Establishing an inventory of energy use and emissions of the territory of the municipality

In a nutshell

SUMMARY
It is best practice to: • systematically collect energy use and emission data from the territory of the municipality; the scope of the inventory includes energy consumption and emissions across the territory from all sectors, encompassing industry, commerce/services, agriculture, construction, housing and transport; • publicly report the data collected and use them to identify actions to reduce greenhouse gas emissions in the territory.
Target group
Local authorities
Applicability
This best practice is applicable to all local authorities.
Environmental performance indicators
• Total annual carbon emissions of the territory of the municipality: absolute (t CO_{2eq}) and per inhabitant (kg CO_{2eq}/inhabitant) • Annual energy use of the territory of the municipality per inhabitant, expressed as final energy (kWh/inhabitant)
Benchmarks of excellence
N/A

Description

Understanding current energy use and greenhouse gas (GHG) emissions is a key first step to reducing environmental impact generated in a certain area. To this aim, public administrations can systematically collect energy use and emission data from the territory of the municipality; the scope of the inventory includes energy consumption and emissions across the territory from all sectors, encompassing industry, commerce/services, agriculture, construction, housing and transport. Additionally, public administrations can, once data il collected, publicly report the data collected and use them to identify actions to reduce greenhouse gas emissions in the territory.

For instance, the Covenant of Mayors methodology requires a Baseline Emission Inventory (SEI) to be established as a prerequisite to preparing a Sustainable Energy Action Plan (SEAP) (Covenant of Mayors, 2010b).

This best practice presents in detail:

- Methods for collecting energy use and emissions data of a territory;
- techniques for reporting data to the public.

The scope of the inventory of data must include energy use and emissions across the territory from:

  - Industry and Commerce/Services (including agriculture, construction…)
  - Housing and domestic energy use
  - Transport

There are several methodologies for producing emissions inventories. ICLEI, the World Resources Institute and the C40 network of cities are currently developing a "Global Protocol for Community Scale GHG Emission Inventories (GPC)" with the latest draft released in July 2014 (C40, 2014). Methodologies generally include consideration of the following issues:

a. Greenhouse gases
b. Energy consumption
c. Emissions factors
d. Baseline determination
e. Geographical boundaries

a. *Greenhouse gases*

The most influential greenhouse gas in terms of overall impact on climate change is **carbon dioxide (CO_2)**, whose primary source is burning fossil fuels to generate energy. CO_2 emissions are distinguished in three categories:

- **Direct** – e.g. natural gas in boilers to heat homes, petrol in combustion-engine vehicles;
- **Indirect** – e.g. via electricity, where the power plant emits CO_2 to generate the electricity for the end user;
- **Embodied** – the CO_2 emitted to create a product, often outside the municipality (e.g. from energy use in a manufacturing plant and transport to the consumer).

Inventories of emissions at the municipality level usually include direct and indirect emissions, but exclude embodied emissions, which are much more difficult to estimate and can only be influenced by the municipality in terms of managing consumption.

Emissions of other GHGs are converted to **CO_2 equivalent (CO_2eq)** according to their different impacts on global warming. The conversion factors for these are standardised. These GHGs are:

- **Methane** (CH_4) – mainly emitted by the agricultural sector, but also by landfill sites
- **Nitrous oxide** (N_2O**)** – used for a variety of purposes, including in the medical sector and food packaging
- **Hydrofluorocarbons** (HFCs) – used as refrigerants
- **Perfluorocarbons** (PFCs) – used in various industrial processes
- **Sulfur hexafluoride** (SF_6) – used in the electrical industry

Since CO_2 is the most important GHG in terms of overall global warming impact, and the majority of CO_2 is emitted for energy generation, energy consumption data is the main focus for most municipalities. Methane may also be a considerable contributor, particularly in municipalities with a large agricultural sector.

b. *Energy consumption*

Energy consumption can be broken down into three main types – heat, electricity and transport – and two main sectors – domestic and non-domestic (which in turn can be broken down into sub-sectors, e.g. commercial, public administration, etc.). Some methodologies use different combinations of these types, sectors and sub-sectors. For example the Covenant of Mayors (2010b) uses two categories, Buildings equipment/facilities and industry (broken down into subsectors), and Transport. The International Energy Agency (2014) uses four: Residential, Services, Transport and Industry. These different categorisations should be compatible as long as the data collection has enough granularity.

