Covenant of Mayors

Committed to local sustainable energy

How to develop a Sustainable Energy Action Plan

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

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Introduction – About this guidebook

The European Union is leading the global fight against climate change, and has made it its top priority. The EU committed itself to reducing its overall emissions to at least 20 % below 1990 levels by 2020. Local authorities play a key role in the achievement of the EU's energy and climate objectives. The Covenant of Mayors is a European initiative by which towns, cities and regions voluntarily commit to reducing their CO_2 emissions beyond this 20 % target. This formal commitment is to be achieved through the implementation of Sustainable Energy Action Plans (SEAPs). The purpose of the present guidebook is to help the Covenant of Mayors signatories to reach the commitments they have taken by signing the Covenant, and in particular to prepare within the year following their official adhesion:

- a Baseline Emission Inventory (BEI);
- a Sustainable Energy Action Plan (SEAP).

BEI is a prerequisite to SEAP elaboration, as it will provide knowledge of the nature of the entities emitting CO_2 on the municipality's territory, and will thus help select the appropriate actions. Inventories conducted in later years will allow determining if the actions provide sufficient CO_2 reductions and if further actions are necessary.

The current guidebook provides detailed step-by-step recommendations for the entire process of elaborating a local energy and climate strategy, from initial political commitment to implementation. It is divided into 3 parts:

- Part I relates to the description of the overall SEAP process and covers the strategic issues;
- Part II gives guidance on how to elaborate the Baseline Emission Inventory;
- Part III is dedicated to the description of technical measures that can be implemented at local level by the local authority in the different sectors of activity;

The guidebook provides a flexible but coherent set of principles and recommendations. The flexibility will allow local authorities to develop a SEAP in a way that suits their own circumstances, permitting those already engaged in energy and climate action to come on board of the Covenant of Mayors, while continuing to follow the approaches they have used before with as little adjustments as possible.

The number of topics covered by this guidebook is quite large. This is why we had to approach some of them in a rather general manner, providing links to further readings and information.

The Joint Research Centre (1) (JRC) – Institute for Energy (IE) and Institute for Environment and Sustainability (IES) – of the European Commission has been assigned the task of scientific and technical support to the Covenant. This guidebook has been elaborated by the JRC, in collaboration with the Energy and Transport Directorate-General (DG TREN) of the European Commission, the Covenant of Mayors' Office, and with the support and input of many experts from municipalities, regional authorities, other agencies or private companies.

This document is intended to help beginner towns/cities/regions to initiate the process and guide them through it. It should also provide experienced local authorities with answers to specific questions they are faced with in the context of the Covenant of Mayors, and if possible, with some fresh and new ideas on how to proceed.

Further information and support:

If you do not find the desired information in the present guidebook, you can refer to the 'Frequently Asked Question' section, available on the Covenant website:
http://www.eumayors.eu/faq/index_en.htm

In addition, a helpdesk has been set up to provide Covenant signatories with information and guidance on the preparation/implementation of both their BEI and their SEAP.

Inquiries can be sent by email:
technical.info@eumayors.org
or by phone: +39 0332 78 9703.

(1) *JRC's website:* ***www.jrc.ec.europa.eu***

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PART I
The SEAP process, step-by-step towards the -20 % target by 2020

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CHAPTER 1
The sustainable energy action plan — A way to go beyond the EU targets

1.1 What is a SEAP?

The Sustainable Energy Action Plan (SEAP) is a key document that shows how the Covenant signatory will reach its commitment by 2020. It uses the results of the Baseline Emission Inventory to identify the best fields of action and opportunities for reaching the local authority's CO_2 reduction target. It defines concrete reduction measures, together with time frames and assigned responsibilities, which translate the long-term strategy into action. Signatories commit themselves to submitting their SEAPs within the year following adhesion.

The SEAP should not be regarded as a fixed and rigid document, as circumstances change, and, as the ongoing actions provide results and experience, it may be useful/necessary to revise the plan on a regular basis.

Remember that opportunities to undertake emission reductions arise with every new development project to be approved by the local authority. The impacts of missing such an opportunity can be significant and will last for a long time. This means that energy efficiency and emission reduction considerations should be taken into consideration for all new developments, even if the SEAP has not yet been finalised or approved.

1.2 Scope of the SEAP

The Covenant of Mayors concerns action at local level within the competence of the local authority. The SEAP should concentrate on measures aimed at reducing the CO_2 emissions and final energy consumption by end users. The Covenant's commitments cover the whole geographical area of the local authority (town, city, region). Therefore the SEAP should include actions concerning both the public and private sectors. However, the local authority is expected to play an exemplary role and therefore to take outstanding measures related to the local authority's own buildings and facilities, vehicle fleet, etc. The local authority can decide to set the overall CO_2 emission reduction target either as 'absolute reduction' or 'per capita reduction' (see chapter 5.2 of Part II of this Guidebook).

The main target sectors are buildings, equipment/facilities and urban transport. The SEAP may also include actions related to local electricity production (development of PV, wind power, CHP, improvement of local power generation), and local heating/cooling generation. In addition, the SEAP should cover areas where local authorities can influence energy consumption on the long term (as land use planning), encourage markets for energy efficient products and services (public procurement), as well as changes in consumption patterns (working with stakeholders and citizens)[1]. On the contrary, the industrial sector is not a key target of the Covenant of Mayors, so the local authority may choose to include actions in this sector or not. In any case, plants covered by the ETS (European CO_2 Emission Trading Scheme) should be excluded, unless they were included in previous plans of the local authority. A detailed description of the sectors to be covered in the Baseline Emission Inventory is provided in table 1 of Part II.

1.3 Time horizon

The time horizon of the Covenant of Mayors is 2020. Therefore, the SEAP has to contain a clear outline of the strategic actions that the local authority intends to take in order to reach its commitments in 2020. The SEAP may cover a longer period, but in this case it should contain intermediate values and objectives for the year 2020.

As it is not always possible to plan in detail concrete measures and budgets for such a long time span, the local authority may distinguish between:

- a vision, with long-term strategy and goals until 2020, including firm commitments in areas like land-use planning, transport and mobility, public procurement, standards for new/renovated buildings etc.;
- detailed measures for the next 3-5 years which translate the long-term strategy and goals into actions.

BOTH THE LONG-TERM VISION AND THE DETAILED MEASURES SHALL BE AN INTEGRAL PART OF THE SEAP

For example, as a long-term strategy, the local authority could decide that all cars purchased for the municipal fleet should be biogas operated. Of course, the municipality cannot vote the budget for all cars that will be purchased up until 2020, but they can include this measure in the plan and evaluate its impact till 2020, as a result of the estimated future purchases of cars by the municipality. For the duration of the local authority's political mandate, this measure should be presented in very practical terms, with budgets, identification of financing sources, etc.

It is also strongly suggested that measures related to the local authority's own buildings and facilities are implemented first, in order to set an example and motivate the stakeholders.

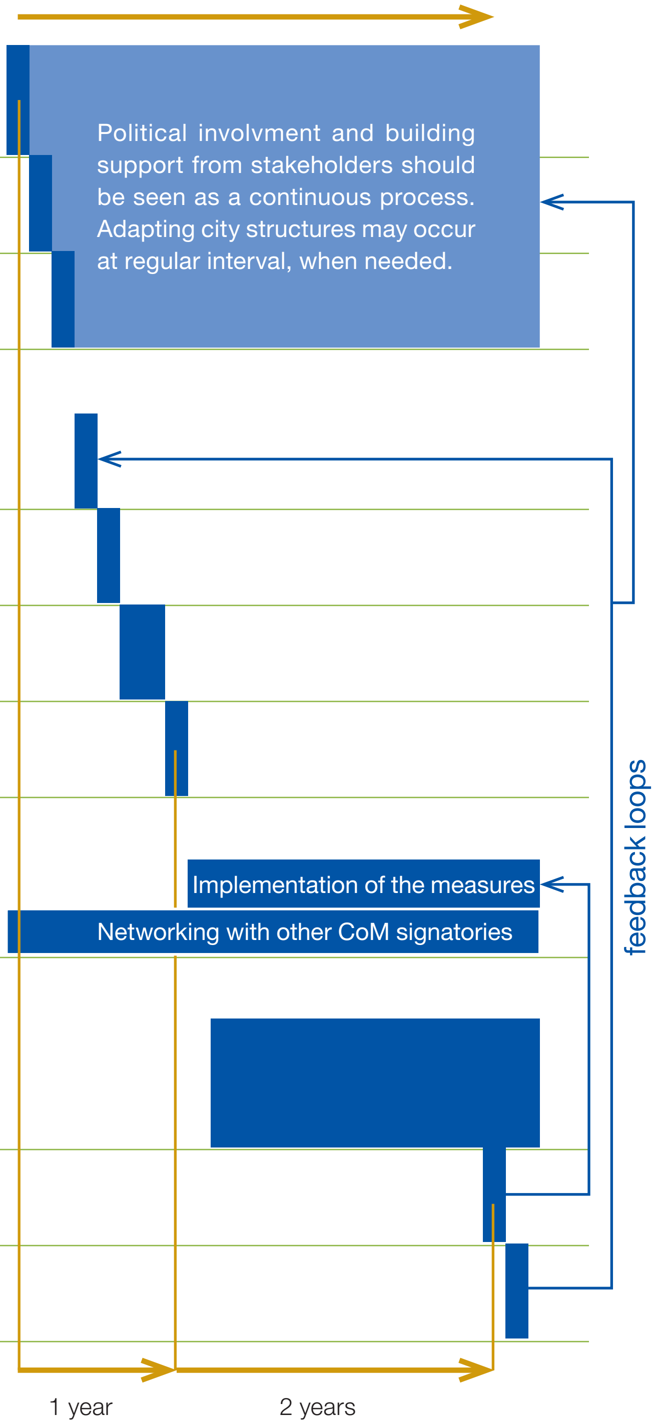
(1) *Note that the effect of such long term actions is not easy to evaluate or measure separately. Their effect will be reflected in the CO_2 emission inventory of the sector(s) they relate to (buildings, transport…). In addition, note that 'green purchases' not related to energy consumption cannot be taken into consideration in the inventory.*

1.4 The SEAP process

The following chart details the key steps for elaborating and implementing a successful SEAP. As shown in the graph, the SEAP process is not a linear one, and some steps may overlap with others. Besides, it is possible that some actions may have started before the adhesion to the Covenant (not shown in the graph).

THE SEAP PROCESS: PHASING OF THE DIFFERENT STEPS

STEP	CORRESPONDING GUIDEBOOK CHAPTER	TIME
PHASE: Initiation		
Political commitment and signing of the Covenant	Part I, Chapter 2	
Adapt city administrative structures	Part I, Chapter 3	
Build support from stakeholders	Part I, Chapter 4	
PHASE: Planning phase		
Assessment of the current framework (*): Where are we?	Part I, Chapter 5 + Part III	
Establishment of the vision: Where do we want to go?	Part I, Chapter 6	
Elaboration of the plan: How do we get there?	Part I, Chapters 7, 8 & 9 + Part II	
Plan approval and submission	–	
PHASE: Implementation phase		
Implementation	Part I, Chapter 10	
PHASE: Monitoring and reporting phase		
Monitoring	Part I, Chapter 11 + specific guidebook to be published later	
Reporting and submission of the implementation report	Part I, Chapter 11 + Part III, Chapters 5 and 7	
Review	–	



(*) *Including the elaboration of the CO_2 baseline emission inventory.*

1.5 Human and financial resources

SEAP elaboration and implementation requires human and financial resources. Local authorities may adopt different approaches:

- using internal resources, for example by integrating the tasks in an existing department of the local authority involved in sustainable development (e.g. local Agenda 21 office, environmental and/or energy department);
- setting up a new unit within the local administration (approx 1 person/100 000 inhabitants);
- outsourcing (e.g., private consultants, universities…);
- sharing one coordinator among several municipalities, in the case of smaller local authorities;
- getting support from regional energy agencies or Supporting Structures (see chapter 3).

Note that the human resources allocated to the SEAP may be highly productive from a financial point of view, via savings on the energy bills, access to European funding for the development of projects in the field of EE and RES.

In addition, extracting as much as possible resources from inside offers the advantages of a higher ownership, saves costs and supports the very materialisation of a SEAP.

1.6 SEAP template and SEAP submission procedure

Covenant signatories commit to submitting their SEAPs within the year following adhesion and to provide periodic implementation reports outlining the progress of their action plan.

The SEAP must be approved by the municipal council (or equivalent decision-making body) and uploaded in national language via the Signatories' Corner (on-line password-restricted area). Covenant signatories will be required, at the same time, to fill in an online SEAP template in English. This will allow them to summarise the results of their Baseline Emission Inventory as well as the key elements of their SEAP.

