Operations Protocol - For the quantification and reporting of greenhouse gas emissions inventories“

# Calculation tools

## Worldwide many calculation tools on the elaboration of BEI exist:

- The tools typically use comparable emission factors and recommend comparable activity data sources.
- Most of the tools are excel sheets and some of them are web based.
- Most of the tools are available in English (and some of them only in national language).
- Some tools that can be used freely and some others need license.

## The main differences are related to the necessary inputs, the analysis level and the output presentation. Differences can be found in:

- the treatment of indirect emissions from electricity produced outside the municipality.
- the manner in which emissions from combined heat and power production (CHP) are allocated between heat and electricity.
- regard to which sectors and compounds are included and how the boundaries and scopes are set for the inventories.

# Calculation tools for elaboration of BEI

## Online tools:

1. **„Climate protection planner“** (Germany)
2. **„Ecospeed“** (Germany, Switzerland, Austria, Italy, Luxemburg)
3. **„Bilan Carbone“** (France)
4. etc.

## Advantages of using an online tool:

- More complex calculation algorithms can be included
- Estimation processes can be included in case of low data quality or missing data
- Basic statistical data can be included, e.g. inhabitants, $CO_2$-emission factors, transportation data
- Central update of databases is possible
- BEIs elaborated with the same tool or methodology are comparable
- Graphical and tabular data visualisation can be included as well as automatic report generation
- Support by tool provider possible

# Calculation tools for elaboration of BEI

ENERGee Watch

## The basic criteria that define a good calculation tool are:

- **Simple structure, concise, web based in a simple form**
- **Flexible** (easy to update or add new subcategories by the user)
- **Applicable in several communities** despite their diversity and characteristics
- **Easy access, easily understandable** by the user
- Bottom-up approach and check with regional or national figures or indicators **(combination of bottom-up and top-down approach)**
- Inputs can by detailed if possible or approximately based on estimations in case of missing data

# How to develop BEI

1. Set boundaries and define clear scope
2. Define baseline year
3. Choose accounting approach
4. Choose GHGs to be included
5. Choose emission factors
6. Identify key target sectors

# How to develop BEI
# 1: SET BOUNDARIES AND DEFINE CLEAR SCOPE

ENERGee Watch

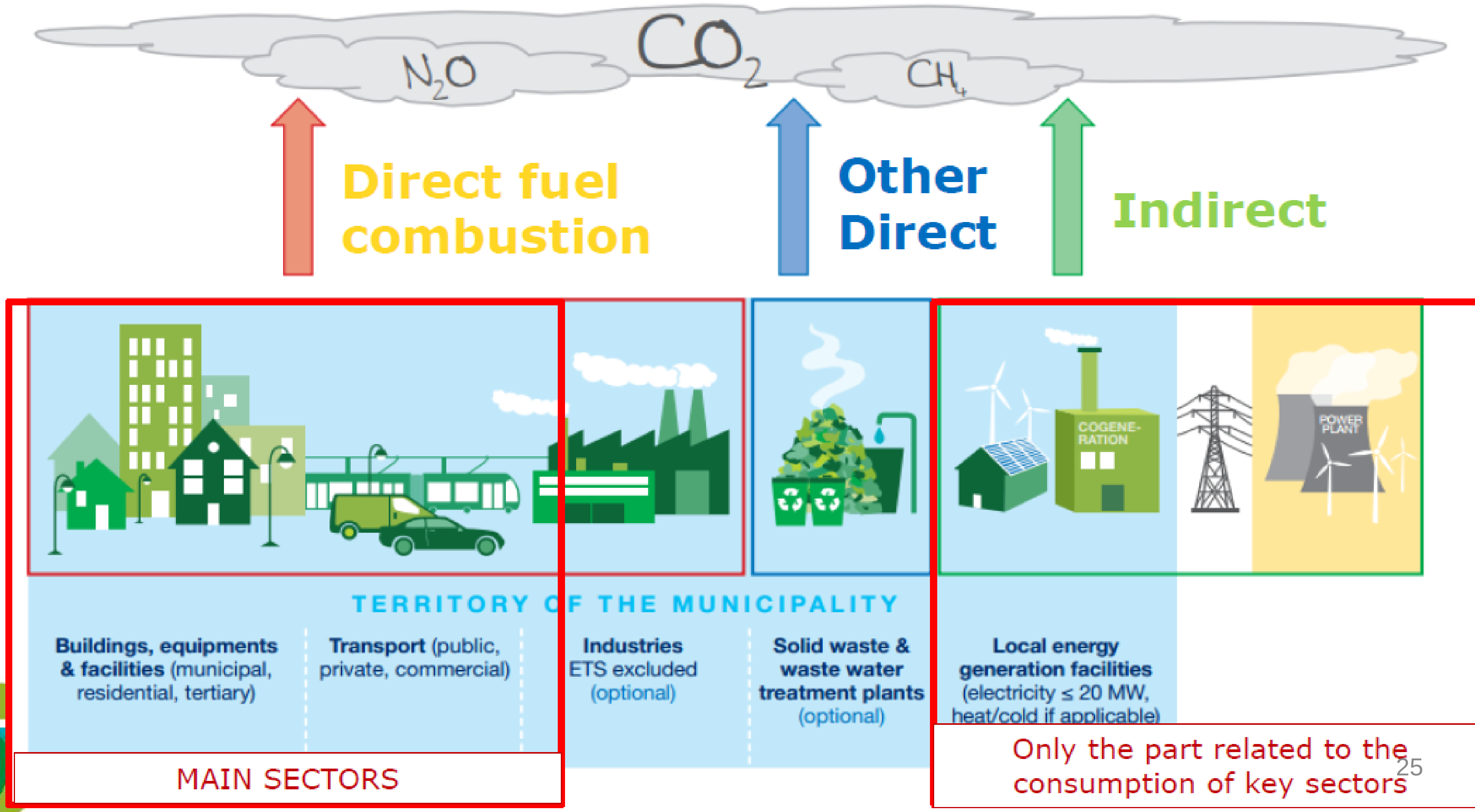
**Territory**

Suggestion: Base emission inventory on administrative boundaries – NUTS(6)

**Type of GHG emissions that can be included (Covenant of Mayors)**

1. **Direct emissions:** physically occur from sources in the administrative territory (mostly $C0_2$)
2. **Indirect emissions:** energy consumption (electricity, heating, cooling) consumed but not produced by the local territory
3. **Non-energy related direct emissions that occur in the territory:** $C0_2$, but also $CH_4$ and $N_2O$

!! At least **scope 1 and 2 emissions** should be included in the carbon footprint, as these are most significant emissions associated with the territory.



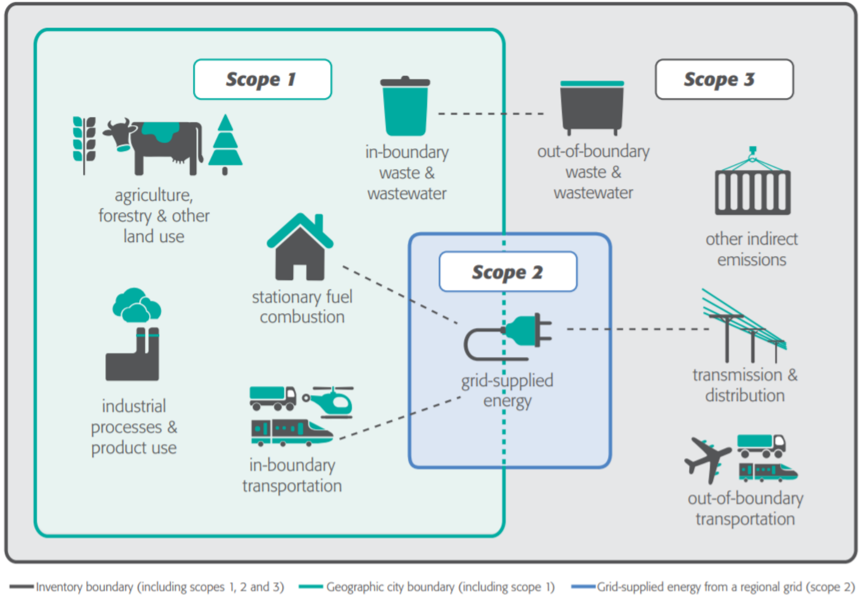
$CO_2$
$N_2O$
$CH_4$
Direct fuel combustion
Other Direct
Indirect
COGENE-RATION
POWER PLANT
TERRITORY OF THE MUNICIPALITY
Buildings, equipments & facilities (municipal, residential, tertiary)
Transport (public, private, commercial)
Industries ETS excluded (optional)
Solid waste & waste water treatment plants (optional)
Local energy generation facilities (electricity ≤ 20 MW, heat/cold if applicable)
MAIN SECTORS
Only the part related to the consumption of key sectors

# How to develop BEI
# 1: SET BOUNDARIES AND DEFINE CLEAR SCOPE

ENERGee Watch

## Greenhouse Gas Protocol methodology suggest the following:

| Scope | Definition |
|---|---|
| **Scope 1** | GHG emissions from sources located within the city boundary. |
| **Scope 2** | GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary. |
| **Scope 3** | All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary. |



# How to develop BEI
# 2: BASELINE YEAR

ENERGee Watch

## Baseline year

- EU recommendation: **year 1990**
- However, you are free to choose the year for which you can get the most comprehensive and reliable data, **which should be the closest subsequent year, but not later than 2005.**
- **Always keep the same baseline year**, even if targets change.

KSSENA

# How to develop BEI
# 3: ACCOUNTING APPROACH

ENERGee Watch

## Activity-based approach

- emissions that occur due to energy consumption **within the local territory**, either **directly** (fuel combustion) or **indirectly** (consumption of electricity and heat/cold)
- The GHG emissions are directly estimated from the carbon content of the fuel.
- Approach used for the national reporting in the frame of UNFCCC and it is compatible with the EU binding legislation on climate and energy.
- Mostly CO2 emissions - emissions of CH4 and N2O are of secondary importance.

## Life Cycle Assessment (LCA) approach

- **emissions from the whole supply chain** (e.g. from the energy extraction to production, transport, use and recycling) and not only from the final combustion.
- Offering more accurate picture of the emissions related to both energy production and use.
- **Internationally standardised approach**, supported by international iniciatives (UNEP, SETAC) and consistent with internationally agreed standards (UNFCCC, ISO).
- It is particularly suitable for assessing potential trade-offs between different types of environmental impacts associated with specific policy and management decisions

# How to develop BEI
# 3: ACCOUNTING APPROACH

ENERGee Watch

| Advantage or specificity | Activity-based | LCA |
|---|---|---|
| Is compatible with the national reporting to the UNFCCC | X | |
| Is compatible with the monitoring of progress of 2030 climate & energy framework (14) and EU Effort Sharing Decision | X | |
| All emission factors needed easily available (IPCC) | X | |
| Is compatible with carbon footprint approaches | | X |
| Is compatible with Ecodesign and Energy Labelling 2009/125/EC and 2010/30/EU directives | | X |
| Reflects the total environmental impact also outside the place of use, and further support the choice of the most climate-friendly biofuels/biomass | | X |
| Tools available for local inventories | X | X |

# How to develop BEI
# 4: GREENHOUSE GASSES TO BE INCLUDED

ENERGee Watch

- **Three main GHGs are cosidered to be $CO_2$, $CH_4$ and $N_2O$.**
- Inclusion of $CH_4$ and $N_2O$ depends on whether measures to reduce also these greenhouse gases are planned in the local action plans, and on the approach chosen.

## Activity-based:

- If only energy-related activity sectors are included in the BEI, it is sufficient to report only $CO_2$ emissions.
- Other greenhouse gases can also be included in the BEI (from combustion, from waste and water management etc) if the activity-based approach is chosen. **In this case, the emission reporting should use unit "tonnes $CO_2$ equivalent".**

## LCA:

- In the case of the LCA approach **other greenhouse gases may play an important role.**
- In this case emission reporting unit **"tonnes $CO_2$ equivalent"** should be used.
- 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, so the unit wil be „tonnes $CO_2$"
- Use Global Warming Potential (GWP) values to convert $CO_2$ to $CO_2$-equivalents

KSSENA

# How to develop BEI
# 5: EMISSION FACTORS

ENERGee Watch

## Choice of emission factors:

- Activity-based/territorial approach offers option to use standard/default emission factors, according to IPCC guidelines (Intergovernmental Panel on Climate Change)

Based on the Carbon content of fuels.

Advantages:

- Simple
- Easily accessible
- In line with international reporting (UNFCC, Kyoto protocol…).

- LCA (Life Cycle Analysis) approach requires LCA emission factors (CoM, ELCD, GHG Protocol…)

Include 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

# How to develop BEI
# 5: EMISSION FACTORS

Activity-based/territorial approach:
Local authority can choose between **LOCAL** emission factors or **DEFAULT** (national, EU, global) factors

## Emission factors should be relevant to the particular situation of the local territory:

- It is encouraged to use local (or regional or even coutry-specific) emission factors, as BEI should be relevant as much as possible to the particular situation of the local territory.
- Local authorities can develop their own emission factors by following IPCC (2006) guidelines on energy in the choice and development of emission factors
- If no local, regional, or country-specific sources are available use default factors.
- In order to ensure the consistency of the time-series, the local authorities shall apply the same emission factors (even if emission factor changes due to new knowledge) to all BEI inventories! Only when the changes in the emission factors reflect changes in the fuel used the emission factors can vary between inventories.

## Default factors available from:

- IPCC „Guidelines for National GHG Inventories“
- EFDB emission factor database (IPCC)
- Covenant of Mayors „How to develop a Sustainable Energy and Climate Action Plan (SECAP) – Part 2 – Baseline Emission Inventory“
- European Investment Bank „EIB Project Carbon Footprint Methodologies“
- Etc.

# How to develop BEI
# 6: IDENTIFY KEY TARGET SECTORS

ENERGee Watch

WHAT TO INCLUDE:

- Emission inventories shall focus on energy-related sectors (e.g. municipal buildings and infrastructure, street lighting, public and private transport, services) for which local authorities have greater influence, even though the scope could be enlarged to other sectors in which they take specific actions (e.g. waste management, agriculture).