When calculating energy consumption, it is important that the consumption of all different fuels (including electricity, heat from district heating and decentralised energy production from renewable energy sources) is considered.

Fuel consumption is often not reported in the same units, for example:

- Natural gas (m^3)
- LPG (litres)
- Solid fuels (coal etc.) (kg/tonnes)
- Electricity (kWh)
- Petrol (litres/barrels of oil equivalent)
- Diesel (litres/barrels of oil equivalent)

In order to calculate the total energy consumption, all the different fuel consumptions need to be converted into a common unit, usually MJ or kWh, before they can be summed up. It is also important to distinguish between primary and final energy consumption. Primary energy is the energy form pre-transformation, e.g. crude oil. Losses from transformation to final energy forms, e.g. electricity, and transportation/transmission of the fuel, result in lower final energy consumption figures. This is an important distinction for energy balances and resource management.

c. *Fuel emissions factors*

In order to calculate the CO_2eq emissions, each of the different fuel consumptions need to be multiplied by an emission factor (CO_2eq/kWh). Standard emission factors are available for all common fuels and should generally be used unless there is a particular reason not to. The CO_2 emissions from electricity vary according to the national mix of energy generation technologies, therefore it is recommended to use the relevant national emissions factor for grid electricity.

d. *Baseline determination*

Emissions reductions reporting need to have a baseline year in order to monitor progress and provide context. The baseline year should be either:

- the earliest year for which the most comprehensive and reliable data can be collected in the areas being monitored; or
- a relevant year for national or international reporting, e.g. 1990 for the Kyoto Protocol and EU reporting.

The baseline year should always be referred to when communicating emissions statistics, e.g. "in 2012 the municipality reduced CO_2 emissions by 25% (compared to 1990 levels)". This is because emissions will vary annually according to multiple factors, including some out of the control of the municipality such as the outside temperature.

e. *Geographical boundaries*

Municipalities will be aware of their physical boundaries and these should correlate to national statistical areas. It can be very useful to analyse emissions or consumption from smaller areas within the municipality, to help target particular interventions. This can be done in two main ways:

- Using smaller statistical/political areas (e.g. postcode areas); or
- Grid mapping (GIS).

The appropriate method to use should be consistent with existing datasets and the intended use of the data. Both methods have advantages in particular situations. For example, energy consumption reported by postcode area can highlight properties in need of energy efficiency interventions, whereas transport emissions mapped by GIS can highlight particular roads that have high traffic levels.

f. *Exclusions*

Since municipalities are usually not isolated from the region and nation, some emissions are not appropriate for local reporting. These include emissions from large power stations feeding the national electricity grid (even if located in the territory of the municipality), national railways, aviation and shipping.

Exclusions should be considered in the context of the specific competences and responsibilities of the municipal government. For example a large power station would most likely serve a wider area than one municipality and so the emissions will be counted as part of the national grid emissions factor. However, a smaller scale renewable energy system owned by the municipality or another local entity should be counted. Similarly, aviation emissions from planes landing at a local airport should not be included, but emissions from the airport buildings should.

The Covenant of Mayors suggests that emitters taking part in the EU Emissions Trading Scheme (ETS) should be excluded (Covenant of Mayors, 2010b), however this may cause opportunities to be missed when deciding on actions. Where possible and practical it is worth noting these emissions in order to obtain as broad a picture as possible of local emissions but, eventually, excluding them from some of the analysis.

Sometimes exclusions that would be fair and appropriate are not currently possible. For example, at 43% of total emissions, the transport sector is the largest source of emissions for Girona (Spain). These emissions are based on the fuel sales figures for the city area. However, as Girona is on the main transport route between Spain and France (for exports to/from Europe) and many trucks refuel in the city area (fuel taxes are cheaper in Spain than in France). A methodology that considers and adjusts the allocation of transport emissions in a fair and proportionate way could be an advantage for the city (LAKs (Girona), 2011). Until this adjustment is made (if possible), analysis of the data should take these local facts into account when recommending actions and priorities.

g. *Data Collection*

Once the municipality has decided what data to collect, the following hierarchy should be used in order to build up the desired database, in order of sequence.