Moreover, the template is a valuable tool that provides visibility to the SEAP that facilitates its assessment, as well as the exchange of experience between the Covenant signatories. Highlights of the information collected will be shown on-line in the Covenant of Mayors website (**www.eumayors.eu**).

Should a group of adjoining Covenant of Mayors´ cities want to elaborate a common SEAP and Baseline Emissions Inventory (BEI), they are allowed to do it as long as a Supporting Structure is coordinating the work. In this case cities can submit only one SEAP and BEI, but each city has to fill in its own template. The objective of reducing 20 % of the CO_2 emissions by 2020 is not shared by the group of cities as it remains an individual objective of each signatory. The emissions´ reductions corresponding to the common measures proposed in the SEAP will be divided among each city sharing these measures.

The SEAP template is available on-line as an internet-based tool that the Covenant signatories are required to fill in themselves. Detailed information on how to fill in the SEAP template is available by clicking on the 'Instructions' link directly accessible in the Signatories' Corner.

A public copy of the SEAP template and supporting instructions document are available in the Covenant of Mayors website library:
http://www.eumayors.eu/library/documents_en.htm

1.7 Recommended SEAP structure

The Covenant signatories could follow the structure of the SEAP template when preparing their Sustainable Energy Action Plans. The suggested content is:

1. SEAP Executive Summary
2. Overall strategy
   A. Objective (s) and Targets
   B. Current framework and vision for the future
   C. Organisational and financial aspects:
   - coordination and organisational structures created/assigned;
   - staff capacity allocated;
   - involvement of stakeholders and citizens;
   - budget;
   - foreseen financing sources for the investments within your action plan;
   - planned measures for monitoring and follow-up.
3. Baseline Emission Inventory and related information, including data interpretation (see Part II of this Guidebook, chapter 5 Reporting and documentation)
4. Planned actions and measures for the full duration of the plan (2020)
   - long-term strategy, goals and commitments till 2020;
   - short/medium term actions.

   For each measure/action, please specify (whenever possible):
   - description
   - department responsible, person or company
   - timing (end-start, major milestones)
   - cost estimation
   - estimated energy saving/increased renewable energy production
   - estimated CO_2 reduction

1.8 Level of detail

The level of detail in the description of each measure/action is to be decided by the local authority. However, bear in mind that the SEAP is at the same time:

- a working instrument to be used during implementation (at least for the next few years);
- a communication tool towards the stakeholders;
- a document that is agreed at the political level by the various parties in charge within the local authority: the level of detail should be sufficient to avoid further discussion at the political level over the meaning and scope of the various measures.

1.9 Key elements of a successful SEAP

- Build support from stakeholders: if they support your SEAP, nothing should stop it! Conflicting stakeholders' interests deserve special attention.
- Secure a long-term political commitment.
- Ensure adequate financial resources.
- Do a proper CO_2 emissions inventory as this is vital. What you do not measure you will not change.
- Integrate the SEAP into day-to-day life and management of the municipality: it should not be just another nice document, but part of the corporate culture!
- Ensure proper management during implementation.
- Make sure that your staff has adequate skills, and if necessary offer training.
- Learn to devise and implement projects over the long term.
- Actively search and take advantage of experiences and lessons learned from other cities that have developed a SEAP.

1.10 Ten key elements to keep in mind when preparing your SEAP

As a summary of what is presented in this guidebook, here are the 10 essential principles that you should keep in mind when elaborating your SEAP. These principles are linked to the commitments taken by the Covenant signatories and *constitute* key ingredients of success. Failure to meet these principles may prevent SEAP validation.

1. SEAP approval by the municipal council (or equivalent decision-making body)

Strong political support is essential to ensure the success of the process, from SEAP design to implementation and monitoring (2). This is why the SEAP must be approved by the municipal council (or equivalent decision-making body).

2. Commitment for a reduction of CO_2 emissions by at least 20 % by 2020

The SEAP must contain a clear reference to this core commitment taken by the local authority when signing the Covenant of Mayors. The recommended baseline year is 1990, but if the local authority does not have data to compile a CO_2 inventory for 1990, then it should choose the closest subsequent year for which the most comprehensive and reliable data can be collected. The overall CO_2 reduction commitment has to be translated into concrete actions and measures together with the CO_2 reduction estimates in tons by 2020 (SEAP template part 3). For the local authorities that have a longer term CO_2 reduction target (for example by 2030) they should set an intermediary target by 2020 for the reasons of comparability.

3. CO_2 baseline emission inventory (BEI)

The SEAP should be elaborated based on a sound knowledge of the local situation in terms of energy and greenhouse gas emissions. Therefore, an assessment of the current framework should be carried out (3). This includes the establishment of a CO_2 baseline emission inventory (BEI), which is a key CoM commitment (4). The BEI has to be included in the SEAP.

(2) *See chapter 3 of part I of the SEAP guidebook for guidance on political commitment.*

(3) *See chapter 3 of part I of the SEAP guidebook for guidance on assessment of the current framework.*

(4) *See Part II of the SEAP guidebook for guidance on how to elaborate the CO_2 emission inventory.*

The BEI and subsequent inventories are essential instruments that allow the local authority to have a clear vision of the priorities for action, to evaluate the impact of the measures and determine the progress towards the objective. It allows to maintain the motivation of all parties involved, as they can see the result of their efforts. Here are some specific points of attention:

- The BEI has to be relevant to the local situation, i.e. based on energy consumption/production data, mobility data etc within the territory of the local authority. Estimates based on national/regional averages would not be appropriate in most cases, as they do not allow to capture the efforts made by the local authority to reach its CO_2 targets.
- The methodology and data sources should be consistent through the years.
- The BEI must cover at least the sectors in which the local authority intends to take action to meet the emission reduction target, i.e. all sectors that represent significant CO_2 emission sources: residential, municipal and tertiary buildings and facilities, and transport.
- The BEI should be accurate, or at least represent a reasonable vision of the reality.
- The data collection process, data sources and methodology for calculating the BEI should be well documented (if not in the SEAP then at least in the local authority's records).

4. Comprehensive measures that cover the key sectors of activity

The commitment taken by the signatories concerns the reduction of the CO_2 emissions *in their respective territories*. Therefore, the SEAP has to contain a coherent set of measures covering the key sectors of activity: not only the buildings and facilities that are managed by the local authority, but also the main sectors of activity in the territory of the local authority: residential sector, tertiary sector, public and private transport, industry (optional) etc (5). Before starting the elaboration of actions and measures, the establishment of a long-term vision with clear objectives is highly recommended (6). The SEAP guidebook contains many suggestions of policies and measures that can be applied at the local level (7).

5. Strategies and actions until 2020

The plan must contain a clear outline of the strategic actions that the local authority intends to take in order to reach its commitments in 2020. It has to contain:

- The long-term strategy and goals until 2020, including firm commitments in areas like land-use planning, transport and mobility, public procurement, standards for new/renovated buildings, etc.
- Detailed measures for the next 3-5 years which translate the long-term strategy and goals into actions. For each measure/action, it is important to provide a description, the department or person responsible, the timing (start-end, major milestones), the cost estimation and financing/source, the estimated energy saving/increased renewable energy production and the associated estimated CO_2 reduction.

6. Adaptation of city structures

One of the ingredients of success is that the SEAP process is not conceived by the different departments of the local administration as an external issue, but that it is be integrated in their everyday lie. This is why 'adapt city structures' is another key CoM commitment (8). The SEAP should outline which structures are in place or will be organised in order to implement the actions and follow the results. It should also specify what are the human resources made available.

7. Mobilisation of the civil society

To implement and achieve the objectives of the plan, the adhesion and participation of the civil society is essential (9). The mobilisation of the civil society is part of the CoM commitments. The plan has to describe how the civil society has been involved in its elaboration, and how they will be involved in implementation and follow up.

8. Financing

A plan cannot be implemented without financial resources. The plan should identify the key financing resources that will be used to finance the actions (10).

(5) *See chapter 2 of Part II of the SEAP guidebook for more advise on the sectors to be covered.*
(6) *See chapter 6 of Part I of the SEAP guidebook for guidance on the establishment of a vision and objectives.*
(7) *In particular, see chapter 8 of Part I, and Part III.*
(8) *See chapter 3 of Part I of the SEAP guidebook for guidance on city structures adaptation.*
(9) *See chapter 4 of Part I of the SEAP guidebook for guidance on the mobilisation of the civil society.*
(10) *See chapter 4 of Part I of the SEAP guidebook for guidance on how to finance the SEAP.*

9. **Monitoring and reporting**

Regular monitoring using relevant indicators followed by adequate revisions of the SEAP allows to evaluate whether the local authority is achieving its targets, and to adopt corrective measures if necessary. CoM signatories are therefore committed to submit an 'Implementation Report' every second year following the submission of the SEAP. A specific guidebook will be published in 2010. The SEAP should contain a brief outline on how the local authority intends to ensure the follow-up of the actions and monitor the results [11].

10. **SEAP submission and filling the template**

Covenant signatories commit to submitting their SEAPs within the year following adhesion. The SEAP must be uploaded in national language (or in English) via the Covenant of Mayor's website. Signatories are required, at the same time, to fill in an online SEAP template in English. This will allow them to summarise the results of their Baseline Emission Inventory as well as the key elements of their SEAP.

The template has to be filled carefully with sufficient level of detail, and should reflect the content of the SEAP, which is a politically approved document. A specific instruction document for filling in the template is available on the Covenant website.

(11) *See chapter 10 of Part I of the SEAP guidebook for guidance on Monitoring and reporting.*

CHAPTER 2
Political commitment

To ensure the success of the process (from SEAP design to implementation and monitoring), it is essential that sufficient empowerment and support is provided at the highest political level. The signature of the Covenant of Mayors by the municipal council (or equivalent decision-making body) is already a clear and visible sign of commitment. In order to reinforce the political support, it may be useful to give a reminder regarding the many benefits that SEAP implementation can bring to local authorities (see Annex II).

WHY DO MAYORS JOIN THE COVENANT?

'…To show that **local authorities already act and lead the fight against climate change.** The States need them to meet their Kyoto objectives and should therefore support them in their efforts…'
Denis Baupin, Deputy Mayor, Paris (FR)

'…To become **a strong partner of the European Commission** and influence adoption of policies and measures which help cities to achieve their Covenant objectives…'
Lian Merx, Deputy Mayor, Delft (NL)

'…To **meet people with the same ambitions**, get motivation, learn from each other…'
Manuela Rottmann, Deputy Mayor, Frankfurt am Main (DE)

'…To support the movement that obliges cities to meet their objectives, allows to monitor results and **involves EU citizens** – because it is their movement…'
Philippe Tostain, Councillor, Lille (FR)

The key decision-makers of the local authority should further support the process by allocating adequate human resources with clear mandate and sufficient time and budget to prepare and implement the SEAP. It is essential that they are involved in the SEAP elaboration process so that it is accepted and backed up by them. Political commitment and leadership are driving forces that stimulate the management cycle. Therefore they should be sought from the very beginning. The formal approval of the SEAP by the municipal council (or equivalent decision-making body), along with the necessary budgets for the first year(s) of implementation is another key step.

As the highest responsible entity and authority, the municipal council must be closely informed of the follow-up of the implementation process. An implementation report should be produced and discussed periodically. In the context of the Covenant, an implementation report has to be submitted every second year for evaluation, monitoring and verification purposes. If necessary, the SEAP should be updated accordingly.

Finally, the key decision-makers of the local authority could also play a role in:

- integrating the SEAP vision with the other actions and initiatives of the relevant municipality departments and making sure it becomes part of the overall planning;
- assuring the long-term commitment to implementation and monitoring, along the full duration of the SEAP;
- providing support to citizens' participation and stakeholders' involvement;
- ensure that the SEAP process is 'owned' by the local authority and the residents;
- networking with other CoM signatories, exchanging experience and best practices, establishing synergies and encouraging their involvement in the Covenant of Mayors.

There is no single route leading to political commitment. Administrative structures, patterns of political approval and political cultures vary from country to country. For such reason, the local authority itself is best suited to know how to proceed to raise the political commitment needed for the SEAP process, i.e. who to contact and in which order (Mayor, municipal council, specialised committees…).

SUGGESTIONS ON HOW TO ENSURE THE NECESSARY LOCAL COMMITMENT:

- Provide Mayor and key political leaders with informative notes about the benefits and resources needed for SEAP. Make sure documents presented to political authorities are short, comprehensive and understandable.
- Brief major political groups.
- Inform and involve general public/citizens and other stakeholders.
- Make a strong reference to the other decisions taken by the municipal council in this field (related strategies and plans, Local Agenda 21, etc.).
- Take advantage of windows of opportunity, for example when the media is focusing on climate change issues.
- Inform clearly about the causes and effects of climate change along with information about effective and practical responses.
- Highlight the other benefits than contribution to climate change (social, economic, employment, air quality, …). Keep the message simple, clear and tailored to the audience.
- Focus on measures on which the agreement of the key actors can be obtained.