WHAT NOT TO INCLUDE (based on CoM):

- Emissions in sectors over which local authority has no control should be excluded:
    - large scale power plants >20 MW capacity
    - aviation and Shipping (except local ferries)
    - Nuclear energy
    - AFOLU Carbon Capture and Storage (CCS) technologies
    - Emission credits purchased or sold on the carbon market
    - All fugitive emissions from the supply chain
    - Process emissions from industrial plants
    - Other source included under the Industrial Processes and Product Use (IPPU) sector

# How to develop BEI
# 6: IDENTIFY KEY TARGET SECTORS

## Covenant of Mayors:

### 1 Buildings, equipment, facilities

- **All GHG emissions (direct emission from fuel combustion and indirect emission due to consumption of grid-supplied energy) occurring in stationary sources within the local authority boundary.**
- These emissions come from final energy consumption in **residential, commercial and municipal/institutional buildings and facilities, as well as from manufacturing, construction industries** (below or equal to 20 MW as thermal energy input) and **agriculture/forestry/fisheries.**
- GHG emissions from "energy generation" industries/facilities should not be reported under this sector to avoid double counting of emissions.

### 2 Transport

- **All GHG emissions** (direct emission from fuel combustion and indirect emission due to consumption of grid-supplied energy) **occurring for transportation purposes within the local authority boundary**
- In addition, local authorities are recommended to further disaggregate by mode (on-road, rail, waterborne navigation and off-road) and by fleet type (Municipal, Public and Private and commercial transport).
- Local authorities are recommended to use the **"geographic (territorial)" methodology** to estimate activity data in the transport sector. In specific circumstances, other methodologies such as "fuel sales", "resident activity" and "city-induced" can be used

### 3 Other non-energy related

- **All GHG emissions non-energy related from disposal and treatment of waste generated within the city boundary.**
- It shall be reported and desegregated by waste management, wastewater management and other non-energy related.
- Where waste/wastewater is used for energy generation, emissions should not be reported under this sector to avoid double counting of indirect emission

### 4 Energy supply

- **GHG emissions from generation of grid-supplied energy within the local authority boundary,** and **GHG emissions from generation of grid-supplied energy by facilities owned** (full or partial) **by the local authority outside the local authority boundary.**
- disaggregated by electricity-only, CHP and heat/cold production plants.
- To avoid double counting, these emissions will not be part of the total direct emissions, but accounted through the local emission factor for indirect emissions.

# How to develop BEI
# 6: IDENTIFY KEY TARGET SECTORS

ENERGee Watch

## Climate Alliance

*(„Klimaschutz in Kommunen – Praxisleitfaden“)*

1. **Private households:** final energy requirements of all private users in the municipality
2. **Manufacturing/industry:** industry sector is subdivided as follows: energy consumption in manufacturing, mining and quarrying
3. **Municipal facilities:** A differentiation according to administrative buildings, municipal schools and day-care centers as well as street lighting is required. Municipal buildings with the purpose of living are to be included. This sector also includes energy consumption of municipal infrastructure systems (water/wastewater, roads and waste and the municipal vehicle fleet..)
4. **Transport:** includes the emissions of all motorized means of transport in passenger and freight transport. The municipal accounting focuses in particular on road transport (passenger and freight transport) and local public transport (public transport, buses, trams and local rail transport), which are in the direct field of action of the municipality and must therefore be recorded in the balance in each case are .

## Greenhouse Gas Protocol

*(„Global Protocol for Community-Scale Greenhouse Gas Emission Inventories“)*

1. **Stationary energy:** Residential buildings, Commercial and institutional buildings and facilities, Manufacturing industries and construction, Energy industries, Agriculture, forestry, and fishing activities, Non-specified sources, Fugitive emissions from mining, processing, storage, and transportation of coal, Fugitive emissions from oil and natural gas systems
2. **Transportation:** On-road, Railways, Waterborne navigation, Aviation, Off-road
3. **Waste:** Solid waste disposal, Biological treatment of waste, Incineration and open burning, Wastewater treatment and discharge
4. **Industrial processes and product use (IPPU):** Industrial processes, Product use
5. **Agriculture, forestry, and other land use (AFOLU):** Livestock, Land, Aggregate sources and non-CO2 emission sources on land
6. **Other scope 3:** Any other emissions occurring outside the geographic boundary as a result of city activities.

# Monitoring

ENERGee Watch

## Use the same tool

Use the same tool you used for baseline emission inventory (web based, excel…)

## Keep it consistent!

- Do not change methodology, data sets, approach, sectors

## Recommendation: monitor on yearly basis

- Monitoring on yearly basis provides better understanding of the various factors that influence the $CO_2$ emissions, allowing quicker reactions. Also specific expertise necessary for inventories can be maintained and consolidated.
- Interval can be chosen individualy – such as 2 or 4 years.

KSSENA

# Recalculations

All emissions over time should be estimated consistently - as far as possible, the time series should be calculated using the same methods, data sources and boundary definitions in all years. However, there are a few occasions when recalculation of BEI  is necessary to ensure that the reported trends in emissions reflect real changes in the emissions, instead of other factors:

1. Changes in inventory boundary:
Changes or adjustments in a city's administrative boundary, or changes in inclusion or exclusion of activities within the city boundary. But no emissions recalculations are needed for activities that either did not exist in the base year, or reflect a natural increase or decrease in city activities (known as "organic growth").

2. Changes in calculation methodology or improvements in data accuracy:
A city may report the same sources of GHG emissions as in previous years, but measure or calculate them differently (new information on local emission factors, correction of heat consumption for outside temperature etc.)

3. Industry delocalization

4. Adding or removing optional activity sectors

5. Discovery of significant errors

6. Methodological changes (not recommended, only if needed).

Existing methodologies make no specific recommendations as to what constitutes "significant."
For example, a city may identify a 5% or 10% threshold to determine if the applicable changes to base year emissions warrant recalculation.

# RVA - RISK AND VULNERABILITY ASSESSMENT

**Risk and Vulnerability Assessment is the second most important part of the baseline review.** RVA will allow the definition of appropriate adaptation strategies, which will translate into the SECAP's actions and contribute to improve the resilience of the territory.

- European cities are heavily vulnerable to the impacts of climate change: Heat, flooding, water scarcity and droughts (among others) can impact health, infrastructure, local economies, and quality of life of inhabitants.

- A Risk and Vulnerability Assessment (RVA) determines the nature and extent of this risks by analysing potential hazards and assessing the vulnerability that could pose from such threat. This can take the form of a single assessment or various assessments undertaken per sector.

- Adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause or taking advantage of opportunities that may arise. Effective climate action and adaptation provides resilience in the face of climate impacts as well as quality of life, improved public health, job creation

ENERGee Watch

Municipalities are exposed to a series of climate hazards that will depend on its geographical location and the climate trends above mentioned. Those hazards are, according to the Covenant of Mayors:

- **Extreme heat**
- **Extreme cold**
- **Heavy precipitation:** rainfall, snowfall, fog or hail.
- **Floods:** flash/surface flood, river flood, coastal flood, groundwater flood or permanent inundation
- **Droughts and water scarcity**
- **Storms:** severe wind, tornado, cyclone (hurricane/typhoon), tropical or extratropical storm, storm surge or lightning/thunderstorm.
- **Mass movement:** landslide, avalanche, rockfall or subsidence
- **Wild fires:** forest or land fire.
- **Chemical change:** saltwater intrusion, ocean acidification or atmospheric $CO_2$ concentrations.
- **Biological hazards:** water-borne disease, airborne disease or insect infestation.
- **Other…**

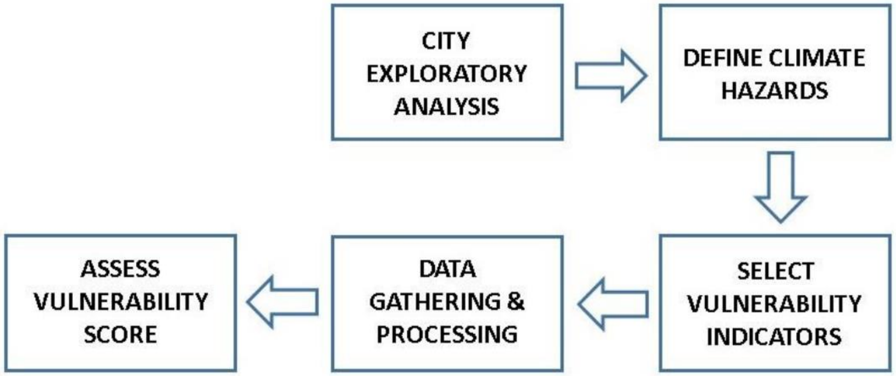
KSSENA

# RVA - methodology

The most common approach for RVA is
**Indicator-based vulnerability assesment.**

Indicator-Based Vulnerability Assessment (IBVA) has been widely used to assess climate change vulnerability in urban contexts.

- This approach is particularly suitable for smaller and mid-size cities since it doesn't demand particularly technical skills or modelling tools and can be fed by using public available datasets.
- Using this approach also allows comparability of results and the possibility of benchmarking European cities in terms of vulnerability to climate change.




*Source: JRC own elaboration*

# RVA - steps

## STEP 1: Exploratory analysis with key-stakeholders

- Carry out an analysis of the historical events that have affected the municipality in recent years or even decades, since they can serve as an indication of potential events that could occur in the future.
- Collect all available documents that provide information on events related to climate change: floods, avalanches, heat island effect, heat waves, etc.
- Map main sources of information: City agencies, civil protection, utility companies, and universities, among others.

For example: information on flood areas can be obtained from data provided by river basin management authorities, data related to avalanches and wildfires can be gathered from Civil Protection programs ect.

- Historical information on floods, avalanches, heat waves ect as well as and corresponding trend analysis should be summarized in a table.

**Table 5-1 Overview of historic and projected extreme weather events affecting Belgrade**

| Extreme weather events | Observed climate trends (1995 – 2014) | Projected climate change scenarios (medium scenario A1b for 2021-2050 and 2071-2100) |
|---|---|---|
| Extreme heat | Involving high temperatures of above 39 degrees Celsius over extended periods between June and August, at times accompanied by an extreme lack of precipitation. The rate of frequency with which heat waves are reported appears to be greater in more recent years with seven of the eight incidents reported occurring between 2000 and 2013. | Mean summer temperatures are projected to increase by 1.25 degrees Celsius between 2021-2050 and by 5.4 degrees Celsius between 2071-2100 with the number of hot days also set to increase by 12 and 60 days, during the respective timeframes. |
| Extreme cold | Involving extended periods over the winter with the number of consecutive ice days and snow days above the annual average. The reported incidents indicate that the rate of frequency has increased in more recent years. | Projections indicate that an overall a balancing effect can be expected to mitigate occurrences of extreme cold owing to overall temperature increases. |
| Droughts | Several incidents of drought in Belgrade have occurred but the most significant involved no rainfall for an extended period of over two consecutive months and reduced precipitation by 15% of the average. Both incidents occurred at the same time as the previously reported heat waves. | Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050; however, between 2071 and 2100, reductions in precipitation of 20 to 40% are forecast with greater risks of drought as a result. |
| Heavy precipitation and floods | Heavy precipitation involving up to more than 200 mm of rain in a week i.e. the equivalent of three months' rain under normal | Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050 and limited risk of heavy precipitation in the longer timeframe (between 2071 and 2100) based on general declining trends.<br>No changes are expected in the number of days with heavy precipitation. |

KSSENA

# Hazards

ENERGee Watch

## STEP 2: Identify climate hazards for the city

A first coarse assessment can be done with the help of the following picture presenting macro-scale information. Even though the exposure to climate change and weather extremes can vary a lot across Europe, a common list of climate change-related indicators and related impacts within the same climate risk zone is helpful.

This macro-scale information should the be crossed with local observed instances of a specific city.

Most urban areas are affected by more than one hazard, and the most recurrent impacts they have are:

- heat waves on human health
- droughts on water management
- inland floods and coastal floods (due to storm surge and heavy rainfalls) on city infrastructure, buildings, socioeconomic tissues and services.
- Ect.