Firstly: Use existing datasets

National governments already collect large amounts of data – census, CO_2 emissions, transport etc. – some of which may be broken down by region, local authority or smaller areas. For example, the UK's Department for Energy and Climate Change publishes annual energy consumption estimates based on supplier reporting for local authority areas, MLSOAs and LLSOAs (medium and small statistical areas that sit within a local authority area) (DECC, 2014).

Some datasets may not be granular enough for the purposes of the desired database. It may be possible however to estimate more granular figures through modelling using other datasets and basic assumptions. The cost of modelling should be weighed up against the cost of collecting new data.

For example, if energy consumption by house type is a desired dataset, this could be estimated using energy consumption by area, information on house types by area (either existing or collected) and an understanding of heat loss in different house types.

Secondly: Data from market operators

The required data may already be collected by market operators such as energy suppliers and transport operators. This data will probably be seen as commercially sensitive and only aggregated data may be available, but could still be useful. However, many public authorities have contractual relationships with operators in their areas (e.g. public transport) and can require that certain data is reported as part of the contract. Note that market operators may already be reporting data to national/regional governments.

Local government itself will very often be the source of a significant proportion of emissions/consumption. Existing records can be used to estimate historic data and policies/processes can be put in place to ensure the desired data is collected in the future. Procurement requirements can also be used to collect data from suppliers.

Thirdly: Data collection from consumers

Collecting data from consumers is likely to be the most expensive option and may not be very effective at collecting good quality data. Surveys delivered directly to consumers often have low response rates and suffer from selection bias (i.e. those who respond have a particular profile, meaning data is not fully representative).

Good quality data could be collected by:

- Working with local organisations in the areas of interest that have direct relationships with consumers. This could be a hospital or doctor's surgery, or a locally based charity or community group.
- Online surveys in combination with face-to-face and phone surveys for a sample of the population. Efforts must be made to ensure a representative sample is surveyed.

Fourthly: Direct measurement

It may be possible to make direct measurements, for example traffic monitoring. This may be more suitable than surveys but also has a cost associated.

h. *Action plans and reporting*

The main benefit of developing a database of emissions and consumption is to analyse and use the data to identify the actions that can be taken to reduce CO_2. A local action plan is usually developed, using the data to support the case for particular interventions. This can be an energy-focused action plan, like the Covenant of Mayors' Sustainable Energy Action Plans (SEAPs) or they can focus on emissions, and therefore include CO_2 emitting activities beyond energy (e.g. agriculture), for example in the Climate Mitigation and Adaptation Action Plans (MAPs) from the LIFE+ supported project Local Accountability for Kyoto Goals (LAKs). Reports are generally made public and used as a basis to engage with the wider community on the actions.

It is possible to develop the software database, but there are also a number of freely available or commercial tools, including the LAKs toolkit (LAKs, 2014) and ICLEI's Heat+ tool (ICLEI, 2014).

Making the underlying data openly available can bring wide economic and social benefits, which has been evaluated for various datasets such as the UK's Ordnance Survey (physical geography) data (Ordnance Survey, 2013). This data can be used by other public authorities, commercial organisations and members of the public to produce a wide variety of tools, services, information and activities.

Environmental benefits

Inventories in themselves do not produce any environmental benefits, but are key enablers to set objectives and monitor progress towards them. They are usually used for action planning to identify key sectors or areas for energy consumption and CO_2 emission reduction measures.

Side effects

There are no negative cross-media effects relating to other environmental pressures as a result of establishing an inventory of energy consumption and emissions of the territory of a municipality.

Applicability

This best practice is applicable to all public authorities across Europe.

Economics

The costs of implementing an emissions/consumption database are largely due to staff time. However, the expertise may not exist within a public authority and external support may be required. The scope of the database and availability of existing datasets will determine the overall cost, but the categories of cost are:

- Analysis and modelling of datasets
- Engagement of market operators to obtain new datasets
- Development and delivery of surveys
- Direct monitoring
- Software licence to host database
- Licence fees for some datasets

Driving forces for implementation

EU member state governments have carbon emission reduction targets and renewable energy targets set by international agreements such as the Kyoto Protocol and the EU 2020 climate and energy package. This has been translated into national legislation in different ways, but action will be necessary by local governments to meet these targets.