Additional ressources

1. MUE-25 PROJECT: The project 'Managing Urban Europe-25 (MUE-25)' provides some suggestions on how to build political commitment.
http://www.mue25.net/Political_Commitment_200907_t1z4D.PDF.file
2. The Policy Network, in its publication 'Building a low carbon future: the politics of climate change', dedicates a chapter to political strategies for strengthening climate policies:
http://politicsofclimatechange.files.wordpress.com/2009/06/building-a-low-carbon-future-pamphlet-chapter-05.pdf

CHAPTER 3
Adapting administrative structures ([12])

Devising and implementing a sustainable energy policy is a challenging and time-demanding process that has to be systematically planned and continuously managed. It requires collaboration and coordination between various departments in the local administration, such as environmental protection, land use and spatial planning, economics and social affairs, buildings and infrastructure management, mobility and transport, budget and finance, procurement, etc. In addition, one of the challenges for success is that the SEAP process should not be conceived by the different departments of the local administration as an external issue, but that it has to be integrated in their everyday life: mobility and urban planning, management of the local authority's assets (buildings, municipal fleet, public lighting…), internal and external communication, public procurement…

A clear organisational structure and assignment of responsibilities are prerequisites for the successful and sustainable implantation of the SEAP. A lack of coordination between the various policies, local authority departments and external organisations has been a considerable shortcoming in the energy or transport planning of many local authorities.

This is why *'Adapting city structures, including allocation of sufficient human resources'* is a formal commitment of those signing the Covenant of Mayors.

Therefore, all Covenant signatories should adjust and optimise their internal administrative structures. They should assign specific departments with appropriate competencies as well as sufficient financial and human resources to implement the Covenant of Mayors' commitments.

3.1 How to adjust administrative structures

Where organisational structures have already been created for other related policies (energy management unit, local Agenda 21 coordination, etc.), they may be used in the context of the Covenant of Mayors.

At the beginning of the SEAP elaboration process, a 'Covenant coordinator' should be appointed. She/he must have full support of the local political authorities and from the hierarchy, as well as the necessary time availability, and the budgetary means to carry out his/her tasks. In large cities, she/he could even have a dedicated unit at his/her disposal, with several staff. Depending on the size of the local authority, one person dedicated to data collection and CO_2 inventory may also be necessary.

As an example of simple organisation structure, two groups may be constituted:

- A steering committee, constituted by politicians and senior managers. Its mission would be to provide strategic direction and the necessary political support to the process.
- One or several working group(s), constituted by the energy planning manager, key persons from various departments of the local authority, public agencies, etc. Their task would be to undertake the actual SEAP elaboration and follow up work, to ensure stakeholders' participation, to organise monitoring, to produce reports, etc. The working group(s) may be opened to the participation of non-municipal key actors directly involved in SEAP actions.

Both the steering committee and the working group need a distinct leader, although they should be able to work together. Moreover, the objectives and functions of each one of these groups must be clearly specified. A well-defined meeting agenda and a project-reporting strategy are recommendable in order to have a good command over the SEAP process. The steering committee and the working group each need a leader, able to work together.

It is essential that sustainable energy management is integrated with the other actions and initiatives of the relevant municipality departments, and it must be ensured that it becomes part of the overall planning of the local authority. Multi-departmental and cross-sectoral involvement is required, and organisational targets need to be in line and integrated with the SEAP. The establishment of a flow chart, indicating the various interactions between departments and actors, would be useful to identify the adjustments that may be necessary to the local authority's organisation. As many key municipal players as possible should be assigned responsible roles to ensure strong ownership of the process in the organisation. A specific communication campaign may help reach and convince the municipal workers in different departments.

Moreover, adequate training should not be neglected in different fields, such as technical competencies (energy efficiency, renewable energies, efficient transport…), project management, data management (lack of skills in this field can be a real barrier!), financial management, development of investment projects, and communication (how to promote behavioural changes, etc). Linking with local universities can be useful for this purpose.

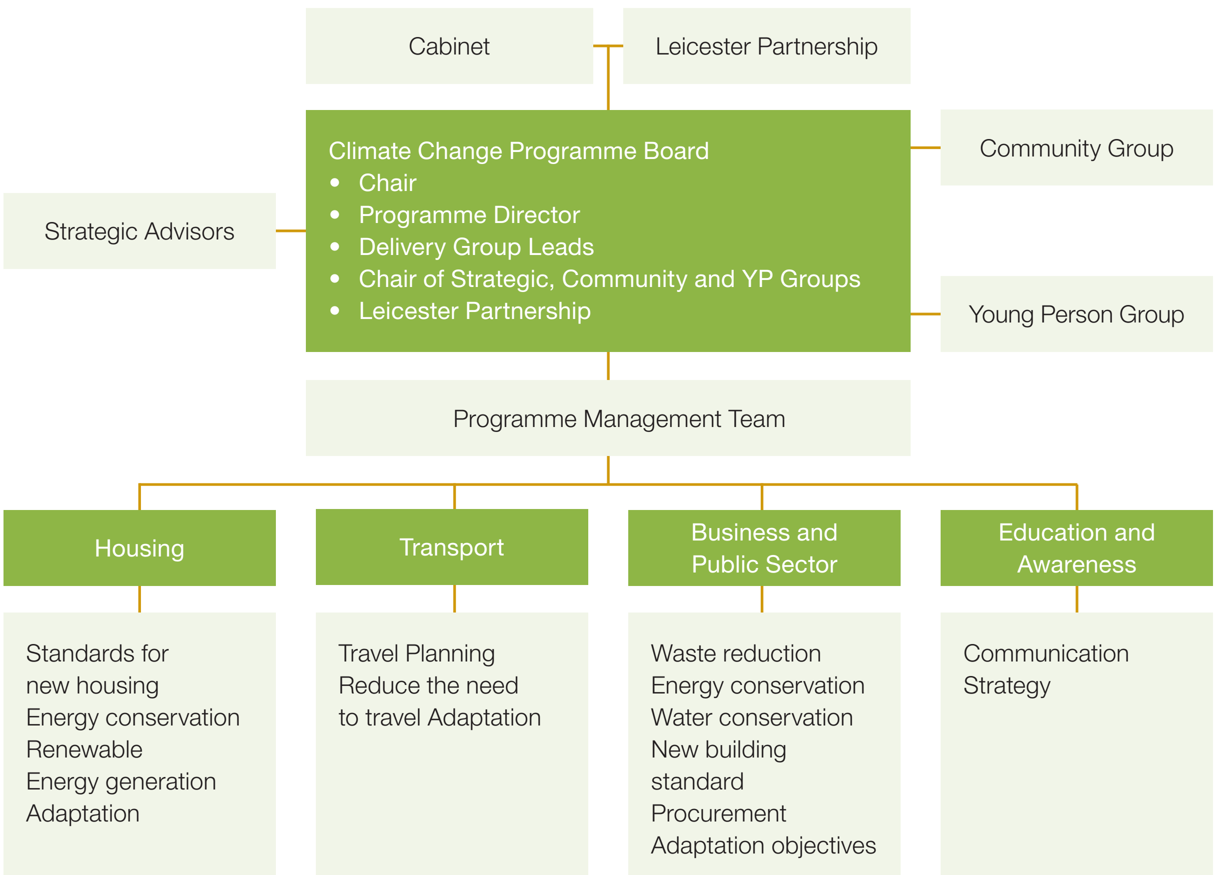
(12) *Parts of this chapter are adapted from* ***http://www.movingsustainably.net/index.php/movsus:mshome*** *developed by the Union of the Baltic Cities Environment and Sustainable Development Secretariat and part-funded by the European Union. Further information about capacity-building and previous experiences are available in the MODEL project webpage* ***www.energymodel.eu***

3.2 Examples from Covenant signatories

Here are two examples of structures that the cities of Munich and Leicester respectively set up for developing and implementing their local energy strategies:

FIGURE 1: ADMINISTRATIVE STRUCTURE OF THE CITY OF MUNICH

FIGURE 2: ADMINISTRATIVE STRUCTURE OF THE CITY OF LEICESTER



3.3 External support

Depending on their size and human resources availability, local authorities may benefit from the assistance of Supporting Structures or energy agencies. It is even possible for them to subcontract some specific tasks (e.g. compilation of a Baseline Emission Inventory) or to use interns (Masters or PhD students can do much of the work associated with the collection of data and entry into a GHG calculation tool to produce the BEI).

Supporting Structures

Local authorities, which do not have sufficient skills or resources to draft and implement their own SEAP, should be supported by administrations or organisations with such capacities. Supporting Structures are in a position to provide strategic guidance and financial and technical support to local authorities with political will to sign up to the Covenant of Mayors, but lacking the skills and/or the resources to fulfil its requirements.

Supporting Structures also have a vocation to keep a close contact with the European Commission and the Covenant of Mayors' Office to ensure the best possible implementation of the Covenant. Thus, Supporting Structures are officially recognised by the Commission as key allies in conveying the message and increasing the impact of the Covenant.

There are two types of Supporting Structures:
1. National and regional public bodies, regions, counties, provinces, agglomerations.
2. Networks or associations of regional or local authorities.

Supporting Structures can offer direct technical and financial assistance such as:
- mobilising technical expertise in order to help Covenant signatories preparing their Baseline Emissions Inventory (BEI) or Sustainable Energy Action Plan (SEAP);
- developing or adapting methodologies for preparing SEAP, taking into account the national or regional context;
- identifying financial opportunities for the SEAP implementation;
- training local officials, who will be the final SEAP owners (type 1 Supporting Structures).

Some concrete examples:
- The Region of Andalucía has undertaken an Emission Inventory on its territory that will be used by Covenant Signatories of the region to prepare their SEAP.
- The Polish Network of Energy Cities (PNEC) is providing direct technical support to four Polish cities willing to join the Covenant of Mayors in 2009. This support is based on the methodology developed under the European-funded project MODEL (Management Of Domains related to Energy in Local authorities).
- The Province of Barcelona, while directly financing the development of SEAPs of the Signatories it supports, is also preparing a programme under the European Local Energy Assistance facility to develop Photovoltaic systems which will benefit those municipalities.

Energy agencies

Local and Regional Energy Agencies (LAREAs) have been active in local energy policy for decades and their knowledge and expertise could be very useful for the Covenant signatories, especially those lacking the technical capacities.

In fact, one of the first activities of each agency is to prepare an energy plan, or to update existing ones in the geographical area covered by the Agency. This strategic process usually comprises several steps, including the collection of energy data, the establishment of an energy balance, as well as the development of short-, medium- and long-term energy policies and plans. Hence, Covenant signatories can expect their Local and Regional Energy Agencies (LAREAs) to give wide-ranging advice on all energy aspects, as well as useful technical assistance in the design of their BEI and SEAP.

Additional ressources

1. Ireland's national energy agency (SEI), provides a link with guidance to 'Resourcing the Energy Management Programme'
http://www.sustainableenergyireland.ie/uploadedfiles/EnergyMAP/tools/01-10a%20Resourcing%20the%20Energy%20Management%20Programme%20v1.0.pdf

CHAPTER 4
Building support from stakeholders (13)

All members of society have a key role in addressing the energy and climate challenge with their local authorities. Together, they have to establish a common vision for the future, define the paths that will make this vision come true, and invest the necessary human and financial resources.

Stakeholders' involvement is the starting point for stimulating the behavioural changes that are needed to complement the technical actions embodied in the SEAP. This is the key to a concerted and co-ordinated way to implement the SEAP.

The views of citizens and stakeholders should be known before detailed plans are developed. Therefore, citizens and other stakeholders should thus be involved and be offered the opportunity to take part in the key stages the SEAP elaboration process: building the vision, defining the objectives and targets, setting the priorities, etc. There are various degrees of involvement: 'informing' is at one extreme whilst 'empowering' is at the other. To make a successful SEAP, it is highly recommended to seek the highest level of participation of stakeholders and citizens in the process.

Stakeholders' participation is important for various reasons:

- participatory policy-making is more transparent and democratic;
- a decision taken together with many stakeholders is based on more extensive knowledge;
- broad consensus improves the quality, acceptance, effectiveness and legitimacy of the plan (at least it is necessary to make sure that stakeholders do not oppose some of the projects);
- sense of participation in planning ensures the long-term acceptance, viability and support of strategies and measures;
- SEAPs may sometimes get stronger support from external stakeholders than from the internal management or staff of the local authority.

For these reasons, to *'Mobilise the civil society in our geographical areas to take part in developing the action plan'* is a formal commitment of those signing the Covenant of Mayors.