KSSENA

**Arctic region**
- Temperature rise much larger than global average
- Decrease in Arctic sea ice coverage
- Decrease in Greenland ice sheet
- Decrease in permafrost areas
- Increasing risk of biodiversity loss
- Some new opportunities for the exploitation of natural resources and for sea transportation
- Risks to the livelihoods of indigenous peoples

**Atlantic region**
- Increase in heavy precipitation events
- Increase in river flow
- Increasing risk of river and coastal flooding
- Increasing damage risk from winter storms
- Decrease in energy demand for heating
- Increase in multiple climatic hazards

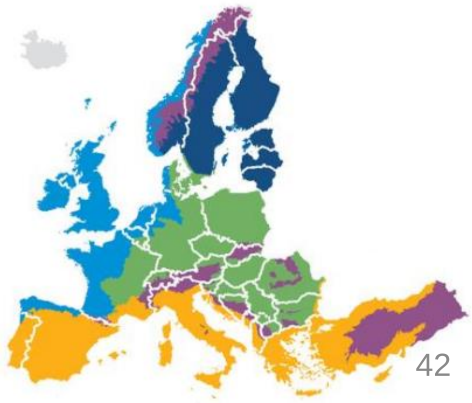
**Mountain regions**
- Temperature rise larger than European average
- Decrease in glacier extent and volume
- Upward shift of plant and animal species
- High risk of species extinctions
- Increasing risk of forest pests
- Increasing risk from rock falls and landslides
- Changes in hydropower potential
- Decrease in ski tourism

**Coastal zones and regional seas**
- Sea level rise
- Increase in sea surface temperatures
- Increase in ocean acidity
- Northward migration of marine species
- Risks and some opportunities for fisheries
- Changes in phytoplankton communities
- Increasing number of marine dead zones
- Increasing risk of water-borne diseases

**Boreal region**
- Increase in heavy precipitation events
- Decrease in snow, lake and river ice cover
- Increase in precipitation and river flows
- Increasing potential for forest growth and increasing risk of forest pests
- Increasing damage risk from winter storms
- Increase in crop yields
- Decrease in energy demand for heating
- Increase in hydropower potential
- Increase in summer tourism

**Continental region**
- Increase in heat extremes
- Decrease in summer precipitation
- Increasing risk of river floods
- Increasing risk of forest fires
- Decrease in economic value of forests
- Increase in energy demand for cooling

**Mediterranean region**
- Large increase in heat extremes
- Decrease in precipitation and river flow
- Increasing risk of droughts
- Increasing risk of biodiversity loss
- Increasing risk of forest fires
- Increased competition between different water users
- Increasing water demand for agriculture
- Decrease in crop yields
- Increasing risks for livestock production
- Increase in mortality from heat waves
- Expansion of habitats for southern disease vectors
- Decreasing potential for energy production
- Increase in energy demand for cooling
- Decrease in summer tourism and potential increase in other seasons
- Increase in multiple climatic hazards
- Most economic sectors negatively affected
- High vulnerability to spillover effects of climate change from outside Europe



# Hazards

There are many easily accessible sources of information about climate change projections and data in Europe, such as:

Technical reports by European and multilateral agencies:

- IPCC, AR5 Synthesis Report: Climate Change 2014: https://www.ipcc.ch/report/ar5/syr/
- PESETA II and PESETA III projects: https://joint-research-centre.ec.europa.eu/peseta-projects/peseta-iii_en

Data sharing platforms, tools:

- Climate-ADAPT Urban Adaptation Map: https://climate-adapt.eea.europa.eu/knowledge/tools/urban-adaptation
- Climate ADAPT platform: https://climate-adapt.eea.europa.eu/countries-regions/countries
- IPCC data Distribution Centre: https://www.ipcc-data.org/archive/
- JPI Climate: http://www.jpi-climate.eu/publications
- Climate Change Knowledge Portal: https://climateknowledgeportal.worldbank.org/

National and international meteorological centers, such as:

- European Centre for Medium Range Weather Forecasts: https://www.ecmwf.int/

# Hazards

ENERGee Watch

**Table 3.** Summary of local climate hazards, based on their qualitative assessment.

| Climate hazard | Current risk of hazard occurring | | Future hazard | | |
|---|---|---|---|---|---|
| | Probability | Impact | Change in intensity | Change in frequency | Timeframe |
| | Low<br>Moderate<br>High | Low<br>Moderate<br>High | Decrease<br>No change<br>Increase | Decrease<br>No change<br>Increase | Long-term<br>Medium-term<br>Short-term |
| | | | | | |
| | | | | | |

***Current risk of hazard occurring***

***Probability of hazard***

1- Low.
2- Moderate.
3- High.

***Impact of hazard***

1- Low.
2- Moderate.
3- High.

***Risk = Probability x Impact***

***Future hazard***

***Expected change in intensity***

1- Decrease.
2- No change.
3- Increase.

***Expected change in frequency***

1- Decrease.
2- No change.
3- Increase.

***Timeframe***

1- Long-term.
2- Medium-term.
3- Short-term.

KSSENA

ENERGee Watch

**Table 5-2 Climate hazards affecting Belgrade**

| Hazards | Impact of hazard | Expected changes in intensity/frequency | Timeframes |
|---|---|---|---|
| **Extreme heat** | High | Mean summer temperatures are projected to increase by 1.25 degrees Celsius between 2021-2050 and by 5.4 degrees Celsius between 2071-2100 with the number of hot days also set to increase by 12 and 60 days, during the respective timeframes. | Medium-term |
| **Extreme cold** | High | Projections indicate that an overall a balancing effect can be expected to mitigate occurrences of extreme cold owing to overall temperature increases. | Medium-term |
| **Droughts & water scarcity** | Moderate | Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050; however, between 2071 and 2100, reductions in precipitation of 20 to 40% are forecast with greater risks of drought as a result. | Long-term |
| **Heavy precipitation and floods** | High | Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050 and limited risk of heavy precipitation in the longer timeframe (between 2071 and 2100) based on general declining trends.<br>No changes are expected in the number of days with heavy precipitation. | Long-term |
| **Storms** | Moderate | Increasing intensity and frequency of storms during summer months is expected to continue. | Long-term |

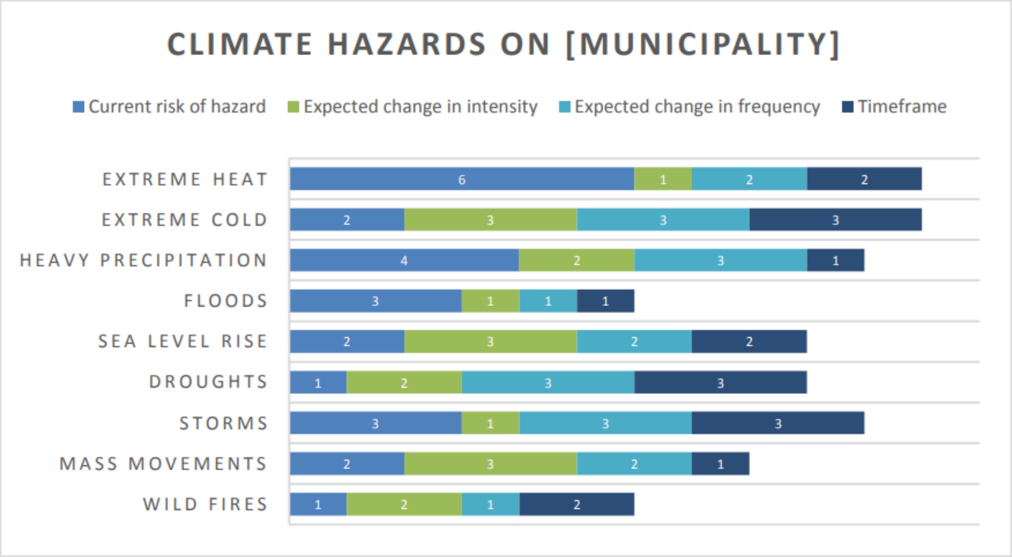



**Figure 10.** Example of chart of the quantification of local climate hazards, based on their qualitative assessment (source: own elaboration)

LIFE-Adaptate-SECAP-Guide.pdf (lifeadaptate.eu)

# Vulnerabilities

## Step 3: Assessment of local vulnerabilities to climate hazards

- Vulnerabilities can be understood as the capacity that a system has to cope with the hazards.

- Each hazard or impact can affect different areas within a city, and if the specific hazard occurs, the consequences of this impact will depend on the vulnerabilities and weaknesses of the city. *(how well is a city able to cope with the impact?)*

- Vulnerabilities depend on specific socioeconomic, institutional and biophysical weaknesses of the city.

# Vulnerabilities

The Covenant of Mayors distinguishes two major types of vulnerabilities:

**Socio-economic vulnerabilities**:
they reflect the lack of resilience of a territory due to social (population) and economic (local economy) factors, as well as others that aggravate the situation.

- Population growth
- Population density
- Percent share of sensitive population (elderly, young, living alone, unemployed, etc.)
- Percent share of population living in high-risk areas (floods, fires, etc.)
- Presence of areas not accessible for municipal services
- Percent share of population with low cultural level
- Economic activity sensitive to climate change (agriculture, fisheries, etc.)

**Physical and environmental vulnerabilities**:
they reflect the lack of resilience caused by the geographical situation of the territory, its spatial planning or environmental aspects, as well as the factors that aggravate the situation.

- Presence of affected coastal areas
- Presence of affected rivers
- Transport networks in areas at risk
- Buildings in areas at risk
- Age of the buildings
- Air pollution
- Water pollution
- Soil pollution
- Urban heat islands
- Difficult access to areas at risk for emergency services
- Forest cover

# Vulnerabilities

Next, it is important to identify the least resilient sectors regarding climate change, which will be the main targets of the action plan for the adaptation of the municipality. The Covenant of Mayors proposes, in a non-exclusive way, the following sectors:

- Buildings: Refers to any (municipal, residential, tertiary; public or private) structure or groups of structures, surrounding spaces, permanently constructed or erected on its site.
- Transport: Includes road, rail, air or water transport networks and related infrastructure (e.g. roads, bridges, tunnels, hubs, ports and airports). It comprises an extensive range of both public and private assets and services and excludes all related vessels, railways or vehicles.
- Energy: Refers to the energy supply service and related infrastructure (transmission and distribution networks, generation systems), for all energy types: coal, petroleum products, natural gas, combustible renewables and waste, electricity and heat.
- Water: Refers to the water supply service and related infrastructure. It also covers water use (e.g. by households, industry, energy production, agriculture, etc.) and (waste-, rain-) water management system, that includes sewers, drainage and wastewater treatment systems.
- Wastes: Includes activities related to the management (including collection, treatment and disposal) of various forms of waste, such as solid or non-solid industrial or household waste, as well as contaminated sites

Also:
Land planning and use, Health, Tourism, Education ect..

# Vulnerabilities

ENERGee Watch

**Table 4.** Justification of the sectors most vulnerable to identified climate hazards.

| Climate hazard | Sector | Level of current vulnerability |
|---|---|---|
| | Buildings<br>Transport<br>Energy<br>Water<br>Wastes<br>... | Low<br>Moderate<br>High |
| | | |

**Table 5-3 Overview of sectors' vulnerability to climate hazards**

| Hazards | Vulnerable sectors | Risk of impact |
|---|---|---|
| Extreme heat | Buildings/equipment/facilities | Very high risk of impact in the summer months |
| | Transport | High risk of impact in summer months. |
| | Energy production and supply | High risk of impact in summer months. |
| | Water supply and sewerage | Very high risk of impact in the summer months. |
| | Land use planning | Very high risk of impact in the summer months. |
| | Agriculture, forestry and biodiversity | Very high risk of impact in the summer months, high in the winter months. |
| | Health | High risk of impact in spring and summer months |
| | Tourism | Medium risk of impact in summer month. |
| Extreme cold | Buildings/equipment/facilities | Medium risk of impact in winter months. |
| | Transport | Medium risk of impact in winter months. |
| | Energy production and supply | Medium risk of impact in winter months. |
| | Water supply and sewerage | Low risk of impact in the winter months. |
| | Land use planning | Low risk of impact. |
| | Agriculture, forestry and biodiversity | Low risk of impact. |
| | Health | High risk of impact winter months |
| | Tourism | Medium risk of impact in winter month. |
| Heavy precipitation and floods | Buildings/equipment/facilities | Very high risk of impact in summer months, high in winter months. |
| | Transport | Very high risk of impact in summer months, high in winter months. |
| | Energy production and supply | Very high risk of impact in summer months and high in winter months. |
| | Water supply and sewerage | Very high risk of impact in the summer and high in the winter months. |
| | Land use planning | High risk of impact in the summer months, medium in winter months |
| | Agriculture, forestry and biodiversity | High risk of impact in the summer months, medium in winter months |
| | Health | High risk of impact in summer and winter months |
| | Tourism | Medium risk of impact in summer month, low in winter months. |

# Vulnerabilities

It is also interesting to identify the population groups most vulnerable to each climate hazard. Covenant of Mayors suggests the following groups:

- Women and girls
- Children
- Youth
- Elderly people
- Marginalized groups
- People with functional diversity
- Chronically ill
- Low-income households
- Unemployed
- People living in substandard housing
- Migrants and displaced persons
- Others

# Vulnerabilities

ENERGee Watch

**Table 5.** Table identifying vulnerable population groups .

| Climate hazard | Most vulnerable population groups |
|---|---|
| | Women and girls<br>Children<br>Youth<br>Elderly people<br>... |
| | |

**Table 5-4 Vulnerable population groups**

| Hazards | Vulnerable categories | Vulnerability level |
|---|---|---|
| **Extreme heat** | The elderly, babies and children, the chronically ill, workers who work outdoor (exposed to heat), people with mobility impairments, homeless, athletes, people who live or work in central urban municipalities etc.<br>The potential consequences are deaths, mainly due to cardiovascular diseases, spread of vector-borne and infectious diseases, altered allergy patterns, heat stress | High vulnerability |
| **Extreme cold** | The elderly, the chronically ill, highly vulnerable persons, workers who work outdoor (exposed to cold), people with mobility impairments, homeless.<br>The potential consequences are casualties and fatalities, spread of respiratory and infectious diseases, deterioration of the state of cardiovascular patients | High vulnerability |
| **Droughts and water scarcity** | People who live or work in affected areas, especially the elderly, the chronically ill, babies and children, workers who work outdoor (exposed to heat or cold), people with mobility impairments, athletes, the homeless.<br>The potential consequences are effects on the air, hygienic conditions, diseases caused by consuming poor-quality water and food. | Medium vulnerability |
| **Heavy precipitati on/ flood** | All persons who live or work in affected areas, especially the elderly, the chronically ill, babies and children, workers who work outdoors (exposed to heat or cold), people with reduced mobility, athletes, homeless etc. Particularly sensitive inhabitants of the city municipalities in the vicinity of rivers Sava and Danube: Obrenovac, Lazarevac, Zemun, Novi Beograd, Rakovica, Zemun, Čukarica, Palilula, Savski Venac.<br>The potential consequences are casualties and fatalities, spread of infectious diseases due to contaminated water, deterioration of state of chronic patients due to difficulty in providing of lack of medical assistance (diabetes, dialysis etc.) | High vulnerability |
| **Storm** | All persons who live or work in affected areas, especially the elderly, babies and children, the homeless, workers who work outdoor, etc.<br>The potential consequences are casualties and fatalities | Medium vulnerability |

## Step 4: Data gathering and processing

City socioeconomic indicators and information about the built environment and biophysical attributes can be extracted from existing databases at local, regional and national level.