In order to implement these targets an evidence base must be established to inform the development of energy and climate change policies and plans as well as monitoring and evaluating their impacts. An inventory of emissions and consumption forms a major part of this evidence base. This also allows benchmarking of performance against other municipalities. Local governments may also have other drivers to implement this BEMP, for example:

- Reducing costs from its own energy consumption
- Improving public health
- Targeting measures for people in fuel poverty

Municipalities may also be required to establish an inventory as part of membership in schemes such as the Covenant of Mayors.

Reference organisations

LAKs

LAKs is a LIFE funded project running from 2009 to 2011 which involved municipalities from three EU member states:

- Reggio-Emilia (Italy)
- Padova (Italy)
- Bydgoszcz (Poland)
- Girona (Spain)

These municipalities developed emissions databases and action plans using a specially developed toolkit (LAKs, 2014).

Genova, Italy

Developed emissions database and implemented Sustainable Energy Action Plan using Covenant of Mayors guidance (Comune di Genova, 2010).

Burgas, Bulgaria

Developed a local strategy for sustainable energy using the Covenant of Mayors guidance (Sustainable Now, 2014).

Literature

C40 (2014). *C40 and Partners Call for Public Comment on Global Protocol for Community-scale Greenhouse Gas Emissions.*[Online]. Available at: http://www.c40.org/blog_posts/c40-and-partners-call-for-public-comment-on-global-protocol-for-community-scale-greenhouse-gas-emissions [Accessed 11 August 2014]

Covenant of Mayors (2010a). *How to develop a Sustainable Energy Action Plan*. Available at: http://www.eumayors.eu/IMG/pdf/seap_guidelines_en.pdf

Covenant of Mayors (2010b). *How to develop a Sustainable Energy Action Plan, Part 2*. Available at: http://www.covenantofmayors.eu/IMG/pdf/004_Part_II.pdf

Comune di Genova (2010). *Sustainable Energy Action Plan*. Available at: http://www.urbancenter.comune.genova.it/sites/default/files/archivio/allegati/SEAP%20summary_0.pdf

Department for Energy and Climate Change (DECC) (2014). Statistics at DECC [Online]. Available at: https://www.gov.uk/government/organisations/department-of-energy-climate-change/about/statistics [Accessed 11 September 2014]

Greenhouse Gas Protocol (2014). *City GHG Accounting* [Online]. Available at: http://www.ghgprotocol.org/city-accounting [Accessed 11 August 2014]

ICLEI (2014). *HEAT+ tool by ICLEI* [Online]. Available at: http://heat.iclei.org/heatplusgpc/indexnew.aspx [Accessed 12 August 2014]

International Energy Agency (IEA) (2014). *Energy Efficiency Indicators: Fundamentals on Statistics.* Available at: http://www.iea.org/publications/freepublications/publication/IEA_EnergyEfficiencyIndicatorsFundamentalsonStatistics.pdf

Local Accountability for Kyoto Goals (LAKs) (2014). *Final Manual* [Online]. Available at: http://space.comune.re.it/laks/web/downloads.html [Accessed 10 August 2014]

LAKs (Girona) (2011). *Girona Case Study* [Online]. Available at: http://space.comune.re.it/laks/stuff/en/cs_gir_en.pdf [Accessed 12 August 2014]

Ordnance Survey (2013). Assessing the Value of OS OpenData to the Economy of Great Britain. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/207692/bis-13-950-assessing-value-of-opendata-to-economy-of-great-britain.pdf

Schumacher Institute (2011). *Genova Case Study* [Online]. Available at: http://www.convergeproject.org/examplegenoaseap [Accessed 11 August 2014]

Sustainable Now (2014). *Case Study - Burgas (Bulgaria).* Available at: http://www.sustainable-now.eu/fileadmin/template/projects/sustainable_now/files/Summary_Burgas_LEAP_Final_EN_01.pdf