4.1 Who are stakeholders?

The first step is to identify the main stakeholders.
The stakeholders are those:

- whose interests are affected by the issue;
- whose activities affect the issue;
- who possess/control information, resources and expertise needed for strategy formulation and implementation;
- whose participation/involvement is needed for successful implementation.

The following table shows the potential roles that the local authority and the stakeholders can play in the SEAP process outlined in chapter 1.

Here is a list of potentially important stakeholders in the context of a SEAP:

- local administration: relevant municipal departments and companies (municipal energy utilities, transport companies, etc.);
- local and regional energy agencies;
- financial partners such as banks, private funds, ESCOs (14);
- institutional stakeholders like chambers of commerce, chambers of architects and engineers;
- energy suppliers, utilities;
- transport/mobility players: private/public transport companies, etc.;
- the building sector: building companies, developers;
- business and industries;
- supporting Structures and energy agencies;
- NGOs and other civil society representatives;
- representatives of the civil society, including students, workers etc.;
- existing structures (Agenda 21, …);
- universities;
- knowledgeable persons (consultants, …);
- where relevant, representatives of national/regional administrations and/or neighbouring municipalities, to ensure coordination and consistency with plans and actions that take place at other levels of decision;
- tourists, where the tourist industry represents a large share of the emissions.

(13) *Parts of this chapter are adapted from* ***http://www.movingsustainably.net/index.php/movsus:mshome*** *developed by the Union of the Baltic Cities Environment and Sustainable Development Secretariat and part-funded by the European Union.*

(14) *ESCO is the acronym of Energy Services Companies.*

THE SEAP PROCESS: THE MAIN STEPS – ROLE OF THE KEY ACTORS			
STEP	ROLE OF THE ACTORS		
	Municipal council or equivalent body	Local administration	Stakeholders
PHASE: Initiation			
Political commitment and signing of the Covenant	Make the initial commitment. Sign the Covenant of Mayors. Provide the necessary impulse to the local administration to start the process.	Encourage the political authorities to take action. Inform them about the benefits (and about the necessary resources).	Make pressure on political authorities to take action (if necessary).
Adapt city administrative structures	Allocate sufficient human resources and make sure adequate administrative structures are in place.		
Build support from stakeholders	Provide the necessary impulse for stakeholders' participation. Show that you consider their participation and support as important.	Identify the main stakeholders, decide what channels of communication/ participation you want to use. Inform them about the process that is going to start, and collect their views.	Express their views, explain their potential role in SEAPs.
PHASE: Planning phase			
Assessment of the current framework: Where are we?	Make sure the necessary resources are in place for the planning phase.	Conduct the initial assessment, collect the necessary data, and elaborate the CO_2 baseline emission inventory. Make sure the stakeholders are properly involved.	Provide valuable inputs and data, share the knowledge.
Establishment of the vision: Where do we want to go?	Support the elaboration of the vision. Make sure it is ambitious enough. Approve the vision (if applicable).	Establish a vision and objectives that support the vision. Make sure it is shared by the main stakeholders and by the political authorities.	Participate in the definition of the vision, express their view on the city's future.
Elaboration of the plan: How do we get there?	Support the elaboration of the plan. Define the priorities, in line with the vision previously defined.	Elaborate the plan: define policies and measures in line with the vision and the objectives, establish budget and financing, timing, indicators, responsibilities. Keep the political authorities informed, and involve stakeholders. Make partnerships with key stakeholders (if necessary).	Participate in the elaboration of the plan. Provide input, feedback.
Plan approval and submission	Approve the plan and the necessary budgets.	Submit the SEAP via the CoMO website. Communicate about the plan.	Make pressure on political authorities to approve the plan (if necessary).

STEP	ROLE OF THE ACTORS		
	Municipal council or equivalent body	Local administration	Stakeholders
PHASE: Implementation phase			
Implementation	Provide long-term political support to the SEAP process.	Coordinate the implementation plan. Make sure each stakeholder is aware of its role in the implementation.	Each stakeholder implements the measures that are under its responsibility.
	Make sure that the energy and climate policy is integrated in the every day life of the local administration.	Implement the measures that are under responsibility of the local authority. Be exemplary. Communicate about your actions.	Make pressure/encourage the local administration to implement the measures under its responsibility (if necessary).
	Show interest in the plan implementation, encourage stakeholders to act, show the example.	Motivate the stakeholders to act (information campaigns). Inform them properly about the resources available for EE and RES.	Changes in behaviour, EE and RES action, general support to SEAP implementation.
	Networking with other CoM signatories, exchanging experience and best practices, establishing synergies and encouraging their involvement in the Covenant of Mayors.		Encourage other stakeholders to act.
PHASE: Monitoring and reporting phase			
Monitoring	Ask to be informed regularly about the advancement of the plan.	Proceed to a regular monitoring of the plan: advancement of the actions and evaluation of their impact.	Provide the necessary inputs and data.
Reporting and submission of the implementation report	Approve the report (if applicable).	Report periodically to the political authorities and to the stakeholders about the advancement of the plan. Communicate about the results. Every second year, submit an implementation report via the CoMO website.	Provide comments on the report and report on the measures under their responsibility.
Review	Ensure that plan updates occur at regular intervals.	Periodically update the plan according to the experience and the results obtained. Involve political authorities and stakeholders.	Participate in plan update.

4.2 How to engage in stakeholder participation

Participation can be obtained through a variety of methods and techniques, and it may be useful to make recourse to a (professional) animator as a neutral moderator. Different levels of participation and tools may be considered (*):

	DEGREE OF INVOLVEMENT	EXAMPLES OF TOOLS
1.	Information and education	Brochures, newsletters, advertisement, exhibitions, site visits.
2.	Information and feedback	Telephone hotline, website, public meetings, teleconferences, surveys and questionnaires, staffed exhibitions, deliberative polls.
3.	Involvement and consultation	Workshops, focus groups, forums, open house.
4.	Extended involvement	Community advisory committees, planning for real, citizen's juries.

EXAMPLE 1

A local energy forum is a local authority driven participatory process, which engages local stakeholders and citizens to work together in order to prepare and implement common actions that can be formalised into an Action Plan. Such forums are already used by some Covenant Signatories. For example Almada (Portugal) organised a local energy forum and invited all interested companies and organisations in order to gather ideas and project proposals that could contribute to their Action Plan. A partnership with a local energy agency and a university was established to develop their plan. Similarly the city of Frankfurt (Germany) asked the forum participants to make their own contributions to meet common energy targets and propose concrete actions to be carried out.

EXAMPLE 2

The municipality of Sabadell (Spain) raised the awareness of citizens by providing smart meters to 100 households. Such meters give an instant reading of energy consumption in euro, kWh and tonnes of CO_2, via a wireless device. Besides, workshops were organised to inform and educate households in relation with energy saving. The data related to energy consumption and CO_2 emissions were collected and the reduction achieved was calculated (expected around 10 % of reduction). Finally, the results were communicated to the families.

EXAMPLE 3

The following methods have been employed at the Greater London Authority during the delivery of the London Mayor's environmental strategies, in order to engage multiple stakeholders in the process:

Public Participation Geographic Information Systems (PPGIS) was used to empower and include marginalized populations (e.g., ethnic groups, young and old people), who normally have little voice in the public arena, through interactive participation and integrated applications of GIS (in a user-friendly format), to change involvement and awareness of the SEAP at a local level. Simplified GIS-based maps and models could be used to visualise the effects of the SEAP at local levels in order to facilitate interactive participation and further promote community advocacy in the SEAP's strategic decision making processes. The use of PPGIS's transparent tools and participative process helped to build trust and understanding between professionally and culturally diverse stakeholders.

Problem Structuring Methods (PSMs) was used to build simple SEAP models in a participative and iterative manner to help stakeholders with distinctive perspectives or conflicting interests to understand and secure shared commitments to the SEAP; embrace value differences, rather than trade-off; represent the complexities of the SEAP diagrammatically not by algebra; appraise and compare discrete strategic alternatives; and also address uncertainty in terms of 'possibilities' and 'scenarios' rather than in terms of 'probability' and 'prediction' only. Cognitive mapping (a means of mapping individual stakeholders' perspectives) can also be used as a modelling device to elicit and record individuals' view of the SEAP. The merged cognitive maps will provide the framework for workshop discussions aimed at assessing the SEAP's objectives and generating agreement on a portfolio of actions.

(*) *Adapted from Judith Petts and Barbara Leach, Evaluating methods for public participation: literature review, Bristol Environment Agency, 2000.*

The roles and responsibilities of each player have to be specified. Partnerships with key actors are often necessary in developing and implementing a successful SEAP. Further communication about SEAP implementation results will be necessary to maintain motivation of stakeholders.

SOME PRACTICAL TIPS:

- Think big: Do not focus on the usual contacts.
- Get decision-makers on board.
- Choose an appropriate facilitator/moderator.
- Some stakeholders can have conflicting interests. In this case it is advisable to organise workshops for each particular group separately to understand the conflicting interests before bringing them together.
- In order to raise the interest of the citizens, it is recommended to use visual tools (GIS tool showing the energy efficiency of the various districts of the local authority, aerial thermography showing thermal losses of individual buildings, or any simple model, which allows to show visually the data being presented).
- Attract media attention.

4.3 Communication

Communication is an essential means to keep the stakeholders informed and motivated. Therefore, a clear communication strategy should be integrated in the SEAP. Before initiating a communication campaign, some information should be specified in order to maximise the impact of the action.

- Specify the message to be transmitted and the effect to be produced (desired outcome).
- Identify the key audience.
- Establish a set of indicators to evaluate the impact of the communication (head count at a seminar, surveys – quantitative/qualitative, hits on website, feedback, e.g. e-mails, …).
- Specify the most appropriate communication channel(s) (face to face – most effective form of communication, advertising, mail, e-mail, internet, blogs, talks/meetings, brochures, posters, newsletters, printed publications, media releases, sponsorship…).
- Specify planning and budget.

Communication can also be internal to the local authority: setting up internal communication means may be necessary to improve collaboration between the departments involved within the local authority.

Additional ressources

1. The Belief Project produced a comprehensive guide on how to 'Involve stakeholders and citizens in your local energy policy' through energy forums.
   www.belief-europe.org
2. The Environment Agency of Bristol published the following paper that contains a review of a variety of public participation techniques, with their main advantages and disadvantages (p. 28).
   http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.129.8717&rep=rep1&type=pdf
3. The Employers' Organisation for local government (EO) produced a toolkit to assist local authorities and their partners to more effective collaborative working.
   http://www.lgpartnerships.com/
4. The Partner Foundation for Local Development has developed training for elected leaders. See Handbook 4, the councillor as communicator.
   http://www.fpdl.ro/publications.php?do=training_manuals&id=1
5. Interesting information about communication strategy can be found in the Energy Model project in step 9 named 'Programme implementation'.
   www.energymodel.eu

CHAPTER 5
Assessment of the current framework: Where are we?

5.1 Analysis of relevant regulations

Within a municipality, there are sometimes conflicting policies and procedures. A first step is to identify the existing municipal, regional and national policies, plans, procedures and regulations that affect energy and climate issues within the local authority.

The mapping and analysis of these existing plans and policies is a good starting point towards better policy integration. See Annex III for a list of the key European regulatory instruments relevant for local authorities.

The next step is to go through and check and compare the objectives and goals in the identified documents with the ones for a sustainable energy policy. The aim is to establish whether these objectives and goals are supporting or conflicting.

Finally, the local authority should invite all the relevant actors and stakeholders to discuss the conflicts identified. They should try to reach an agreement on the changes that are necessary to update policies and plans, and clearly establish who and when should put them into practice. The relevant actions should be planned (when possible) and the list of actions to be taken should be included in the SEAP. Changes may take time to show their beneficial effects, but should nevertheless be endorsed by the political leadership.

5.2 Baseline review and Baseline Emission Inventory

Energy consumption and CO_2 emissions at the local level are dependent on many factors: economical structure (industry/service oriented and nature of the activities), level of economic activity, population, density, characteristics of the building stock, usage and level of development of the various transport modes, citizens' attitudes, climate, etc. Some factors can be influenced in the short term (like citizens' attitudes), while others can only be influenced in the medium or long term (energy performance of the building stock). It is useful to understand the influence of these parameters, how they vary in time, and identify upon which the local authority can act (in the short, medium and long term).

This is the purpose of baseline review: establish a clear picture of 'where we are', a description of the city's current situation in terms of energy and climate change.

A baseline review is the starting point for the SEAP process from which it is possible to move to relevant objective-setting, elaboration of adequate Action Plan and monitoring. The baseline review needs to be based on existing data. It should map relevant legislations, existing policies, plans, instruments and all departments/ stakeholders involved.