- The Urban Audit database (Eurostat, 2016) provides a comparable set of indicators (mainly socioeconomic data) with European coverage: https://ec.europa.eu/eurostat/web/cities/data/database
- The Urban Vulnerability Map Book of the Climate-ADAPT platform provides useful maps and data at city-level about urban capacity for response, governance, resources and economic status, among others: https://climate-adapt.eea.europa.eu/knowledge/tools/urban-adaptation
- National Statistical Institutes also provide useful information about the demographics and socioeconomic status of the urban population.
- European Statistical System was created with the objective of providing comparable statistics at EU level. https://ec.europa.eu/eurostat/web/european-statistical-system
- Social vulnerability to climate change in European cities is a technical paper that discusses the concepts of social vulnerability and socially just adaptation to climate change: https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_1-2018

# Vulnerabilities

## Step 5: Assess vulnerability score

Once local vulnerabilities to climate hazards have been identified, it is necessary to assess them according to three parameters:

- **Exposure:** Information about the location and characteristics of relevant local assets must be collected. This could result in a map of relevant places and their level of exposure to different threats, which could be georeferenced, for example, on the Google Earth platform. Mapping could also highlight municipal growth trends
- **Sensitivity:** In the context of risk assessment, this term refers to the degree to which a system (relevant local asset) could be affected or is capable of responding to a hazard. Sometimes, this sensitivity is determined by how relevant and critical that asset is for the municipality.
- **Adaptive capacity:** It will be determined by the existence of technical and scientific knowledge, as well as the financial capacity and other factors mentioned in the next point, which favour to carry out adaptation actions against such vulnerability.

Sensitivity to and adaptation capacity for specific climate threats can be calculated through different equations and aggregation approaches (e.g. linear, geometric, noncompensatory Multi-Criteria Analysis). Using GIS map is a common and simple way to combine variables of city sensitivity and adaptation capacity into the vulnerability indicator. https://www.esri.com/en-us/what-is-gis/overview

# Vulnerabilities

ENERGee Watch

Vulnerability score can also be made by using qualitative approach; each category will be assigned a numerical value that quantifies it. This analysis will be carried out either for each vulnerability or for each sector (and hazard) on which vulnerabilities have been identified:

***Exposure***

1- Very low: the level of exposure to climate change of assets is very low. Climate hazards cannot affect local assets.
2- Low: the level of exposure to climate change of assets is low. Some climate hazards can slightly affect local assets.
3- Moderate: assets are exposed to climate change through one or more climate hazards.
4- High: assets are highly exposed to climate change through one or more climate hazards.
5- Very high: assets are very highly exposed to climate change through one or more climate hazards.

***Sensitivity***

1- Very low: the effects of the vulnerability will not have any impact on the municipality.
2- Low: the effects of the vulnerability on the municipality will be observed in the long term.
3- Moderate: the effects of the vulnerability on the municipality will be observed in the medium term.
4- High: the effects of the vulnerability on the municipality will be observed in the short term.
5- Very high: the effects of the vulnerability on the municipality are already visible.

***Adaptive capacity***

5- Very low: the potential of the municipality in terms of adaptive capacity is very low; there are great difficulties in implementing adaptation measures.
4- Low: the potential of the municipality in terms of adaptive capacity is low; but some adaptation measures can be implemented.
3- Moderate: the municipality has some potential to mitigate the effects of climate change, although no adaptation measure has been implemented.
2- High: the municipality has implemented some measures to reduce its vulnerability to climate change, but much work remains to be done.
1- Very high: the municipality has resources and has implemented measures to reduce the impact of climate change.

Analysis will be carried out either for each vulnerability:

**Table 6.** Summary of local vulnerabilities assessed qualitatively.

| Vulnerability | Exposure | Sensitivity | Adaptive capacity |
|---|---|---|---|
| | Very low<br>Low<br>Moderate<br>High<br>Very high | Very low<br>Low<br>Moderate<br>High<br>Very high | Very low<br>Low<br>Moderate<br>High<br>Very high |
| | | | |

Or for each sector (and hazard) on which vulnerabilities have been defined:

**Table 7.** Summary of local vulnerabilities assessed qualitatively.

| Sector | Climate hazard | Relevant factors for adaptive capacity | Present level of the adaptive capacity |
|---|---|---|---|
| | | Access to services<br>Socio-economic<br>Governmental & institutional<br>Physical & environmental<br>Knowledge & innovation | Very low<br>Low<br>Moderate<br>High<br>Very high |
| | | | |
| | | | |

# Vulnerabilities

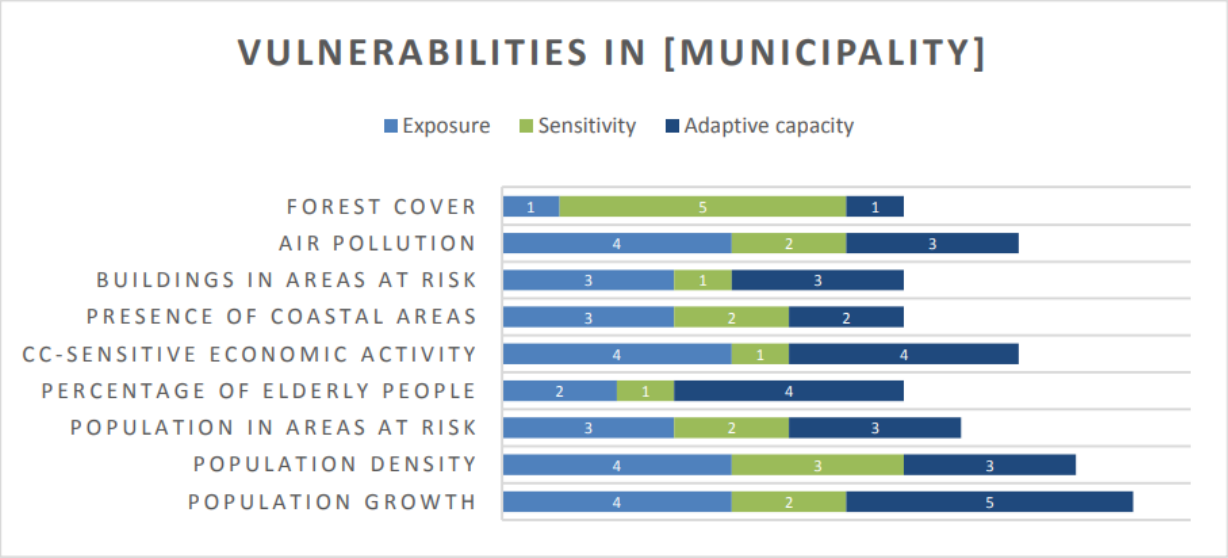



**Figure 11.** Example of chart of the quantification of local vulnerabilities, based on their qualitative assessment (source: own elaboration)

# Impact risks

Additionally:

Impact risks can be identified for each affected sector.

Impact risk is climate hazard in conjuction with local vulnerability. The identified vulnerabilities must be associated with the climate hazards to which they apply, obtaining a set of possible impacts produced by climate change.

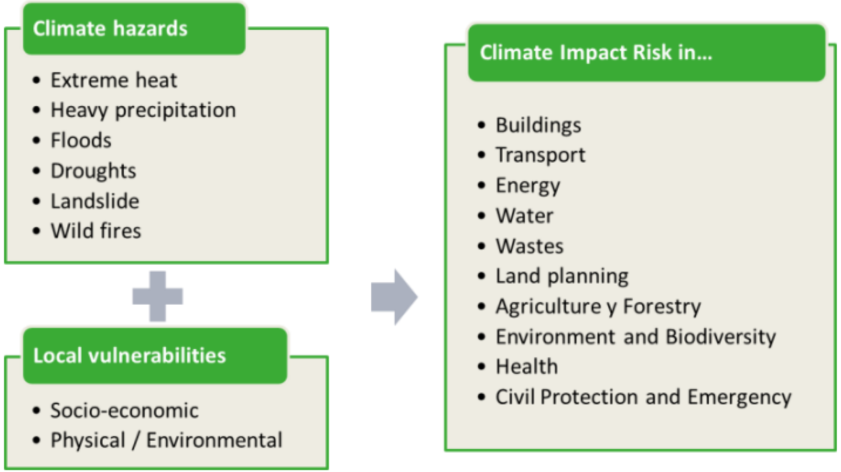



**Figure 12.** Scheme for obtaining climate risks from local hazards and vulnerabilities (source: own elaboration)

# Risk

ENERGee Watch

***Likelihood of Occurrence***

1- Unlikely.
2- Possible.
3- Likely.

***Expected Impact Level***

1- Low.
2- Moderate.
3- High.

***Timeframe***

1- Long-term.
2- Medium-term.
3- Short-term.
4- Current.

**Table 8.** Summary of the expected climate impact risks in the municipality, assessed qualitatively.

| Sector | Climate Hazard | Vulnerability | Expected Impact Risk | Likelihood of Occurrence | Expected Impact Level | Timeframe |
|---|---|---|---|---|---|---|
| | | | | Unlikely<br>Possible<br>Likely | Low<br>Moderate<br>High | Long-term<br>Medium-term<br>Short-term<br>Current |
| | | | | | | |
| | | | | | | |

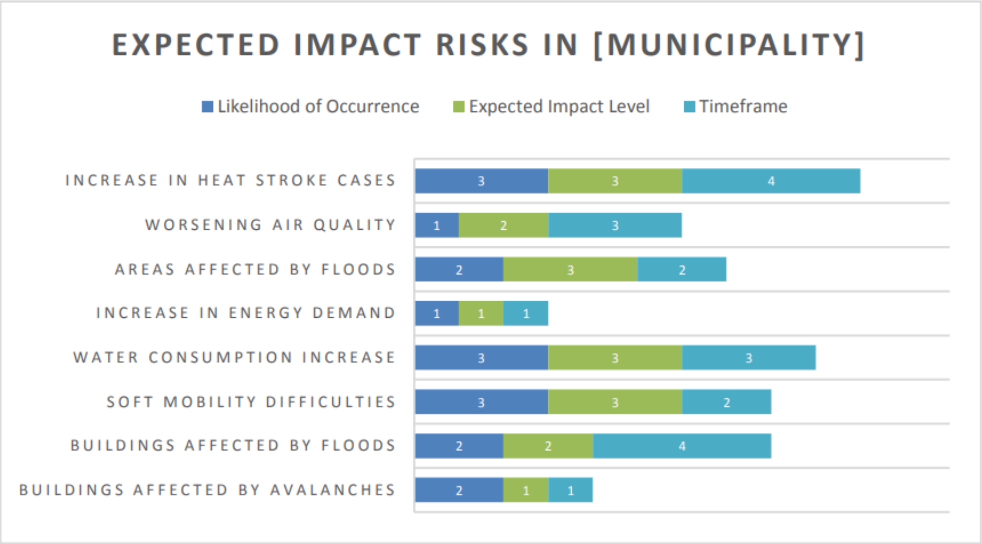



**Figure 13.** Example of chart of the quantification of climate impact risks in the municipality, based on their qualitative assessment (source: own elaboration)

## Recap

- A Risk and Vulnerability Assessment (RVA) determines the nature and extent of this risks by analysing potential hazards and assessing the vulnerability that could pose from such threat.

Hazards + Vulnerabilities = Risks

SESSION 2

# Energy management

ENERGee Watch has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892089.

# Legal background

ENERGee Watch

**DIRECTIVE 2012/27/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL** of 25 October 2012 on energy efficiency:

**Article 5, section 7**
Member States shall encourage public bodies, including at regional and local level, and social housing bodies governed by public law, with due regard for their respective competences and administrative set-up, to:

- adopt an energy efficiency plan, freestanding or as part of a broader climate or environmental plan, containing specific energy saving and efficiency objectives and actions
- put in place an energy management system, including energy audits, as part of the implementation of their plan
- use, where appropriate, energy service companies, and energy performance contracting to finance renovations and implement plans to maintain or improve energy efficiency in the long term

KSSENA

# Legal background

EED 2012/27/EU as adopted by the Energy Community states in paragraph 1:

… **from 1 December 2017, 1% of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements** that it has set in application of Article 4 of Directive 2010/31/EU, as incorporated and adapted by the Ministerial Council Decision 2010/02/MC-EnC.

The 1% rate shall be calculated on the total floor area of buildings with a total useful floor area over 500 $m^2$ owned and occupied by the central government of the Contracting Party concerned that, on 1 January of each year, do not meet the national minimum energy performance requirements set in application of Article 4 of Directive 2010/31/EU, as incorporated and adapted by the Ministerial Council Decision 2010/02/MC-EnC.