Completing a baseline review requires adequate resources, in order to allow the data sets to be collated and reviewed. This assessment permits elaborating a SEAP that is suited to the emerging issues and specific needs of the local authority's current situation.

In Annex II, you will find a list of suggested aspects to be covered in the baseline review.

The aspects to be covered can be either quantitative (evolution of energy consumption…) or qualitative (energy management, implementation of measures, awareness…). The baseline review allows to prioritise actions and then to monitor the effects based on relevant indicators. The most demanding element is to build a complete CO_2 emission inventory, based on actual energy consumption data (refer to Part II of this guidebook, which provides guidance on how to collect the energy data and how to elaborate the CO_2 emission inventory).

DETAILED STEPS FOR CONDUCTING THE BASELINE REVIEW:

1. **Select the review team – preferably the inter-sectoral working group.**
   At this stage you should decide what degree of stakeholder's involvement you wish for this process. As stakeholders generally posses a lot of valuable information, their involvement is highly recommended (see chapter 3).
2. **Assign tasks to team members.**
   Consider the competencies, as well as the availability of each member of the group, in order to assign them tasks that they will be able to perform.
3. **Establish review schedule.**
   Indicate realistic start and end date of all data collection activities.

4. **Identify the most important indicators to be** included in the assessment.
   The following elements should be covered:
   - What is the energy consumption and CO_2 emissions of the different sectors and actors present in the territory of the local authority and what are the trends? (See Part II).
   - Who produces energy and how much? Which are the most important sources of energy? (See Part II).
   - What are the drivers that influence energy consumption?
   - What are the impacts associated with energy consumption in the city (air pollution, traffic congestion…)?
   - What efforts have already been made in terms of energy management and what results have they produced? Which barriers need to be removed?
   - What is the degree of awareness of officials, citizens and other stakeholders in terms of energy conservation and climate protection?

   In annex, we provide a table with more detailed specifications of the aspects that could be covered in the assessment.

5. **Collect the baseline data.**
   It requires the collection and processing of quantitative data, the establishment of indicators, and the gathering of qualitative information using document review and interviews/workshops with stakeholders. The selection of data sets needs to be based on criteria that are agreed on with stakeholders, who are then actively involved in contributing data. Part II of this guidebook provides guidance for the collection of data related to energy consumption.

6. **Compile the CO_2 baseline emission inventory.**
   Based on energy data, the CO_2 baseline emission inventory can be compiled (see Part II of this guidebook).

7. **Analyse the data.**
   It is not enough just to collect data: data needs to be analysed and interpreted in order to inform policy. For example, if the baseline review shows that energy consumption is increasing in a specific sector, try to understand why it is so: population increase, increased activity, increased usage of some electrical devices, etc. …

8. **Write the self-assessment report –**
   be honest and truthful, as a report which does not reflect reality serves no purpose.
   The baseline review can be carried out internally within the local authority as a self-assessment process, but combining the self-assessment with an external peer review can add additional value to the process. Peer review offers an objective third-party review of achievements and future prospects. Peer reviews can be carried out by external experts who work in other cities or organisations in similar fields of expertise. It is a cost-effective method and often a more politically acceptable alternative to consultants.

Based on the data collected and on the different sets of hypothesis, it may be relevant to establish scenarios: how would energy consumption and CO_2 emissions evolve under current policies, what would be the impact of the projected actions, etc?

5.3 SWOT analysis

A SWOT analysis is a useful strategic planning tool that can be applied in the SEAP process. Based on the findings of the baseline review, it allows one to determine the Strengths and Weaknesses of the local authority in terms of energy and climate management, as well as the Opportunities and Threats that could affect the SEAP. This analysis can help to define priorities when devising and selecting SEAP actions and measures.

Additional resources

1. The Model project provides some guidance on how to build different scenarios:
   http://www.energymodel.eu/IMG/pdf/IL_4_-_Baseline.pdf
2. The Managing Urban Europe 25 project gives detailed instructions on how to prepare a baseline review (based on sustainability management).
   http://www.localmanagement.eu/index.php/mue25:mue_baseline
3. The charity village website provides additional guidance on SWOT Analysis.
   http://www.charityvillage.com/cv/research/rstrat19.html
4. The businessballs website provides free resources on SWOT analysis, as well as examples.
   http://www.businessballs.com/swotanalysisfreetemplate.htm

CHAPTER 6
Establishment of a long-term vision with clear objectives

6.1 The vision: towards a sustainable energy future

A further step to undertake to make your municipality in line with the Covenant of Mayor's energy-efficiency objectives is to establish a vision. The vision for a sustainable energy future is the guiding principle of the local authority's SEAP work. It points out the direction in which the local authority wants to head. A comparison between the vision and the local authority's current situation is the basis for identifying what action and development is needed to reach the desired objectives. The SEAP work is a systematic approach to gradually get closer to the vision.

The vision serves as the uniting component that all stakeholders can refer to; meaning everyone from leading politicians to citizens and interest groups. It can also be used for marketing the local authority to the rest of the world.

The vision needs to be compatible with the Covenant of Mayors' commitments, i.e. it should imply that the 20% CO_2 emission reduction in the 2020 target will be reached (at the minimum). But it could also be more ambitious than that. Some cities already plan to become carbon neutral in the long run.

The vision should be realistic but still provide something new, add real value and break some old boundaries that do not have real justification any more. It should describe the desired future of the city and be expressed in visual terms to make it more understandable for citizens and stakeholders.

It is warmly recommended to involve stakeholders in the process to get more new and bold ideas and also to use stakeholder participation as the starting point of behavioural change in the city. Besides, stakeholders and citizens may provide a strong support to the process, as they sometimes want stronger action than what other levels of government would be prepared to support.

EXAMPLES OF VISIONS OF SOME LOCAL AUTHORITIES

Växjö (Sweden):
'In Växjö, we have the vision that we will live and act so as to contribute to sustainable development where our consumption and production are resource-effective and pollution free.' And *'The vision is that Växjö shall become a city where it is easy and profitable to live a good life without fossil fuels.'*

Lausanne (Switzerland):
'Our 2050 vision is a reduction by 50% of the CO_2 emissions on the city's territory.'

6.2 Setting objectives and targets

Once the vision is well established, it is necessary to translate it into more specific objectives and targets, for the different sectors in which the local authority intends to take action. These objectives and targets should be based on the indicators selected in the baseline review (see chapter 5.2).

Such targets and objectives should follow the principles of the SMART acronym: Specific, Measurable, Achievable, Realistic, and Time-bound. The concept of SMART objectives became popular in the 1980s as an efficient management concept.

To set SMART targets, ask yourself the following questions:

1. **Specific** (well-defined, focused, detailed and concrete) – ask yourself: What are we trying to do? Why is this important? Who is going to do what? When do we need it done? How are we going to do it?
2. **Measurable** (kWh, time, money, %, etc.) – ask yourself: How will we know when this objective has been achieved? How can we make the relevant measurements?
3. **Achievable** (feasible, actionable) – ask yourself: Is this possible? Can we get it done within the timeframe? Do we understand the constraints and risk factors? Has this been done (successfully) before?
4. **Realistic** (in the context of the resources that can be made available) – ask yourself: Do we currently have the resources required to achieve this objective? If not, can we secure extra resources? Do we need to reprioritise the allocation of time, budget and human resources to make this happen?
5. **Time-Bound** (defined deadline or schedule) – ask yourself: When will this objective be accomplished? Is the deadline unambiguous? Is the deadline achievable and realistic?

6.3 Examples of SMART objectives (15)

TYPES OF INSTRUMENT	EXAMPLES OF SMART TARGETS
Energy performance standard	S: Focus on specific product or product group M: Performance characteristics aimed for/set baseline A: Performance standard links to best available product on the market and is regularly updated R: Best available product is accepted by the target group T: Set clear target period
Subsidy scheme	S: Focus on specific target group and on specific technologies M: Quantified energy savings target/set baseline A: Minimize freeriders R: Link the savings target to the available budget T: Link the energy savings target to a target period
(Voluntary) Energy audit	S: Focus on specific target group M: Quantify the target audit volume (m^2, number of companies, % of energy use, etc.)/set baseline A: Encourage to implement recommended measures, e.g. by offering financial incentives R: Ensure that sufficient qualified auditors have been assigned and financial incentives are in place to carry out audits T: Link the quantified target to a target period

In practice, a potential SMART target could be: '15 % of the dwellings will be audited between 1/1/2010 and 31/12/2012'. Then, it is necessary to check every condition of being SMART. For example, the answer could be:

*'It is **Specific** because our action (energy audits) and target group (dwellings) is well defined. It is **Measurable** because it is a quantified target (15 %) and because we have a system in place to know the number of audits actually carried out. It is **Achievable** because there is a financial incentive scheme that allows people to be reimbursed and because we will organise communication campaigns about audits. It is **Realistic** because we have trained 25 auditors that are now well-qualified, and we have verified that this number is sufficient. It is **Time-bound** because the time-frame is well defined (between 1/1/2010 and 31/12/2012).'*

SOME TIPS

- Avoid putting 'raising awareness' as an objective. It is too big, too vague and very difficult to measure.
- Add the following requirements to the objectives:
  - understandable – so that everyone knows what they are trying to achieve;
  - challenging – so everyone has something to strive for.
- Define specific targets for 2020 for the different sectors considered and define intermediate targets (at least every 4 years, for instance).

Additional resources

1. The 'practice of leadership' website provides additional guidance on setting SMART Objectives:
   http://www.thepracticeofleadership.net/2006/03/11/setting-smart-objectives/
   http://www.thepracticeofleadership.net/2006/10/15/10-steps-to-setting-smart-objectives/
2. **The European Sustainable Development Network publishes** a study on (SMART) Objectives and Indicators of Sustainable Development in Europe:
   www.sd-network.eu/?k=quarterly%20reports&report_id=7

(15) *http://www.aid-ee.org/documents/SummaryreportFinal.PDF – April 2007.*

CHAPTER 7
SEAP elaboration

The core part of the SEAP relates to the policies and measures that will allow to reach the objectives that have been previously set (see chapter 6).

SEAP elaboration is only one step in the overall process and it should not be considered as an objective in itself, but rather as a tool that allows to:
- outline how the city will look like in the future, in terms of energy, climate policy and mobility (the vision);
- communicate and share the plan with the stakeholders;
- translate this vision into practical actions assigning deadlines and a budget for each of them;
- serve as a reference during the implementation and monitoring process.

It is desirable to create a broad political consensus for the SEAP in order to ensure its long-term support and stability, regardless of changes in the political leadership. Discussions will be needed at the highest level to agree on the way in which stakeholders and political groups will be involved in the SEAP elaboration.

Also remind that the work does not finish after drafting the SEAP and its formal approval. On the contrary, this moment should be the start of the concrete work of putting the planned actions into reality. A clear and well-structured SEAP is essential for this (i.e. all actions should carefully be designed and described properly, with timing, budget, sources of financing and responsibilities, etc.).

Some chapters of this guidebook (chapter 8 dealing with policies, as well as Part III of the guidebook) will provide you with useful information in order to select and devise adequate policies and measures for your SEAP. Adequate policies and measures are dependent on the specific context of each local authority. Therefore, defining measures that are suited to each context is also highly dependent on the quality of the assessment of the current framework (see chapter 5).

Here is a list of recommended steps for drafting a successful SEAP:

Make a prospective of best practices

In addition to the resources on policies and measures provided in this guidebook (see chapter 8), it may be useful to identify what best practices (successful examples) have delivered effective results in similar contexts in reaching similar targets and objectives than those set by the municipality, in order to define the most appropriate actions and measures. In this sense, joining a network of local authorities can be very helpful.

Set priorities and select key actions and measures

Different kinds of actions and measures may contribute to the achievement of the objectives. Undertaking the entire list of possible actions will often surpass the current capabilities of the local authority, in terms of costs, project management capacities, etc. In addition, some of them may be mutually exclusive. This is why an adequate selection of actions in a given time horizon is necessary. At this stage a preliminary analysis of the possible actions is necessary: what are the costs and benefits of each of them (even in qualitative terms).

To facilitate the selection of measures, the local authority may rank the possible measures by importance in a table summarising the main characteristics of each action: duration, level of required resources, expected results, associated risks, etc. The actions may be broken down in short-term actions (3-5 years) and long-term actions (towards 2020).

Specific methods for the selection of priorities are available [16]. In simple terms, you should:
- define which criteria you want to consider for the selection of measures (investment required, energy savings, employment benefits, improved air quality, relevance to the overall objectives of the local authority, political and social acceptability…);
- decide which weight you give to each criterion;
- evaluate each criterion, measure by measure, in order to obtain a 'score' for each measure;
- If necessary, repeat the exercise in the context of various scenarios in order to identify the measures whose success is not scenario-dependent (see chapter 5).

Such an evaluation is a technical exercise, but it has definitely a political dimension, especially when selecting the criteria and their respective weighting. Therefore, it should be carried out in a careful manner, and be based on relevant expert and stakeholders' opinion. It may be useful to refer to various scenarios (see chapter 5).

Carry out a risk analysis [17]

The selection of actions and measures should also be based on the careful estimation of risks associated with their implementation (especially when significant investments are planned): how likely is it that an action fails or does not bring the expected results? What will be the impact on the objectives? And what are the possible remedies?

(16) *See for example* ***http://www.energymodel.eu/IMG/pdf/IL_6_-_Priorities.pdf***

(17) *Further information on risks and project management can be found in scientific literature. This information on risk management is based on the paper 'Role of public-private partnerships to manage risks in the public sector project in Hong Kong' INTERNATIONAL JOURNAL OF PROJECT MANAGEMENT 24 (2006) 587-594.*

Risks can be of different nature:

- Project-related risks: cost and time overruns, poor contract management, contractual disputes, delays in tendering and selection procedures, poor communication between project parties…
- Government-related risks: inadequate approved project budgets, delays in obtaining permissions, changes in Government regulations and laws, lack of project controls, administrative interference…
- Technical risks: inadequate design or technical specifications, technical failures, poorer than expected performance, higher than expected operation costs…
- Contractor-related risks: inadequate estimates, financial difficulties, delays, lack of experience, poor management, difficult in controlling nominated subcontractors, poor communication with other project parties, etc.
- Market-related risks: increase in wages, shortages of technical personnel, materials inflation, shortage of materials or equipment, and variations in the price of the various energy carriers…

Risks may be assessed using conventional quality management techniques. Finally, remaining risks have to be evaluated and either accepted or rejected.

Specify timing, clear responsibilities, budget and financing sources of each action

Once the actions have been selected, it is necessary to plan them carefully so that they can become a reality. For each action, specify:

- The timing (begin date – end date).
- The person/department responsible for implementation.
- The modality of financing. As municipality resources are scarce, there will always be competition for available human and financial resources. Therefore, efforts should be continuously made to find alternative sources of human and financial resources (see chapter 9).
- The modality of monitoring: identify the kind of data that need to be collected in order to monitor the progress and results of each action. Specify how and by whom the data will be collected, and who will compile it. See chapter 11 for a list of possible indicators.

To facilitate implementation, complex actions could be broken down into simple steps, each of them having its own timing, budget, person responsible, etc.

Draft the Action Plan

At this stage, all the information should be available to complete the SEAP. A suggested table of content is presented in chapter 1.

Approve the Action Plan and its associated budget

Formal approval of the SEAP by the municipal council is a mandatory requirement of the Covenant. In addition, the local authority should allocate the necessary resources in the annual budget and whenever possible make commitments for the forward (3-5 year) planning budget.

Perform regular SEAP reviews

Continuous monitoring is needed to follow SEAP implementation and progresses towards the defined targets in terms of energy/CO_2 savings, and eventually to make corrections. Regular monitoring followed by adequate adaptations of the plan allows initiating a continuous improvement cycle. This is the 'loop' principle of the project management cycle: Plan, Do, Check, Act. It is extremely important that progress is reported to the political leadership. SEAP revision could for example occur every second year, after the implementation report has been submitted (mandatory as per the Covenant of Mayors' commitments).

Additional resources

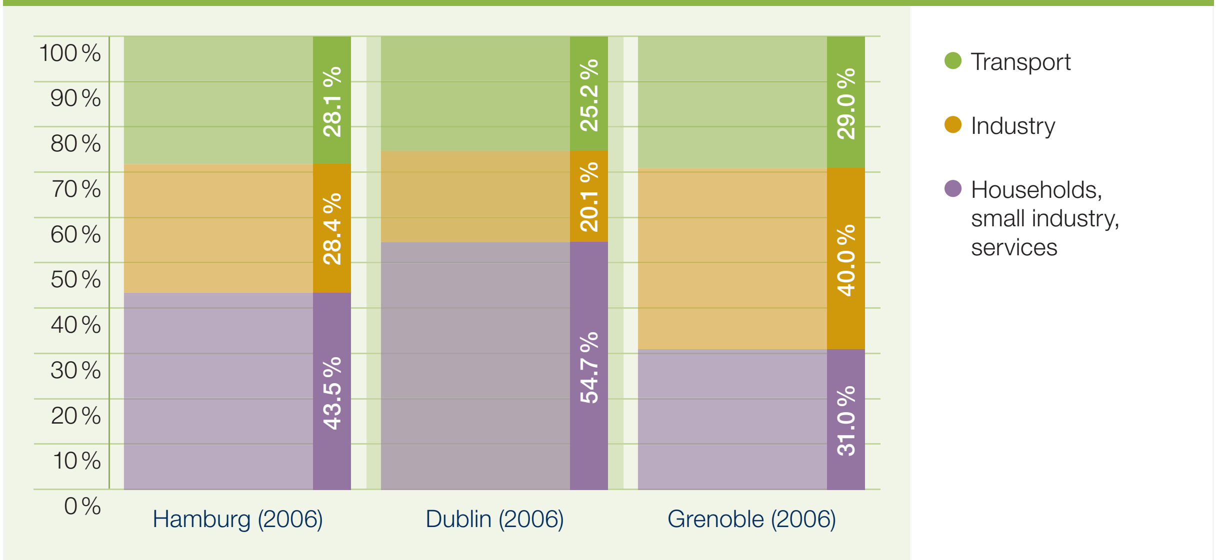
1. The JRC published a review of existing methodologies and tools for the development and implementation of SEAPs: **http://re.jrc.ec.europa.eu/energyefficiency/pdf/CoM/Methodologies_and_tools_for_the_development_of_SEAP.pdf**
2. Climate Alliance developed a 'Compendium of Measures' helping to develop a climate change strategy at local level. Local authorities have the possibility to choose a set of measures in those fields where they are more interested and decide the level of ambition (that will help to define the indicators of achievement) for each field. **http://www.climate-compass.net/fileadmin/cc/dokumente/Compendium/CC_compendium_of_measures_en.pdf**
3. There are also case studies based on the different areas of action relevant for the Action Plan: **http://www.climate-compass.net/_cases.html**

CHAPTER 8
Policies and measures applicable to your SEAP

The Covenant of Mayors concerns action at local level within the competence of the local authority. This chapter provides suggestions and examples of policies and measures that can be adopted by the local authority in order to reach the SEAP objectives. It concentrates on 'policy' actions that will generally deliver CO_2/energy saving over the longer term, e.g. via subsidies, regulations, information campaigns.

The establishment of the baseline review (chapter 5), and in particular the knowledge of the share of the various economic sectors in the total CO_2 emissions, will help the municipality to define priorities and select relevant measures in order to cut the CO_2 emissions. As this share of emissions per sector is specific for each city, three different examples are presented below.

CO_2 EMISSIONS PERCENTAGE PER SECTOR IN DUBLIN, GRENOBLE AND HAMBURG



Source: information extracted from values of the climate Action Plan of Hamburg, Dublin and Grenoble.

Policies and measures aiming at reducing the CO_2 emissions at the local level can be categorised in different ways, for example:

- the sectors addressed (residential, industry, transport, etc.);
- whether they are addressed to the local administration itself or not;
- the type of instrument used (financial support, regulation, communication and information, demonstration, etc.);
- the type of impact on the energy consumption and production patterns: energy efficiency of equipment, buildings, cars, etc., more rational behaviour (e.g. turning off lights, increased usage of public transport), cleaner energy (e.g. use of renewable energies, biofuels).

This chapter provides information on policies related to the key target sectors of the Covenant: buildings and transport, usage of renewable energies and CHP, and covers the key fields of action: land-use planning, public procurement, working with the citizens, and information and communication technologies (ICT).

Additional resources

1. A study carried out for the European Commission (DG TREN) and coordinated by the Fraunhofer-Institute provides information on energy-saving potentials in various sectors: **http://ec.europa.eu/energy/efficiency/studies/doc/2009_03_15_esd_efficiency_potentials_final_report.pdf**
2. The AID-EE project provides guidelines for the monitoring, evaluation and design of energy-efficiency policies: **http://www.aid-ee.org/documents/000Guidelinesforthemonitoringevaluationanddesign.PDF**
3. The AID-EE project also provides information on the overall impact assessment of current energy-efficiency policies and potential 'good practice' policies': **http://www.aid-ee.org/documents/WP5_AID-EE_Final_000.pdf**

8.1 Buildings sector

Buildings are responsible for 40 % of total EU energy consumption and are often the largest energy consumer and CO_2 emitter in urban areas. Therefore, it is crucial to devise efficient polices to reduce energy consumption and CO_2 emissions in this sector.

The policies and measures allowing to promote energy efficiency and renewable energies in buildings depend on the type of buildings, their usage, age, location, ownership (private/public…), and if the building is in a project-phase or is an existing one. For example, historic buildings may be protected by law so that the number of options to reduce energy consumption is quite restricted.

The main energy usages in buildings are: maintaining an adequate indoor climate (heating, cooling, ventilation and humidity control), lighting, production of sanitary hot water, cooking, electrical appliances, elevators.

Key factors that affect energy consumption in buildings are the following:

- performance of the building envelope (thermal insulation, building tightness, surface and orientation of the glazed surfaces…);
- behaviour (how we use the buildings and its equipment in our day-to-day life);
- efficiency of the technical installations;
- quality of the regulation and maintenance of the technical installations (are the technical installations managed and maintained in such a way as to maximise their efficiency and minimise their overall usage?);
- ability to benefit from heat gains in the winter and limit them in the summer (appropriate summer comfort strategy);
- ability to benefit from natural lighting;
- efficiency of electrical appliances and lighting.

Recourse to renewable energy sources will not result in a reduction of energy consumption, but will ensure that the energy used in the building has a lower impact on the environment.

In this section, we first provide policy suggestions applicable at the local level to the buildings sector as a whole. In part III of the guidelines, we provide specific considerations related to different situations: new buildings, existing buildings, public buildings, historical buildings… The technical measures that can be implemented to increase the efficiency of buildings are also described in part III of this guidebook.

The Energy Performance of Buildings Directive (2002/91/EC) is a key regulatory instrument which is meant to boost the energy performance of the building sector. We suggest the local authorities to get informed about the specific rules that apply in their country, and to take maximum advantage of this regulation to improve the performance of their building stock (for example local authorities could make use of the standards developed at national/regional level to impose more stringent energy performance requirements than those applicable at national/regional level – this will be developed below). See Annex III.

Here are some suggestions of policies that can be implemented at the local level in order to boost energy efficiency and renewables in buildings:

Regulations for new/renovated buildings

- Adopt stricter global energy performance standards than those applicable at national/regional level, especially if such standards are not particularly demanding. Depending on the national/regional regulatory context, local authorities may be able to adopt such standard in their urban planning rules and regulations. Global energy performance standards leave many options open to building designers to choose how they will reach the objectives. In principle, architects and building designers should be familiar with those norms, as they apply to the entire national/regional territory. Generally fewer options exist to reduce energy consumption with refurbishments than for new buildings; therefore the requirements are generally less stringent. Eventually they may be adjusted according to the building's characteristics.
- Adopt specific standards for building components (thermal transmittance of the envelope, of windows, efficiency of the heating system, etc.). This option has the advantage to be simple to understand, and guarantees the minimal performance of the components, even if the overall performance cannot be achieved.
- Impose the inclusion of some components that will help to improve the energy efficiency (shading devices, presence of meters that record the energy consumption, heat recovery devices for mechanical ventilation…). This can be done as a general rule that would apply to all new buildings, or could be imposed on a case-by-case basis, according to the building characteristics (e.g. impose shading devices to buildings having a significant glazing surface oriented to the south).
- Impose a certain quantity of renewable energy production/usage, in particular in public buildings.
- Adopt energy performance standards for renovation works which are not considered as 'major renovation' by national/regional law, and for which no energy performance standards apply.

Enforcement of regulations

- Ensure that the energy performance standards are respected in practice and apply penalties if necessary. It is recommended to adopt both 'on paper' and 'on site' verifications. The presence of a representative of the authority at some point during construction/ renovation works will clearly show that the authority is taking the regulations seriously and will help to improve the practices of the construction sector at the local level.