That threshold shall be **lowered to 250 $m^2$ as of 1 January 2019.**

# Legal background in Slovenia

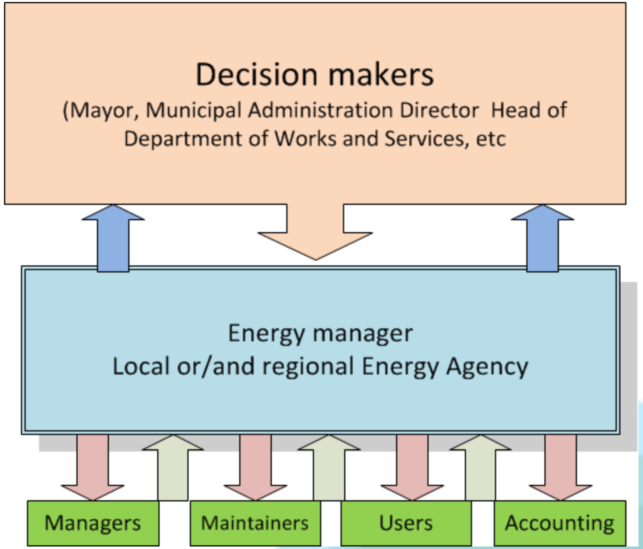
This obligation has been transposed into Slovenian legislation with the Energy Act EZ-1, which in Article 324 requires from public entities to establish a system of energy management in the public sector. This system includes:

- ✓ Set annual and long-term goals of energy efficiency and energy consumption,
- ✓ Preparation of the action plan of measures to achieve the objectives,
- ✓ Appointment of an energy manager;
- ✓ Regular collection of data on energy and water consumption - energy accounting (or bookkeeping),
- ✓ verification of objectives, reporting on the achievement,
- ✓ Information and awareness of users

# Set up an Energy management system

Adequate administrative structures in municipalities:

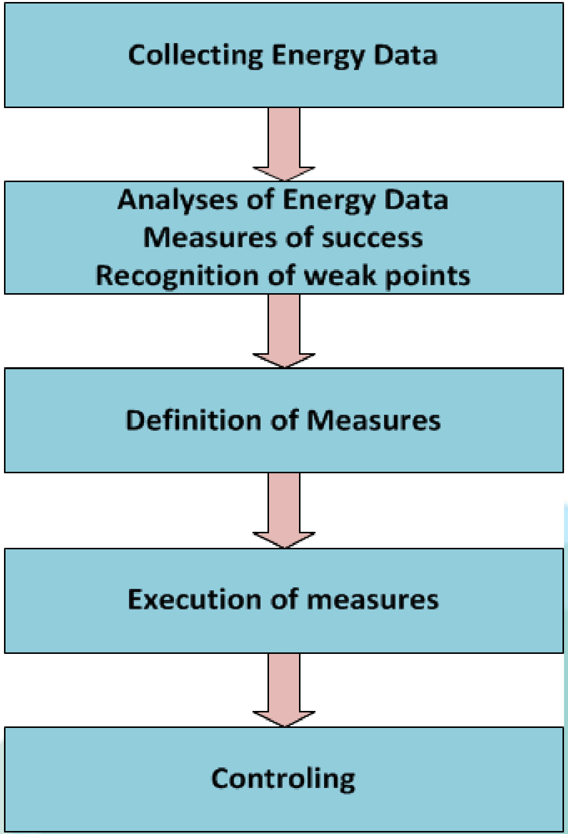
- Energy manager (internal or external expert organization; Energy manager has specific hierarchic position)
- Direct link with decision makers: Mayor, Head of Department of Works and Services, Head of Mayor's office, etc;
- Cooperation with Department of Economy and Finance (possibilities of investments, budget, etc)



# Set up an Energy management system

## Role of the energy manager – TASKS

- Analyses of energy supply, consumption and costs (Secure, stabile and quality of energy supply);
- Energy audits
- Preparation of RES and RUE measures (Energy Action plan);
- Communication between decision makers and maintainers, accouters, etc;
- Measurements of the Environmental impacts;
- To create long-term strategy on energy management;
- Monitoring - Energy bookkeeping
- Education, motivate and raise the awareness of all employees.



# Energy management system

ENERGee Watch

## PHASES:

### 1 Systematic acquisition of energy data

**Building stock** – creating building stock of buildings owned by municipality

**Energy data** – collecting data in regular time intervals, preferably by software - energy bookkeeping.

**Preliminary analysis and energy audits**

*Accurate and correct data collection is a baseline for all the later processing and calculations of EE and RES implementation*

### 2 Processing and analyzing energy data

Analysis of energy data reveals opportunities for:

- understanding patterns
- improvement in buildings (reports, templates, calculations)

### 3 Implementation and action:

-selection of concrete measures
-feasibility studies
-financial and economical analyses
-implementation
-monitoring & verifying

# Systematic aquisition of energy data

- Establishing EMIS
- Creating Building stock inventory
- Preliminary analysis
- Energy audits

Provide base for energy planning, making sustainable energy action plans, prioritizing buildings, planning budget, implementation of actions, follow-up on actions and monitoring

# Energy management information systems (EMIS)

ENERGee Watch

- One of the key elements of a comprehensive energy management program.
- It provides opportunity for systematic and timely acquisition of energy data.
- A well-designed EMIS can save from 5% up to 10% in overall energy consumption based exclusively on improved management capability by facility managers
- Advanced and complex centralized EMIS system based on for e.g. Supervisory Control and Data Acquisition (SCADA) can reduce energy consumption much further

## MAIN BENEFITS:

- ✓ saving time and personnel capacity
- ✓ provision of accurate and timely information
- ✓ simple process for manipulating, allows an easy manipulation of input parameters).
- ✓ analyzing and storing data for future reference
- ✓ a direct decision support tool for decision makers (building owners, operators),
- ✓ capability to provide more accurate projections of energy use in the future and under changed circumstances (for e.g. application of an energy renovation measure
- ✓ shows data visualization and visualization of trends

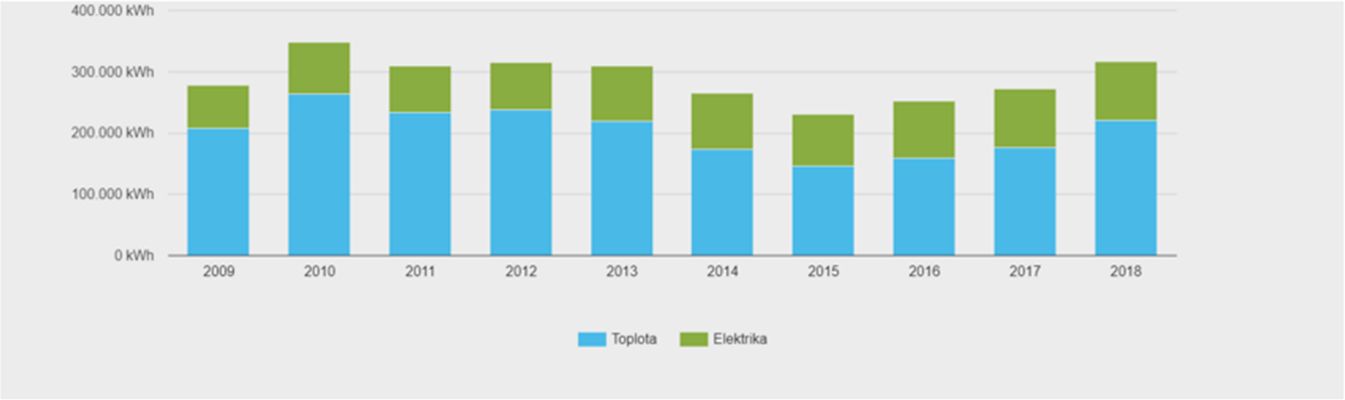
KSSENA

# EMIS tool – E2 example


- Enter invoices / e-invoices regularly and accurately

# EMIS tool – E2 example

- Energy analysis – comparison by year



# Building inventory

ENERGee Watch

At the start of an energy management in a municipality – independent of the size of the public body – it is essential to collect concrete information about the buildings owned and used by the municipality (suggestion: *include buildings with conditioned area >250 m²*)

**Building inventory is a baseline for the next steps**, like setting up an EMIS, and later on, planning long-term renovation strategies with selection of priority buildings and benchmark assessments.

**The building inventory should include:**

- Building: official name of the building
- Address of the building
- Category - building use including possible specific features in the use
- Occupancy – is the municipality the owner or is the building leased / rented?
- Status in context of refurbishment (already refurbished, in plan for next years, etc.)
- **Year of construction and refurbishment(s)**
- **Surface area in m2**
- Conditioned surface area in m2
- Heating system
- Main energy source for heat – energy carrier
- **Annual energy consumption for heat, electricity and water**

# Preliminary analysis

- A questionnaire form
- Get a rough overview of many buildings in a short time (unlike energy audits)
- On-site visit necessary
- To form an overview over possible measures to increase the energy-efficiency of the buildings (with a rough idea of the time-frame needed)
- To be able to prioritize buildings for elaboration of long-term renovation strategy

EmBuild

| Building: Rathaus | | | | |
|---|---|---|---|---|
| year of construction: | 1887 | | | |
| building type: | administration building, town hall | | | |
| energy carrier for heat: | natural gas | | | |
| type of heat supply: | ☐ single stoves<br>☐ constant temp. boiler | ☐ low temp. boiler | ☒ condensing boiler<br>☐ heat pump<br>☐ CHP<br>☐ district heating | |
| age: | ☐ > 20 years | ☒ 10 – 20 years | ☒ < 10 years | |
| heating system: | radiators | | | |
| heating circuit pumps: | ☐ unregulated multi-level | ☒ with electr. control > 2009 | ☐ high-efficient pumps | |
| insulation of heating pipes : | ☐ none with voids | ☐ sufficient | ☒ good | |
| control and regulation system: | ☐ faulty broken<br>☐ hard to operate | ☐ ok, but no documentation (available) | ☒ central control<br>☐ single room control<br>☐ building control system | |
| heating times adapted to building use | ☐ no | ☐ unknown | ☒ yes | |
| heating curve adapted to the standard of the building: | ☐ no | ☐ unknown | ☒ yes | |
| hydraulic balanced system: | ☐ no | ☐ unknown | ☒ yes | |
| ventilation: | windows. | | | |
| domestic hot water: | ☐ none | ☐ decentral | ☒ central | ☒ circulation |
| exterior walls: | masonry ~30 – 50cm | | | |
| | ☒ without insulation | | ☐ with insulation | |
| windows: | ☒ single glazing | ☒ twin pane glazing | ☐ heat protection glas | ☐ triple glazing |
| top floor ceiling / roof: | ☒ without insulation | | ☒ with insulation | |
| cellar ceiling: | ☒ without insulation | | ☐ with insulation | |
| lighting system: | ☐ filament lamps | ☒ energy saving lamps | ☒ fluorescent lamps<br>☐ LED | |
| responsible person: | ☐ no | ☒ yes | ☐ expert, energy manager | |
| energy monitoring: | ☐ no | ☒ yes | ☐ monthly | |
| energy passport issued: | ☒ no | | ☐ yes | |
| potential for low- and no-cost measures: | ☐ high potential | ☒ fair | ☐ low potential | |



This project receives funding from the Horizon 2020 European Union Research and Innovation Programme under Grant Agreement No. 695169

# Energy audits

ENERGee Watch

- The energy efficiency directive of the European Union defines an energy audit as: “a **systematic procedure with the purpose of obtaining adequate knowledge of the energy consumption profile of a building or group of buildings, an industrial or commercial operation or installation or a private or public service,** identifying and quantifying cost-effective energy saving opportunities, and reporting the findings”

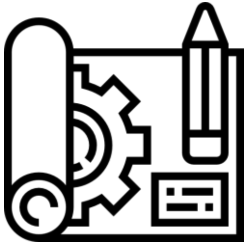
**Design tool** → public administration can acquire technical specifications for project design

**Assessment tool** → based on which the public administration can take an informed decision on the implementation of energy efficiency measures in a building

# Energy audits – Data collection

ENERGee Watch

## 1 Gather relevant information about the building



- **engineering drawings** like (ground plots, cross sections)
- **detailed plans** (if available) for information about the constructions and parts of the buildings that cannot be inspected, (e.g. flat roof constructions under sealing)
- **energy consumption of at least the last 3 years** for heat and electric energy;
- **the surface area** (especially the conditioned area can be determined via the engineering drawings)
- typical **number of inhabitants** and operation schedule (hours of use)
- **typical heating and cooling schedule;**
- previous energy audits;
- reports from pervious analysis of the efficiency of the boilers and of the air-conditioning installation,
- information about last renovation steps taken

# Energy audits – Data collection

ENERGee Watch

## 2 Gather relevant information about the energy consumption

Gather data from building owner (finance and management departments of municipalities), such as:

➨ **ENERGY BILLS**, that provide information about:

- annual energy consumption
- energy prices, tariffs and costs
- specific CO2-emissions of the energy carrier [kg CO2/MWh]

➨ **ENERGY MONITORING**, provides information about:

- the energy consumption in a higher resolution: annual, monthly, weekly, daily, real-time
- trends..

# Energy audit – Field work

ENERGee Watch

## Gather information on:

- **Area of building elements:** measure external walls, windows, doors, roof; define type and orientation (North, South, etc.); evaluate heated and cooled area, volumes (If the existing documentation is not sufficient or not update than all sizes should be measured on-site and the areas should be calculated).
- **Construction layers and u-values:** inspection of the parts of the building is necessary (define construction layers, materials, thickness). The u-value [W/mK] can be calculated for every type of building elements and is the basis for the calculation of the thermal losses of the building envelope.
- **Technical infrastructure:** collect information about the technical infrastructure for heating, ventilation, cooling, heat distribution and hot water as well as lighting systems.

- **heat generation:** (i) year of construction, type, power; (ii) measurement of the efficiency by gas analyser if applicable; and (iii) operating regimes
- **heat distribution:** heating circuits, heating pumps, length of the pipe system, insulation of the heating pipes
- **heat delivery:** radiators, convector heaters, thermostat valves
- **control and regulation systems, set-ups**
- **ventilation system:** central or decentralised systems, heat recovery, ventilators, operating regimes
- **cooling systems:** type of machines; efficiency characteristics; operating regimes
- **domestic hot water generation and consumers of hot water**
- **lighting system:** type and number of lamps, installed capacities; maintenance; operating regimes
- **appliances divided in groups** influencing the heating balance of the building and influencing the heating balance: type and number of appliances, installed capacities, operating regimes

# Energy audit – Analysis

ENERGee Watch

Result of the analysis of the gathered data are the calculation and proposals for different sets of energy efficiency improvement measures compared to the established baseline. To be able to do that, data must be analysed while taking into account following key aspects of energy audit:

- ✓ Climate correction:

  Due to changes in the weather from year to year, the energy consumption varies. Thanks to a climate correction it is possible to compare the energy consumption of a single building over several years.

- ✓ Calculation of the energy balance of the building:

  Determined by the energy losses and energy gains.

- ✓ Comparison of energy demand and energy consumption

- ✓ Calculation of the energy performance characteristics of the building and determination of the energy class (A+, A, B, C…):

  With the data about the energy consumption, specific values can be calculated and be compared with reference values from existing building benchmarks.

# Energy audit – Report

ENERGY AUDIT REPORT

**1. Introduction**

**2. Building general information**

**3. Executive Summary table**

**4. Legal and normative references**

**5. Overview of sources of information**

**6. Description of the building**

- 6.1 Description of the actual state of the building fabrics
- 6.2 Description of the actual state of the engineering systems
- 6.3 Description of specific anomalies detected during building inspection

**7. Building renovation**

- 7.1 Description of the proposed energy efficiency measure
- 7.2 Estimated energy savings
- 7.3 Economic analysis of the proposed renovation package

**8. Integration of Renewable energy sources (if requested)**

**9. Conclusion and recommendations**

**Annexes**

# Energy audit – Report

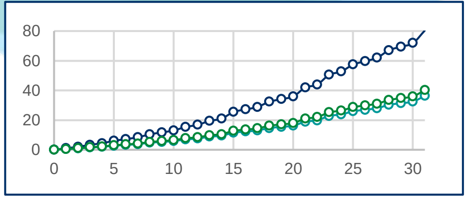
ENERGee Watch

| Number of person-day for energy audit | Small building | | | Mid-size building | | | Large building | | |
|---|---|---|---|---|---|---|---|---|---|
| | < 200 toe<br><5000 m² | | | 200 < toe < 350<br>5000 <m²<15000 | | | > 350 toe<br>>15000 m² | | |
| Building use | Min. | Mean | Max. | Min. | Mean | Max. | Min. | Mean | Max. |
| Administration / office | 4 | 8 | 12 | 6 | 12 | 18 | 7 | 14 | 21 |
| School | 4 | 8 | 12 | 7 | 14 | 21 | 8 | 16 | 24 |
| Kindergarten | 4 | 8 | 12 | 7 | 14 | 21 | 8 | 16 | 24 |
| Health /elderly house | 4 | 8 | 12 | 5 | 10 | 15 | 8 | 16 | 24 |
| Sport centres | 4 | 8 | 12 | 5 | 10 | 15 | 8 | 16 | 24 |
| Social housing | 3 | 6 | 9 | 4 | 8 | 12 | 5 | 10 | 15 |

# Recommisioning/optimization/fine tuning

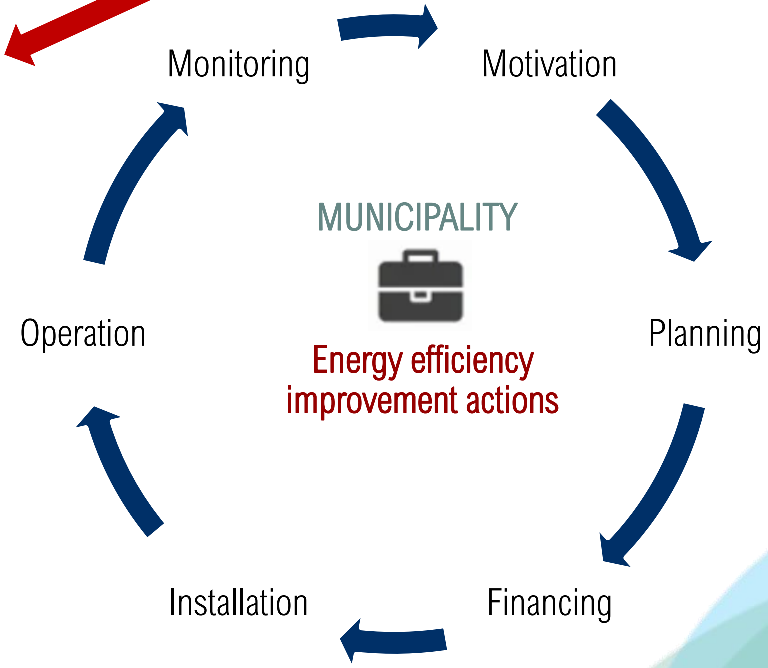
ENERGee Watch

### Monitoring




### Operation, optimization

### Installation

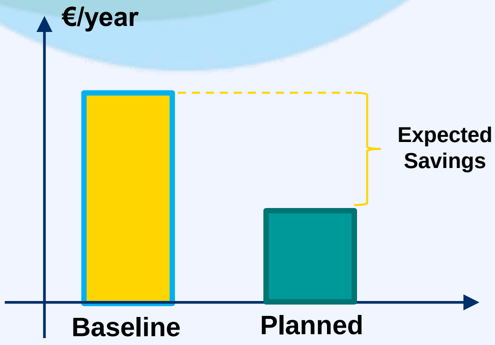


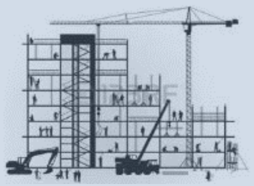

### Motivation, information advice


### Planning and development

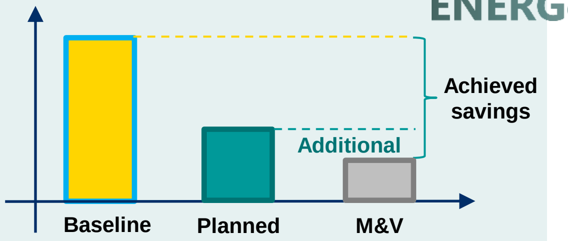

### Financing

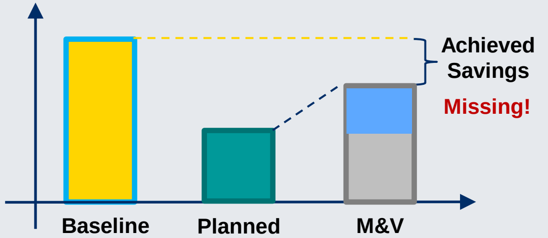
## Energy Audit & Feasibility study



Construction/
installation
works




ENERGee Watch

# What did it go wrong?

ENERGee Watch

## Poorly managed procurement process

- Lack of sufficient technical specification
- Service, goods and works do not meet expectations/requirements

## Irregular financial calculation

- miscalculated financial and economical parameters

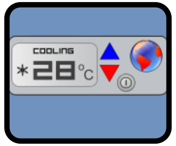
## Inappropriate goals set

- Too high/too low energy savings
- Underestimated investment costs

## Poorly performed energy audit

- Not meeting minimum requirement
- Wrong input data, calculation, etc.

## Inappropriate system`s regulation

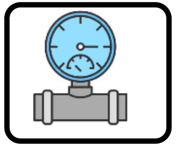



- Thermostat, valves, settings, etc.

## Inappropriate human behaviour in buildings

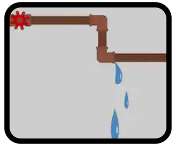
- miscalculated financial and economical parameters

## Inappropriate measuring of the results



- lack of suitable monitoring and verification to check achieved results

## Inappropriate energy system, equipment, solution, wrong installation



- over or under sized design
- wrong installation, implementation

# Recommisioning/optimization/fine tuning

Recommissioning is a **systematic approach** focusing on inspection of existing energy systems in buildings, the processes of its operations and maintaining. In order to achieve the desired building performance, it is necessary to develop and define **procedures** and corrective **measures** to improve current situation.

**Measures** → implemented systematically

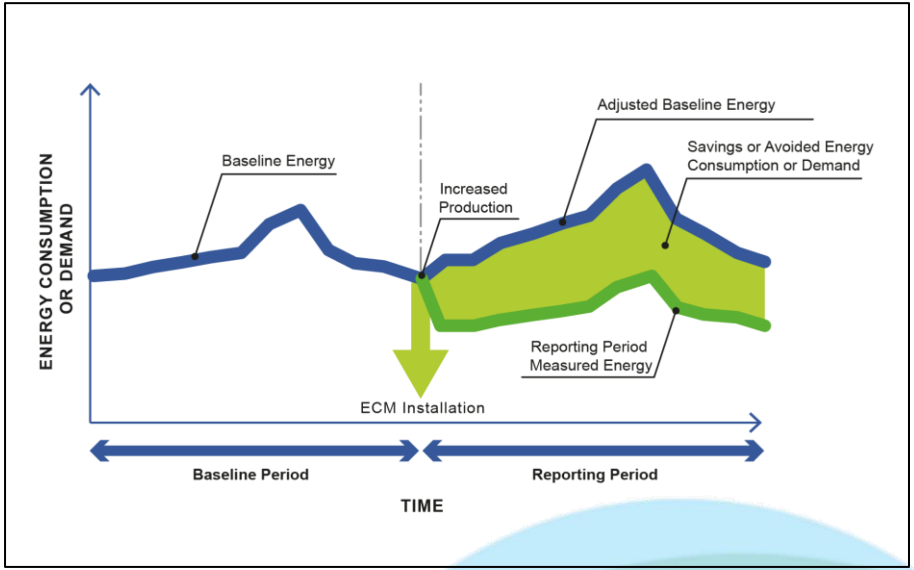
**Procedures** → Monitoring, Measurement and verification

# Measurement and verification

ENERGee Watch

- Measurement and Verification (M&V) is the process of planning, measuring, collecting and analyzing data for the purpose of verifying and reporting energy savings within an individual facility resulting from the implementation of energy efficiency measures.

- Savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions. The following simplified equation summarizes the calculation method:




SAVINGS = (Baseline period use or demand – Reporting period use or Demand) ± Adjustments

**MEETINGS**: during the process you need to periodically meet with the municipality: kick off meeting, progress meetings and final meeting are necessary.

START

## Asses building site

Understanding the current situation. Review documentation, like energy audits, financial analyses, project design, tender, settings

## Measurement & verification plan

A measurement and verification plan is an essential element for developing and analysing implemented energy efficiency measures and/or spot fine-tuning opportunities of a building or facility

## Testing and energy monitoring

Monitoring is a key activity for recommissioning and fine-tuning. Depending on the level needed:

- Energy accounting/bookkeeping
- Installation of temporary monitoring system
- Advance monitoring systems

## Prioritise improvements



A list of potential improvements for the building is the results of the detailed analysis and assessment of the building, the collection of monitoring data and testing facilities and system.

## Implementation

The implementation of recommissioning improvement measures
Most of the time will require a separate contract because is difficult to predict the results for the recommissioning process.

END

Building 8 in the table

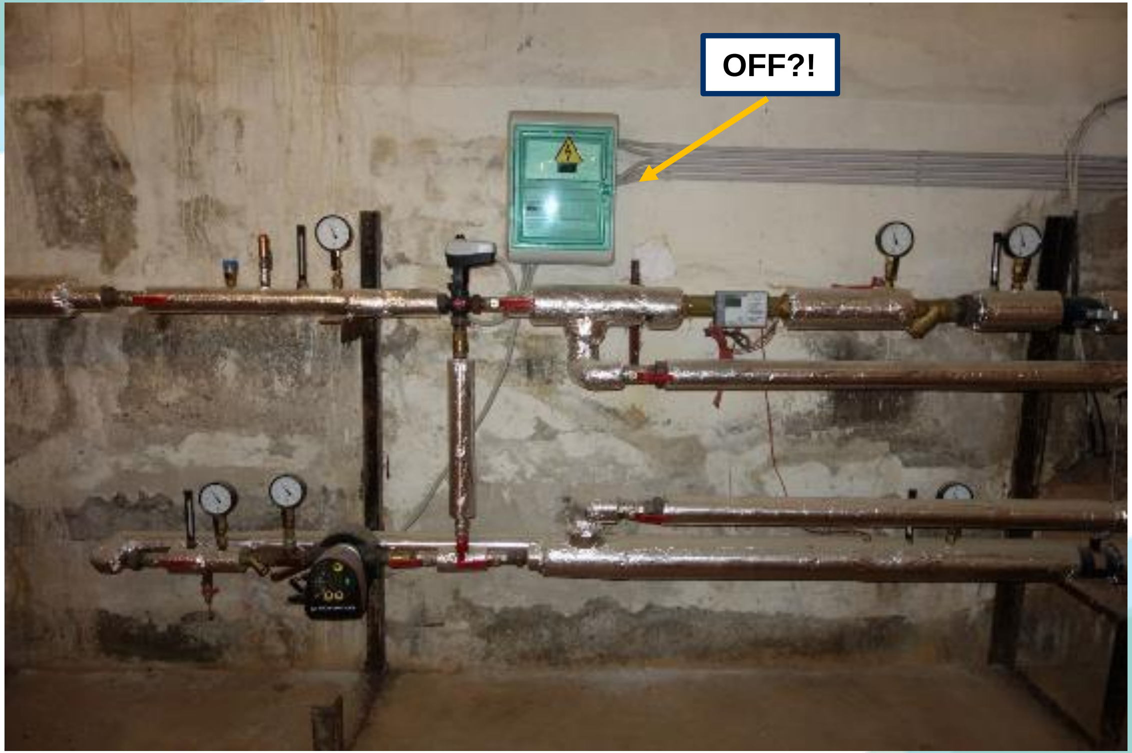
ENERGee Watch

# Kindergarten – example

- Heated area – 1566 m$^2$
- Heat energy consumption **before** renovation – 206 kWh/m$^2$ year
- Estimated heat energy consumption **after** renovation – 99 kWh/m$^2$ year
- Real measured heat energy consumption **after** renovation – 180,1 kWh/m$^2$ year

# During inspection

Around 50% of windows were open at outdoor air temperature of 1-3 $^{o}C$


OFF?!

SESSION 3

# Energy supply and production

The key gatekeepers of energy data are:

1. **Public Authorities** (as they are major consumers of energy)

2. **Energy Data Providers** (including major energy producers, consumers, Transmission System Operators (TSOs) and Distribution System Operators (DSOs).

3. **Energy Planning Facilitators** (including Regional Energy Observatories and academic institutions)

There are no obligations within most EU and national legislative frameworks for TSOs and DSOs to provide local energy data to public authorities at sub-national level. As a result, data exchange is only implemented on a voluntary basis.

Data can be gathered from a variety of sources:

- government departments and statistics agencies
- a country's national GHG inventory report
- universities and research institutes
- scientific and technical articles in environmental books
- journals and reports
- sector experts/stakeholder organizations
- Many data on energy production and consumption per sectors, fuels, etc. are available from energy statistic reports and databases periodically published by energy providers and agencies.