Financial incentives and loans

- The local authority could complement the financial support mechanisms existing at national or regional level, with extra financial incentives for energy efficiency or renewable energy sources. Such a scheme could focus on the global energy performance of buildings (e.g. the incentive could be proportional to the difference between a minimal threshold of energy performance, calculated according to the existing national/regional standards, and the level of performance actually achieved), or could be used to support specific techniques that the local authority would consider of particular relevance for new buildings, considering its own context and objectives (thermal insulation, RES, …). The latter option is particularly relevant for renovated buildings, for which the precise calculation of the overall energy performance is generally less easy than for new buildings. Ideally, the financial incentive would cover (part of) the difference between the cost of 'standard construction work' and a construction/renovation that is considered as energy efficient.
- In addition, the local authority could provide financial support for the purchase of energy efficient equipment that allow to reduce energy consumption of buildings (efficient lamp bulbs, efficient appliances, …).
- Although financial incentives do reduce the cost of investment related to energy-efficiency, investors (either citizens, private companies, etc) still have to face up-front payments. To facilitate the access to capital, the local authority may liaise with local banks and financial institutions, so that low-interest loans are available for energy efficiency or RES.

Notes:
Even if the budgets that the local authority can devote to such subsidies is not immense, they could still make a great difference in terms of citizens' motivation: with proper communication, such subsidies could be seen as a clear sign that the local authority is willing to achieve success in the field of energy and climate policy, and that it is willing to support its citizens in this direction.

Note that the European Regulations on State Aid fix a framework for the financial support Member States are allowed to provide to commercial activities.

Information and training

- Make the relevant stakeholders (architects, building developers, construction companies, citizens…) aware of the new energy performance requirements for buildings, and provide them some motivating arguments (the savings on the energy bills can be highlighted, as well as the benefits in terms of comfort, environmental protection, etc. …).
- Inform the general public and key stakeholders about the importance and benefits of behaviour favouring the reduction of energy consumption and CO_2 emissions.
- Involve local companies: they may have an economic interest in the energy efficiency and renewable energy business.
- Inform the stakeholders about the resources available: where can the information be found, what are priority measures, who can provide proper advice, how much does it cost, how can households do proper work by themselves, what are the tools available, who are the local competent architects and entrepreneurs, where can the necessary materials be purchased locally, what are the available subsidies, …? This could be done via info days, brochures, information portal, information centre, helpdesk etc. …
- Organise specific info and training sessions for the architects, workers and construction companies: they must become familiar with the new design and constructing practices and regulations. Specific training could be organised to cover basic issues (basic building thermal physics, how to install properly thick insulation layers) or more specific issues that are often neglected (thermal bridges, building air tightness, natural cooling techniques, etc.).
- Make sure the tenants, owners and managers of new and renovated buildings are informed about the building's features: what makes this building energy efficient and how to manage and operate the equipment and facilities offered in order to obtain a good comfort and minimise the energy consumption. All the technical information needs to be passed to technicians and maintenance companies.

Promote successes

- Encourage people to build efficient buildings by offering them recognition: buildings significantly above the legal standards of energy performance could be made visible by a label, open day visits, an exhibition in the town hall, an official ceremony, signposting on the local authority's website, etc. The energy performance certificate, which is a requirement of the Energy Performance of Buildings Directive (see above), could be used for that purpose (e.g. the local authority could organise a contest for the first 'Label A' buildings built in the municipality). Other standards can be used as well ('passive house' standard, etc.).

Demonstration buildings

Demonstrate that it is feasible to build energy-efficient buildings or to make renovation with high-energy performance standards. Show how it can be done. Some high-performance buildings could be open to the public and stakeholders for this purpose. It does not necessarily need to be a high technology building – the most efficient ones are sometimes the simplest ones: the problem with energy efficiency is that it is not always quite visible (think about thick insulation for example). However, listening to the owner and the occupants talking about their experience, their reduced energy bills, their improved comfort, etc should already be worthwhile. Visits during construction stage could be interesting for training and educational purposes for construction companies and architects.

Promote energy audits

Energy audits are an important component of energy-efficiency policy, as they enable identifying, for each audited building, the best measures allowing to reduce energy consumption. Therefore, the local authority could promote such audits via proper information, ensuring the availability of competent auditors (training…), financial support to audits… (see part III of the guidebook for more information on energy audits).

Urban planning

As explained in the dedicated section, urban planning is a key instrument to boost and plan refurbishments. In addition to setting energy performance standards, as mentioned above under 'regulation', urban regulations should be devised in such a way not to deter energy efficiency and RES projects. For instance, long and complex authorisation procedures to install solar panels on roofs of existing buildings will be a clear obstacle to RES promotion and should be avoided.

Increase the rate of refurbishment

By accelerating the rate of buildings undergoing energy efficient refurbishments, the impact of the above measures on the energy and CO_2 balance will increase. Some of the above measures, and in particular urban planning, financial incentives, loans or information campaigns about the benefits of energy efficient renovations are likely to have such an effect.

Energy taxes

Higher energy prices generally increase awareness and motivation towards energy savings. If the local authority has the legal power to do so, it may decide to levy taxes on energy. However, the social consequences of such a measure should be evaluated and debated thoroughly before such a decision is made. In addition, an adequate communication plan should be devised to ensure citizens understand and adhere to such a policy. The question related to the usage of tax revenues should also be dealt with in a very transparent manner (e.g. financing an energy-efficiency support fund, financial compensation economically for vulnerable citizen groups, etc.).

Coordinate policies with other levels of authority

A number of policies, instruments, tools in the field of energy efficiency of buildings and RES exist at regional, national and European level. We recommend that the local authority has a good view of these, in order to avoid duplication, and to take the maximum advantage of what already exists.

Some recommendations for public buildings

Management of public buildings: a local authority has often control over a large number of buildings. Therefore a systematic approach is recommended in order to ensure a coherent and efficient energy policy covering the entire building stock over which the local authority exercises control. Such an approach could be:

- Identify all buildings and facilities owned/managed/controlled by the local authority.
- Collect energy data related to those buildings and set up a data management system (see section 4.1.2 a of part II of these guidelines).
- Classify the buildings according to their energy consumption, both in absolute values and per square metre or other relevant parameters like: number of pupils for a school, number of workers, number of users for libraries and swimming pools, etc.
- Identify buildings which consume the most energy and select them for priority action.
- Prepare an Action Plan (part of the SEAP) in order to progressively reduce the energy consumption of the building stock.
- Nominate someone in charge of the implementation of the plan!
- Verify that the commitments and obligations of the contractors, in terms of energy efficiency, are met in practice and apply penalties if it is not the case. On-site verifications during construction are advisable (e.g. thick insulation which is not placed adequately will not be very efficient).
- Recycle the savings: if the local authority's financial rules allow to do so, savings obtained through simple and low-cost measures could be used to finance larger energy-efficiency investments (e.g. revolving funds, for further details see chapter 9).

POLICY INSTRUMENTS AT DISPOSAL OF THE LOCAL AUTHORITY	PRIVATE BUILDINGS			PUBLIC BUILDINGS		
	New	Renovated	Existing	New	Renovated	Existing
Energy performance regulations	X	X	–	+	+	–
Financial incentives and loans	X	X	+	+	+	–
Information and training	X	X	X	X	X	X
Promote successes	X	X	+	X	X	+
Demonstration buildings	X	X	–	X	X	–
Promote energy audits	–	X	X	–	X	X
Urban planning and regulations	X	+	–	X	+	–
Increase the rate of refurbishment	–	X	–	–	X	–
Energy taxes	+	+	+	+	+	+
Coordinate policies with other levels of authority	X	X	X	X	X	X

X = most relevant + = somehow relevant – = low relevance

Table: Relevance of the policies exposed in this guidebook related to different buildings situations.

8.2 Transport (18)

The transport sector represents approximately 30 % of the final energy consumption in the European Union. Cars, trucks and light vehicles are responsible for 80 % of the final energy consumed in the transport sector. The European Commission and the European Parliament have recently adopted the Communication COM (2009) 490 (19) 'Action Plan on Urban Mobility'. The Action Plan proposes twenty measures to encourage and help local, regional and national authorities in achieving their goals for sustainable urban mobility.

Before the local authority proposes specific policies and measures concerning transport, an in-depth analysis of the local current situation is highly recommended. The actual means of transport and the possible connections or synergies with different means of transport must be well-matched with the geographic and demographic features of the city and the possibilities to combine different types of transport.

Effective, Sustainable Urban Transport Planning (SUTP) (20) requires long-term vision to plan financial requirements for infrastructure and vehicles, to design incentive schemes to promote high quality public transport, safe cycling and walking and to coordinate with land-use planning at the appropriate administrative levels. Transport planning should take into account safety and security, access to goods and services, air pollution, noise, greenhouse gas emissions and energy consumption, land use, cover passenger and freight transportation and all modes of transport. Solutions need to be tailor-made, based on wide consultation of the public and other stakeholders, and targets must reflect the local situation. This chapter aims to offer different possibilities to municipalities to build their own SUTP.

1. Reducing the need for transport (21)

Local authorities have the possibility to reduce the needs for transport. Here are some examples of policies to be implemented locally.

(18) *Further information on transport sector in Transport Research Knowledge Centre (TRKC)* **www.transport-research.info**
Project funded by the European Commission's Directorate General for Energy and Transport under the Sixth Framework Programme for Research and Technological Development (FP6).
This chapter is based on the document 'Expert Working Group on Sustainable Urban Transport Plans' *provided by the International Association of Public Transport UITP.* **www.uitp.orgv**

(19) *Available on* **http://ec.europa.eu/transport/urban/urban_mobility/action_plan_en.htm**. *All European Union regulations may be found on* **http://eur-lex.europa.eu/**

(20) *Further information about SUTPs on* **http://ec.europa.eu/environment/urban/urban_transport.htm**. *In addition, the webpage* **http://ec.europa.eu/environment/urban/pdf/transport/2007_sutp_annex.pdf** *provides an important amount of information concerning local transport policies and good practices in several European cities.*

(21) *This paragraph has been developed using information from the Moving Sustainably Project that contains an interesting methodology aimed at implementing Sustainable Urban Transport plans. Further information is available at* **www.movingsustainably.net** *in which it is possible to find a methodology to develop SUTPs.*

- Providing door-to-door access choices across the urban agglomeration. This objective may be reached through an appropriate combination of less flexible ways of transport for long and medium distances and other more flexible ways, such as bike hiring for short distances.
- Making efficient use of space, promoting a 'compact city' and targeting the urban development to public transport, walking and cycling.
- Strengthening the use of information and communication technologies (ICT). The local authorities have the opportunity to use ITC technologies to implement online administrative procedures and avoid citizens travelling to fulfil their duties with public administrations.
- Protecting existing short-routes in the network in order to diminish the energy consumption of those less efficient or more necessary means of transport (i.e. massive public transport)

2. Increasing the attractiveness of 'alternative' transport modes

Increasing the modal share for walking, cycling and public transport can be achieved through a wide variety of plans, policies and programmes.

As a general principle linked to transport policies, managing the overall offer and demand of transport is essential to optimise the use of infrastructure and transport systems. This allows making compatible the different ways of transport such as bus, train, tramway and underground to take advantage of each one and avoid unnecessary overlapping.

Public transport

Increasing the modal share for public transport requires a dense network of routes that meets the mobility needs of people. Before implementing any transport policy, the local authority should determine the reasons/factors of why citizens/businesses are NOT using public transport. Therefore, it is essential to identify barriers for public transport use. Some examples (22) of such barriers for buses are:

- inconvenient stops and inadequate shelters;
- difficulty in boarding buses;
- infrequent, indirect and unreliable services;
- lack of information on services and fares;
- high cost of fares;
- long journey times;
- lack of practicability of connections between different modes of transport;
- fear of crime, particularly at night.

To increase the share of public transport among the citizens, the local authority could implement the following measures:

- Develop a set of indicators measuring the access to public transport of citizens. Perform a comprehensive analysis of the current situation and adopt corrective actions to improve these indicators. The network should be attractive and accessible for all communities of interest and ensure that stops are sited within walking distance from key residential, commercial and tourist centres.
- A marketing strategy and service information availability should be integrated across public transport modes within 'travel to work' urban areas. The use of marketing enables a permanent improvement in all customer relations activities like sales, advertising, branding, network design, product (Public Transport) specifications, complaint management and customer service.
- Promote collective transport programmes for schools and businesses. This requires a forum with companies, unions and consumer associations in order to identify their needs, share the costs of the service and maximize the number of citizens with access to the public transport.
- Provide an integrated public transport information service through a call centre, Information Centres, 24 hour information points and Internet.
- Services need to be reliable, frequent, cost and time-competitive, safe to use and perceived by the public as such. Therefore an important communication effort is necessary to inform users about the advantages of using public transport with respect to other means of transport.
- Information about services needs to be 'real-time', widely available and include predicted arrival times (for arriving passengers, it is also possible to give information about connections). For example, displays may give passengers a countdown in minutes until the arrival of the next bus, as well as showing the stop name and current time.
- 'Public transport only' and priority routes will be essential policies. This will reduce travel time which is one of the most considered factors by users when choosing among the different means of transport. Spatial planning should deliver the required loading factors to allow public transport to compete with car transport.
- Work in partnership with the district councils and others to ensure a high standard of provision and maintenance of the public transport infrastructure, including bus shelters and improved facilities at bus and rail stations.
- Create a suggestion box to consider the ideas of users and non-users in order to improve your service. Consider the possibility to create 'transport charter' according to the specific needs of a group of users.
- Create a Free Tourist Shuttle System with a fixed route and stops at a variety of popular tourist destinations. This would eliminate vehicle trips and parking spaces at popular destinations and provide an easy transportation alternative for tourists who are uncomfortable with a complex transit schedule.