- Start data collection activities with an initial screening of available data sources
- Itis preferable to use local and national data over international data
- Data should be from reliable and robust sources
- Data should be time- and geographically-specific to the territorial boundary and technology-specific to the activity being measured
- Missing data will need to be:

  - gained by surveys among energy providers, fuel traders, large and industrial enterprises and other consumers
  - estimated by extrapolating, scaling, ect.
  - measured (generating new data)

# Collecting data in the building sector

ENERGee Watch

A **variety of approaches** are likely to be needed to develop an estimate of energy consumption in the building sector. Several options are available, and often a combination of them is necessary to have an overall picture of the energy consumption within the local territory:

1. Getting data for municipal/institutional buildings and facilities
2. Getting data from regional/ national sources
3. Getting data from the market operators
4. Getting data from a consumer survey
5. Managing data quality and uncertainity

KSSENA

# 1. Getting data for municipal buildings and equipment/facilities

ENERGee Watch

Well-advanced local authorities already have a full energy accounting system in place (EMIS). For other local authorities who have not yet initiated such a process, the energy data collection could require the following ten steps:

I. identify all buildings and equipment/facilities owned/managed by the Local Authority
II. identify all energy delivery points (electricity, natural gas, heat from heating district network, fuel oil tanks…);
III. identify the person/department receiving the invoices and energy data
IV. organise a centralised collection of these documents/data;
V. select an appropriate system to store and manage the data (could be a simple spreadsheet or a more elaborate software, available commercially);
VI. 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 datacollection;
VII. note that this process of data collection may be the opportunity to deal with other important energy related issues;
VIII. rationalise the number of energy delivery and invoicing points;
IX. renew/improve contractual arrangements with energy suppliers;
X. initiate a real energy management process within the local territory

# 1. Getting data for municipal buildings and equipment/facilities

ENERGee Watch

- Heating 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.

- Fuel for electricity or district heating/cooling: 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 and fuel used for district heating/cooling generation)

- Electricity from renewable sources: If the local authority and inhabitants buy electricity from renewable sources with guaranteed origin, this will not affect its energy consumption, but it may be counted as a bonus to improve the CO2 emission factor. The quantity and the guarantee of origin can be obtained from the supplier.

- Public lighting: The local authority should be able to collect all data regarding Public lighting. If it is not the case, 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)

# 4. Getting data from the consumer survey

May be necessary when all data cannot be obtained by any other previously mentioned approaches. This may be the case for energy carriers which do not pass through a centralised grid (e.g. fuel supplied in bulk) or if it is not possible to identify all suppliers.

Options:

1. For sectors where there is **a large number of small consumers** (like the residential sector), it is recommended addressing a questionnaire to a representative sample of the population (depending on the size of the population). Determine the size of needed sample with sample calculator (CheckMarket: https://www.checkmarket.com/sample-size-calculator)

2. 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).

3. 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.). Identify them through:
   - knowledge, statistical or commercial data (such as telephone directories)
   - inquiry to the grid operator (ask who are the main electricity/gas consumers in the local territory)
   - 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 rare cases).

# 4. Getting data from the consumer survey

ENERGee Watch

**Questionnaire on industry, commerce and other major consumers**
**- Data collection for the preparation of an energy and $CO_2$ balance for the municipality/city XY -**

**The following questions refer exclusively to properties in the municipality indicated on the right!**

This questionnaire was completed by:

*Please enter your name, company name, location, telephone number and e-mail address where we can reach you in case of queries!*

*Please enter the answers in the cells marked yellow after the question. The years 2013 to 2016 are particularly relevant here. Please make no effort to research the year 2017. If the requested data is not available for the entire period, please enter the existing data and leave the other cells empty. All information will be made anonymous.*

1. How many combustion plants (boilers, drying plants, air heaters, district heating transfer stations) exist in your company / your property?

| Number of combustion plants | |
|---|---|

2. What is the nominal capacity (heat capacity in kW) of these combustion plants?
Note: The data can be found on the nameplate of the combustion plant or on the measuring report.

| Nominal capacity (heat capacity in kW) | | | | |
|---|---|---|---|---|
| Plant 1 | Plant 2 | Plant 3 | Plant 4 | Plant 5 |
| | | | | |

3.When were the combustion plants brought into operation?

| Year of start of operation | | | | |
|---|---|---|---|---|
| Plant 1 | Plant 2 | Plant 3 | Plant 4 | Plant 5 |
| | | | | |

4. Which energy carrier / fuel (heating oil, natural gas, liquid gas, logs, wood chips, wood pellets, district heating, sewage gas, waste materials for thermal utilization) are the combustion plants operated with? Please indicate all fuels for combi boilers.

| Energy carrier / fuel | | | | |
|---|---|---|---|---|
| Plant 1 | Plant 2 | Plant 3 | Plant 4 | Plant 5 |
| | | | | |
| | | | | |

Example: questionnaire for industry, commerce and other major consumers *(IMEAS project)*

# Renewable energy

- Renewable electricity production (solar, hydro, CHP)

Information on number of devices and amount on electricity produced can be gathered from Distribution System Operators.

- Renewable heat production

If available, solar thermal heat production and consumption could be estimated by installations funded by national programmes. Databases on funded solar thermal areas within the communities can be requested at the respective authorities (in Germany e.g. at www.solaratlas.de , in France e.g. at Observ'ER: http://www.energies-renouvelables.org/). In Italy, solar thermal installations and heat production are monitored by GSE, in a section of the national information system on RES called SIMERI.

Additions need to be made by the estimation of non-funded installations. Alternatively, estimations could be done by the analysis of geodata or of areal views. However, here a differentiation method to PV installations needs to be found, e.g. by the knowledge of PV-installation areas or capacities from the electricity grid provider. In case installation areas are available, solar thermal heat utilization can be estimated by the assumption of an average utilization parameter per square meter (e.g. 350 kWh/$m^2$ and year, depending on regional solar radiation and on user habits).

- Biogas heat

The utilization of biogas heat needs to be requested individually at each biogas plant.

# Collection of data on local production of energy

Local production of heat/cold:

- collect the data on:

- heat/cold produced on the local territory, energy inputs and associated emissions (in tCO2 or tCO2-eq);

- heat/cold exported outside the local territory and associated energy input and emissions (in tCO2 or tCO2-eq);

- heat/cold imported in the local territory and associated energy input and emissions (in tCO2 or tCO2-eq).

- The data should be obtained via direct contact (or questionnaires) with the plant managers.

- When heat/cold from a plant located in the territory of the local authority is partly used in the local territory and partly exported, based on your BEI accounting approach be mindful, to include only the heat/cold produced, energy input and emissions corresponding to the share of heat consumed in the local territory.

- Similar approach should be used for imported heat/cold, i.e. only the heat/cold produced, energy input and emissions corresponding to the share of heat consumed in the local territory should be included.

# 5. Managing data quality and uncertainity

ENERGee Watch

## EXTRAPOLATION

/estimation based on known facts/

EXAMPLES:

-Fuels ratios obtained from the sample can be used to assess the overall energy consumption for each individual fuel. *(For example if the overall energy and gas consumption for a given sector is available, but not the heating fuel oil consumption, the electricity/fuel oil ratio or the natural gas/fuel oil ratio of the sample can be extrapolated to the whole population, provided that the sample is representative.)*

-Data on the energy consumption per square metre or per inhabitant in the household sector for different types of buildings and different classes of revenues can be extrapolated to the entire sector using relevant local statistical data.

KSSENA

# 5. Managing data quality and uncertainity

## SCALING

- Where the best available activity data do not align with the geographical boundary of the city or the time period of the assessment, the data can be adapted to meet the relevant territory boundary by adjusting for changes in activity using a scaling factor.
- The scaling factor represents the ratio between the available data and the required territory data. Scaled data can be useful and relevant where data for the inventory year, or city-specific data, are unavailable or incomplete. It is helpful when:
  - Gaps in periodic data
  - Recent data are not yet available;
  - Only regional or national data are available (scaling down)
  - Data do not align with the geographical boundary of the city; or data are only available for part of the city or part of the year.
  - Data collected by surveys on a representative sample-set to scale up to the entire sector/city (scaling up)
- **Population is one of the most common scaling factors used to scale data** (because the number of people is a key driver of GHG emissions, particularly in the residential sector). Other scaling factors, such as GDP or industry yield or turnover, may be more suitable to scale data for **economic activities.**

$$\text{Missing data} = \frac{\text{Factor}_{\text{missing data}}}{\text{Factor}_{\text{available data}}} \times \text{Available data}$$

| | |
|---|---|
| Available data | Activity (or emissions) data available which needs to be scaled to align with the territory boundary |
| Missing data | Activity (or emissions) data that is missing |
| $\text{Factor}_{\text{missing data}}$ | Scaling factor for the missing data |
| $\text{Factor}_{\text{Available data}}$ | Scaling factor for avaiable data |

# Scaling

$$\text{Missing data} = \frac{\text{Factor}_{\text{missing data}}}{\text{Factor}_{\text{available data}}} \times \text{Available data}$$

- Example 1:

$$\textbf{City household waste data 2014} = \frac{\text{City Population}_{2014}}{\text{City Population}_{2013}} \times \text{City household waste data 2013}$$

- Example 2:

1000 houses of which:

- 800 use natural gas – final energy consumption obtained from DSO (16.000 MWh)
- 200 houses use biomass - final energy consumption **unknown (x)**
- Scaling factor: **number of houses**

$$\text{Final energy consumption biomass} = \frac{\text{Number of houses}_{\text{with biomass}}}{\text{Number of houses}_{\text{with natural gas}}} \times \text{Final energy consumption natural gas}$$

$$X = \frac{200}{800} \times 16.000 \text{ MWh}$$

# 5. Managing data quality and uncertainity

## SURROGATE DATA

/alternative data that have a correlation with the data that they are replacing/

- **The estimate should be related to the statistical data source that best explains the activity for which you are gathering data**

- EXAMPLE: mobile source emissions may be related to trends in vehicle distances travelled, emissions from domestic wastewater may be related to population, and industrial emissions may be related to production levels in the relevant industry.

# 5. Managing data quality and uncertainity

ENERGee Watch

Example: Calculating stationary fuel combustion emissions

- **Getting data from representative sample set of real consumption data from surveys:** While surveying for fuel consumption for each sub-sector, determine the built space (i.e., square meters of office space and other building characteristics) of the surveyed buildings for scaling factor.

- **Modeling energy consumption data:** Determine energy intensity, by building and/or facility type, expressed as energy used per square meter (e.g., GJ/m2/year) or per unit of output.

- **In case of incomplete data:**
  - Where fuel consumption data by sub-sector are unavailable, but data are available for total emissions from stationary sources within the city, apportion by total built space for each sub-sector or building type.
  - Where data are only available for a few of the total number of fuel suppliers, determine the population (or other indicators such as industrial output, floor space, etc.) served by real data to scale-up the partial data for total city-wide energy consumption.
  - Where data are only available for one building type, determine a stationary combustion energy intensity figure by using built space of that building type, and use as a scaling factor with built space for the other building types.

- **Scaling down:** In case of regional or national fuel consumption data available - scale down using population or other indicators.

SESSION 4

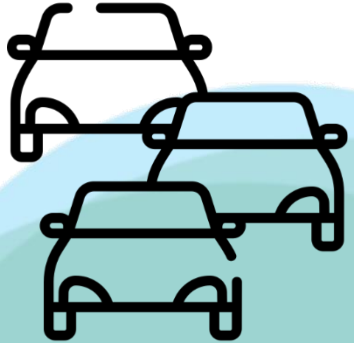
# Transport

# Collecting data in the transport sector

ENERGee Watch

- transit by definition is mobile and can pose challenges in both accurately calculating emissions and allocating them to the cities linked to the transit activity

- a transportation sector GHG inventory can be a vital metric that shows the impact of transportation policies and mitigation projects over time.



# Collecting data in the transport sector

ENERGee Watch

## Emission sources in the transport sector by transit mode:

- **On-road transportation** (including electric and fuelpowered cars, taxis, buses, etc.)
- **Railway** (including trams, urban railway subway systems, regional (inter-city) commuter rail transport, national rail system, and international rail systems, etc.)
- **Water-borne transportation** (including sightseeing ferries, domestic inter-city vehicles, or international water–borne vehicles.)
- **Aviation** (including helicopters, domestic inter-city flights, and international flights, etc.)
- **Off-road transportation** (including airport ground support equipment, agricultural tractors, chain saws, forklifts, snowmobiles, etc.)

# Collecting data in the transport sector

- **If it is possible, identify sub-categories within each transit mode:** municipal fleet, public transport, private and commercial transport ect.
- This is not always possible > **but make note to specify which of the above individual activity sectors are included in the aggregated data.**

Recommendations (CoM):

- The data to be collected can mainly concern the road and rail transport. Air and waterborne transport can be excluded. Exception may be the **local ferries** used for public transport.
- **Road and rail transport** should be included if it is serving mainly the local territory and/or regulated by the local authority, meaning, that you can exclude highways and regional trains if no actions are foreseen to be implemented by local authority (e.g. in SECAP)
- **The off-road transportation** should be included only if related actions are foreseen (e.g. in SECAP).

# Road transportation

- This category includes vehicles such as buses, cars, trucks, motorcycles, on-road waste collection and transportation vehicles (e.g. compactor trucks), etc.
- Most vehicles burn liquid or gaseous fuel in internal combustion engines. The combustion of these fuels produces **CO2, CH4, and N2O**, often referred to collectively as tailpipe emissions.
- Electric or hybrid vehicles can be charged at stations within or outside the city. Charging stations might be at homes or workplaces that are already included in other categories, so it is important to **ensure energy used for electric vehicle charging is separate** (included in stationary energy categories) and not double counted.

The energy consumption and associated emissions in road transport could be accounted for in different ways. Among the most common methodologies are:

- fuel sales method
- territorial method
- residential method
- city induced method

# Road transportation - methods

ENERGee Watch

## *top-down method*

# FUEL SALES METHOD

- This method calculates on-road transportation emissions based on the total fuel sold within the city boundary.

- The fuel sold on the territory is used as a proxy for transportation activity occurring in the same territory.

- The activity data on the fuel sold within the city boundary can be obtained from fuel dispensing facilities and/or distributors, or fuel sales tax receipts. If a strictly in-boundary fuel sales figure is unavailable, data may still be available at the regional scale (through distributors).

- Calculating fuel sales emissions requires multiplying activity data (quantity of fuel sold) by the GHG-content ofthe fuel by gas (CO2, CH4, N2O).

- The use of fuel sales data is more precise for cities for which the number of vehicle trips over the city borders is small compared with the number of trips within the city. Reason being, that fuel sold in the territory of the local authority may not in most of the cases correctly reflect the fuel used in the territory.

# Road transportation - methods

ENERGee Watch

## *Bottom-up methods*

- Based on travel patterns and commuter behaviour
- Require more data collection and analysis, but provide far more useful and accurate information.
- Resident activity method, induced activity method and geographic method
- Bottom-up approaches generally rely on an **ASIF framework:** GHG = VKT x modal share x energy intensity x carbon intensity of fuel

## RESIDENT ACTIVITY METHOD

- This method quantifies emissions from transportation activity undertaken by city residents only, considering all their trips, within or across the city borders.
- It requires information on resident Vehicle Kilometre Travelled (VKT) from **vehicle registration records** and **surveys** on travel behaviour of residents.
- limitation to resident activity overlooks the impact of non-city resident traffic by commuters, tourists, logistics providers, and other travelers.

ENERGee Watch

# INDUCED ACTIVITY METHOD

- This method seeks to quantify transportation emissions induced by the city, including trips that begin, end, or are fully contained within the city (**usually excluding pass-through trips**).
- **The method relies on models or surveys to assess the number and length of all on-road trips occurring - both transboundary and in-boundary.** This gives us a vehicle kilometers traveled (VKT) figure for each identified vehicle class. It also requires information on vehicle fuel intensity (or efficiency) and fuel emission factors.
- This is the most sophisticated methodology. It requires a substantial amount of data from city residents and other travellers, which can be gathered through different sources, including data collection at major routes, Big Data (e.g. from smart phones) and satellite data.
- **The method identify the origin and destination of each trip assessed.** To reflect the responsibility shared by both cities inducing these trips, cities can use an origin-destination allocation in two ways:

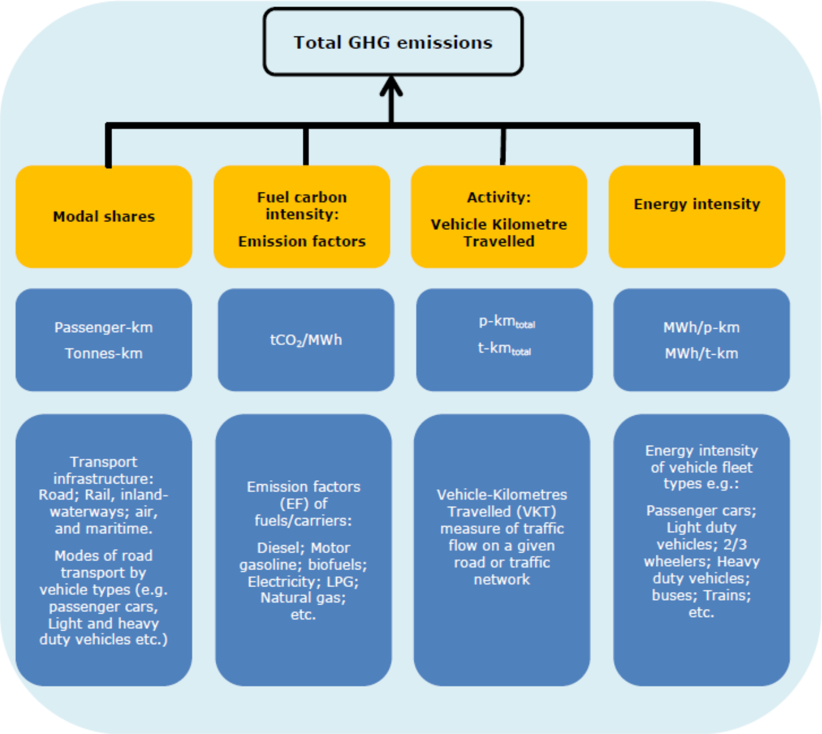
  > **Reporting 50% of transboundary trips** (and excluding pass-through trips).

  > **Reporting departing on-road trips only** (here, 100% of the trip is counted).

# Road transportation - methods

## TERRITORIAL METHOD

- Most recommended
- This method quantifies emissions from transportation activity occurring solely within local boundaries, regardless of the trip's origin or destination and whatever the driver is a resident of the municipality or not.
- **Basic traffic counts** are required to estimate the number of vehicles traveling, including the average trip length and potentially also the type of vehicle.




Following parameters are important:

1. The modal share and fleet distribution
2. Fuel carbon intensity
3. The Vehicle-Kilometres Travelled (VKT)
4. Energy intensity

# Road transportation – territorial method

ENERGee Watch

## 1. Modal share and vehicle fleet distribution

- The modal share and distribution of trips to different types of vehicles (fleet distribution).
  Modal share describes portion of trips by different modes of transport (road, rail, water..) and vehicle fleet distribution indicates the share of each vehicle type of the total stock.

- In urban areas the most important mode relates to road passanger, which can be further disaggregated into vehicle types or so called fleet distribution (e.g. passenger, light-duty or heavy-duty for road vehicles)

- 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 (this does not reveal relative driving levels)
  - vehicles registered in the municipality
  - national statistics
  - Eurostat statistics at national or regional level.

# Road transportation – territorial method

ENERGee Watch

## 2. Fuel carbon intensity and share of biofuels

- Fuel carbon intensity relates to the **emission factors of the fuels (e.g. diesel, motor gasoline/petrol, electricity, hydrogen etc.).**
- If the local authority plans to promote the use of biofuels, produced in a sustainable manner, in the SECAP, it is important to estimate the share of biofuels in the fuel used in the local territory. This can be done, for instance, by making polls to the most important fuel distributors in the local territory and surrounding areas. In the case of the use of biofuels in the municipal fleet (beyond the average use in the local territory), the LA is likely to have access to the amount of biofuel consumed, especially if special filling stations are used for municipal fleet.
- For local authorities that do not intend to promote biofuels, national average shares can be found from Eurostat statistics.

## 3. Vehicle-kilometres travelled (VKT)

- The Vehicle-Kilometres Travelled (VKT) as a measure of traffic flow, determined by multiplying the number of vehicles on a given road or traffic network by the average length of their trips measured in kilometres; it can be measured as passenger-kilometre (a unit of measure = 1 passenger transported a distance of 1 kilometre) and tonne-kilometre (a unit of measure: 1 tonne transported a distance of 1 kilometre);
- **There are various options to estimate the number of vehicle kilometres travelled on the street network of a local authority, which can be based on information on traffic flows and length of the street network. As the first step, local authorities can access data from local sources, such as the municipal transport department or the local, state or national road management authorities.**
- In the case of the LA's own fleet and public transportation, fleet the mileage driven can be estimated using the information in the odometers of the vehicles.
- Alternatively, fuel consumption by municipal and public transportation fleet can be estimated based on fuelled amount. However, attention has to be paid to the fact that the BEI/MEI should consider only mileage driven (and fuel used) in the local territory. In the case of contracted services for public transport or other services, the information should be available from the operator.

# Road transportation – territorial method

ENERGee Watch

## 3. Energy intensity

- Energy intensity is a measure of the fuel consumption (actual in-use or alternatively average) assessed as the product of the average fuel consumption of vehicle the type [l fuel/km] and the Net Calorific Value (NCV) of the fuel [e.g. in Wh/l].
- 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 urban 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 national average figures for fuel consumption would not be representative for urban areas.
- Especially if the LA 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 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 to later emission inventories
- **Net calorific values for different types of fuels are available as default values (IPCC, 2006).**

KSSENA

# Basic data and potential sources for estimating emissions from road transportation

ENERGee Watch

| DATA | SOURCE |
|---|---|
| **Vehicle kilometres travelled** | |
| Vehicle flow and mileage driven for transport planning purposes | Local transport department, public |
| • Travel Surveys including numbers of vehicles passing fixed points per unit time (traffic volumes)<br>• Household transport surveys (origin and destination surveys) | Some surveys count vehicle numbers by type of vehicle, but information on the fuel (e.g. diesel or gasoline) is usually not available. |
| Average daily traffic volumes for the whole EU | Open Transport Map: http://opentransportmap.info/ |
| Data on transport infrastructure and standardised indicators on transport, covering 35 European cities | UITP: http://www.uitp.org/<br>(not free of charge not free of charge) |
| “Big data” such as smart phones and other travel data loggers that can provide details of trips | Various voluntary web apps |
| | |

# Basic data and potential sources for estimating emissions from road transportation

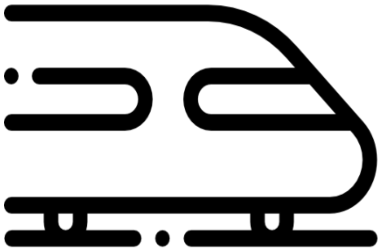
| DATA | SOURCE |
|---|---|
| **Vehicle fleet distribution** | |
| Data on mode share for many European cities | Eurostat: https://ec.europa.eu/eurostat/web/cities/data/database |
| Passenger travel mode share surveys | Various national or city-level surveys |
| **Average fuel consumption per km** | |
| Fuel consumption per km and vehicle type | EMEP/EEA 2016 air pollutant emission inventory guidebook 2016 (EEA, 2016) |
| Fuel efficiency and CO2 emission data sources for vehicle types | National inventories of vehicles |
| Local estimates of fuel economy for different vehicle types | Local vehicle registration data |
| **Fuel NCV** | |
| Default Net Calorific Value in TJ/Gg | IPCC (2006) |

# Rail transportation

ENERGee Watch

The rail transportation in the local territory can be divided into two parts:

1. **Urban rail transportation:** for example tram, metro and local trains. **The inclusion of this urban rail transportation in the BEI is strongly recommended.**
2. **Other rail transportation,** which covers the long-distance, intercity and regional rail transportation that occurs in the local territory. Other rail transportation does not only serve the local territory, 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 SECAP.**



There are two types of 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 local territory is usually low. The LA is recommended to ask the annual electricity and fuel use data directly from the service providers by fuel types and by application (e.g., transit system, freight, etc.)

# Rail transportation

ENERGee Watch

If such data are not available, the LA can:

- Use rail company surveys:
  > Survey rail companies for real fuel consumption and amount of goods or people moved
  > Calculate real fuel consumption per tonne of freight and/or per person (e.g., gallons of diesel per person).

- Scale up incomplete transportation activity data (e.g., tonnes freight and/or people movement). Total city activity may be determined through local, state, or national statistics or transportation agencies for the city.

- Scale down regional transit system fuel consumption based on:
  > Population of the city, to derive an in-boundary number.
  > Share of transit revenue service miles served by the region (utilize data on scheduled stops and length of the railway) and the number of miles that are within the city's geopolitical boundary.

- Scale down national railway fuel consumption based on city population or other indicators.

# Baseline emission inventory

When setting up BEI for transport macro-sector, Covenant of Mayors suggests to define transport activity sectors as follows:

<table>
<tr><th>Activity sector</th><th colspan="2">Description</th></tr>
<tr><td>Municipal fleet</td><td rowspan="2">Road transportation</td><td>All final energy consumption and related GHG emissions from fuel combustion and use of grid-supplied energy (e.g. electricity) for transportation occurring in urban street network under the competence of the local authority shall be reported in this sector</td></tr>
<tr><td rowspan="3">Public transport</td><td>All final energy consumption and related GHG emissions from fuel combustion and use of grid-supplied energy (e.g. electricity) for transportation occurring in roads serving a larger area and/or not under the competence of local authority (e.g. highways) are recommended to be included if mitigations actions are planned in that area</td></tr>
<tr><td>Off-road transport</td><td>All final energy consumption and related GHG emissions from fuel combustion and use of grid-supplied energy (e.g. electricity) occurring in off-road transportation (vehicles/mobile machinery in any activity sector) are recommended to be included if mitigations actions are planned in that area</td></tr>
<tr><td rowspan="2">Rail transport</td><td>All final energy consumption and related GHG emissions from fuel combustion and use of grid-supplied energy (e.g. electricity) for transportation occurring in the local transport (e.g. metro, tram and local trains) shall be reported in this sector</td></tr>
<tr><td rowspan="2">Private and commercial transport</td><td>All final energy consumption and related GHG emissions from fuel combustion and use of grid-supplied energy (e.g. electricity) occurring for transportation from long-distance trains, intercity trains, regional and cargo rail transportation are recommended to be included if mitigations actions are planned in that area</td></tr>
<tr><td>Waterborne navigation</td><td>All final energy consumption and related GHG emissions from fuel combustion and use of grid-supplied energy (e.g. electricity) occurring for transportation from local ferries in public transport acting on the local territory are recommended to be included if mitigations actions are planned in that area</td></tr>
</table>

# Existing tools

ENERGee Watch

To develop a CO2 emission inventory for the transport sector and to assess the direct and indirect CO2 emission reduction potential from bottom up methods, there are a number of tools that require only minimal data and no modelling efforts, as the ones provided below:

- COPERT4 road transport emissions model (European Environment Agency and EMISIA)

http://emisia.com/products/copert/copert-5

- Greenhouse Gas Protocol Tools (GHG Emissions from Transport)

http://www.ghgprotocol.org/calculation-tools

- Transport Emissions Evaluation Model (TEEMP) by ITDP

https://www.itdp.org/what-we-do/climate-and-transport-policy/transport-emissions-evaluation-models-for-projects/

KSSENA

# Thank you!

Thank you for participating in our learning course.

**For any questions or information, e-mail us!**

bostjan.krajnc@kssena.velenje.eu

ziva.vovk@kssena.velenje.eu