It is important to keep in mind that choices are occasionally based on comparisons among public transport and car. For instance, some actions aimed at increasing the share of public transport are not only linked to the measures undertaken in this sector, but also in other areas such as reducing the use of cars (for example pricing public parking policy). The monitoring results of public transport may be an effective indicator to know the effectiveness of some policies mentioned in this chapter.

(22) *These reasons exposed as an example stem from the document 'Lancashire Local Transport Plan 2008-2010' that can be downloaded from* ***www.lancashire.gov.uk/environment/***

Cycling (23)

Increasing the modal share for cycling also requires a dense network of well-maintained routes that are both safe to use and perceived by the public as such. Spatial and transport planning should treat cycling as an equal mode of transport, along with cars and public transport. This means reserving the space that is necessary for the 'cycling infrastructure', direct connections and ensuring continuity with attractive and secure cycle parking facilities at transport hubs (train and bus station) and workplaces. Infrastructure design should ensure that there is a hierarchy of routes that are safe, attractive, well-lit, signposted, maintained all year round and integrated with green space, roads and the buildings of urban areas.

The international transport forum (24) (OECD) has identified seven key policy areas (25) in which authorities can act to promote cycling:

- Image of cycling: it is not only a leisure/sport activity but also a means of transport.
- Infrastructure: an integrated network of cycling paths connecting origins and destinations, and separate from motorised traffic, is essential to promote cycling.
- Route guidance and Information: information such as number or colour of the cycling ways and distances in order to make them easy to follow for cyclists.
- Safety: approve standards for safe driving and avoid the mixture of bicycles and other heavy means of transport.
- Links with public transport: develop parking facilities at railway stations or tramway/bus stops. Rent bicycles at public transport and railway stations.
- Financial arrangements for cycling infrastructure should be considered.
- Bicycle theft: prevent theft imposing electronic identification bicycles and/or the realisation of a national police registration for stolen bicycles (26).

It is also recommended to increase Workplace Shower Facilities for cyclists. Facilitate bicycle commuting by requiring new developments to provide shower and changing facilities, and/or offer grant programmes for existing buildings to add shower facilities for cyclists.

The City of San Sebastian (Spain) has started a large programme for developing the cycling culture in the city, together with the creation of a new cycling network. The European Mobility Week represents the perfect opportunity to promote the benefits of bicycles, to organise bicycle training and free maintenance, as well as to create new cycle lanes. This comprehensive programme to raise awareness on sustainable urban mobility and soft modes also includes road safety educational activities targeted to children. These actions lead to a clear modal shift in favour of bicycles. In 2007 the city enjoyed a 4 % modal share for bicycles, which is a tremendous increase compared to previous years (27).

Walking

As previously stated for '*Cycling*', increasing the modal share for walking requires a dense network of well-maintained routes that are both safe to use and perceived by the public as safe to use. Spatial planning should reserve the space that is necessary for the 'walking infrastructure' and ensure that local services are sited within walking distance from residential areas.

Many urban areas have produced design manuals that provide the detailed specifications for the practical tools and techniques that deliver high-quality, walking friendly urban environments. Examples of such environments are 'Pedestrian only zones' and 'low speed zones' with lower vehicle speed limits that allow pedestrians and cars safely share the same space. In these areas pedestrians always have priority over cars.

3. Making travel by car less attractive (28)

Walking, cycling and public transport can become more attractive alternatives if car travel becomes more difficult or expensive. Disincentives include:

Pricing (29)

By making car drivers pay a fee for driving in the city (centre), drivers can be charged some of the social costs of urban driving, thus also making the car a less attractive option. Experience from local authorities that implemented congestion charges, shows that they can reduce car traffic considerably and boost the use of other transport modes. Pricing can be an effective instrument to reduce congestion and increase accessibility for public transport.

(23) *More information about cycling policies, increasing bicycle use and safety, by implementing audits in European cities and regions, can be found in the ByPad project webpage* ***www.bypad.org*** *and* ***www.astute-eu.org****. Information on mobility management can be found on* ***www.add-home.eu****. All these projects are supported by Intelligent Energy Europe. 'National Policies to Promote Cycling' OECD –* ***http://www.internationaltransportforum.org/europe/ecmt/pubpdf/04Cycling.pdf***

(24) ***www.internationaltransportforum.org***

(25) ***http://www.internationaltransportforum.org/europe/ecmt/pubpdf/04Cycling.pdf*** *contains 'National Policies to Promote Cycling' OECD – This document is addressed to national authorities, but most of the policies proposed in this document may be used or adapted by local authorities.*

(26) *Policies implemented by the Dutch Ministry of Transport, Public Works and Water Management. 'National Policies to Promote Cycling' document – OECD.*

(27) *Example from the European Mobility Week Best Practice Guide 2007* ***http://www.mobilityweek.eu/IMG/pdf_best_practice_en.pdf***

(28) *Measures aimed at making travel by car less interesting should be developed at the same as those aimed at offering better alternatives to users. In order to avoid negative consequences, these types of measures should be debated and planned thoroughly.*

(29) *Further information on urban road user charging may found on the CURACAO – Coordination of Urban Road User Charging Organisational Issues – project webpage. This project has been funded by the European Commission through the FP6 programme.* ***www.curacaoproject.eu***

Parking management

Parking management is a powerful tool for local authorities to manage car use. They have several tools to manage parking, e.g., pricing, time restrictions and controlling the number of available parking spaces. Parking time restriction for non-residents, e.g., to two hours, is a proven tool to reduce commuting by car without affecting accessibility to urban shops.

The number of parking spaces is sometimes regulated by the local building act, demanding a certain number of parking spaces for new developments. Some local authorities have building regulations, where location and accessibility by public transport, influence the number of parking spaces allowed. Adequate pricing of urban parking lots is another important tool with similar potential to influence urban driving as congestion charging.

GRAZ (AT): LOWER PARKING TARIFF FOR LOW EMISSION VEHICLES

Low emission vehicles can get a 30 percent reduction of parking fees in Graz. This new differentiated parking system is expected to encourage more citizens to use low emission vehicles. Drivers of non low emission vehicles have to pay € 1.20 per hour, whereas low emission vehicles pay € 0.80 per hour. Hence, the scheme gives real benefits to low emission vehicles and provides a popular selling point of the new system.

In order to get the reduction, the car has to comply with EURO 4 emissions standards (all new cars sold after 1st January 2005 must comply with EURO 4 emissions standard) and be low CO_2 emission. Petrol cars have indeed to emit less than 140 gCO_2/km, whereas diesel cars have to emit less than 130 gCO_2/km and be fitted with a particles trap.

To get the special fee, the drivers will have to register their vehicle at the city council. Then they will get a special parking coin ('Umweltjeton') and a special sticker. The sticker is an official document that is filled out by the city and includes the car number, type of car, colour of the car and the official seal of the city of Graz. The Umweltjeton and the special sticker are free, so no extra registration fee is applicable. The sticker is valid for two years; the user can apply for a time prolongation of the sticker. The Umweltjeton is to be inserted into parking machines to trigger the fee reduction. Once inserted, the parking ticket is marked in the upper corner with a U meaning 'Umweltticket' (environmental friendly ticket). The sticker has to be located on the dashboard behind the windscreen to be clearly visible for the enforcement team.

Source: CIVITAS initiative ***www.civitas-initiative.org***

This type of actions shall be done with the support of technical and social studies aimed at ensuring equal opportunities among the citizens.

4. Information and marketing

Local marketing campaigns that provide personally tailored information about public transport, walking and cycling alternatives have been successful in reducing car use and increasing levels of public transport use. These campaigns should also use arguments of health and environmental benefits provided by walking and cycling.

Information about how to start a campaign and where sources of information can be found are available in the report 'Existing methodologies and tools for the development and implementation of SEAP' on methodologies collection (WP1). The full version of this document can be downloaded from the Institute for Energy (30) webpage. As an example of a successful awareness campaign, the European Commission DG ENER organises every year the European Sustainable Energy Week — **www.eusew.eu**

5. Reduce municipal and private vehicle fleet emissions

Municipal and private vehicles emission reductions may occur by using hybrid or other highly efficient technologies, the introduction of alternative fuels and promoting efficient driving behaviour.

Among the main uses of green propulsion in public fleets are the following:

- Use hybrid or totally electric vehicles in public fleets. These types of vehicles use a fuel motor (hybrid vehicles) and an electric engine whose aim is the generation of power for the motion. The electricity to be supplied to the vehicles is stored in batteries that can be recharged either by plugging the car to the electrical grid or producing the electricity on board, taking advantage of braking and the inertia of the vehicle when power is not demanded. Make use of fully electric vehicles in public transport and recharge them with renewable electricity.

According to the European Commission Directive 93/116/EC relating to the fuel consumption of motor vehicles, CO_2 emissions for two equivalent vehicles (combustion and hybrid) can be reduced by 50 % (for instance from 200g/Km to 100g/Km) (31).

(30) *http://re.jrc.ec.europa.eu/energyefficiency/*

(31) *Further information on car emissions can be found in* ***http://www.vcacarfueldata.org.uk/index.asp*** *and* ***http://www.idae.es/coches/***

- Use biofuels in public fleets and make sure that vehicles acquired through public tenders accept the use of biofuels. The most common biofuels that can be supplied by the market are biodiesel, bioethanol and biogas. Biodiesel and bioethanol can be used in mixes in diesel and gasoline engines respectively, whereas biogas can be used in natural gas vehicles (NGV).

> The use of biofuels in vehicles, according to the 2009/28/EC Directive, will reduce GHG emissions in the range 30 %-80 % in comparison with fossil fuels over the entire life cycle. These values collected from the Directive's Annex V correspond to the case in which biofuels are produced with no net carbon emissions from land-use change.

- Like battery electric cars, if produced from renewable sources, hydrogen fuel cell vehicles generate virtually zero CO_2 emissions over the entire fuel pathway from production to use. Again, like charging electric cars, hydrogen will require installation of new distribution and refuelling infrastructure. Public fleets are ideal applications as fleet vehicles typically return to a central base for garaging, fuelling and maintenance. Hydrogen buses and delivery vans are of especial interest to cities, due to their zero emissions (ultra low if combustion engines), low noise, extended operating range and comparable refuelling times to diesel buses. Demonstrations have proved high levels of reliability and public acceptance. Development effort continues with a view to further improving performance, durability and reducing lifetime costs.
- Promote low fuel consumption, hybrid and electric vehicles through a low taxation regime. This can be done dividing vehicles in different categories according to the priorities of the local authority.

> In its Vehicles´ Fiscal Ordinance, Madrid's City council applies reductions of 50 %, 30 %, 20 % and 15 % the first 4 years to small cars and a 6 years' 75 % tax discount to hybrid vehicles. When the vehicle is fully electric, this 75 % discount is extended to its whole life.

These more energy-efficient vehicles can also be promoted by local authorities through the application of local incentives:

- Free parking.
- Test fleet (companies can borrow an alternative fuelled vehicle for a week to try out the new technology, the efficiency, the refuelling, etc.).
- Special lanes for alternative vehicles.
- Access to city zones with restrictions for high GHG emitting cars, i.e. cultural city centres, environmental zones.
- No congestion charges to clean vehicles.
- Some examples of national incentives are tax reductions on fuel, on vehicles and regulations that favour the use of alternative vehicles in companies.
- 'Environmental Loading Points' adjacent to pedestrian areas only open for alternative vehicles.
- Efficient driving behaviour may reduce cars´ GHG emissions up to 15 %. The European project ECODRIVEN – **www.ecodrive.org** – provides good practices to drivers. In the framework of the 2006/32/EC Directive, some European countries through their National Energy Action Plans have signed agreements with driving schools in order to spread the knowledge of efficient driving practices to citizens. Some of these training courses are not only addressed to car drivers, but also to truck drivers.

6. Smart transport

Urban traffic control systems are a specialized form of traffic management which integrate and coordinate traffic signal control. The primary purpose of urban traffic control is to optimise overall traffic performance in accordance with the traffic management policies of the local authority. It uses the signal settings to optimise parameters such as travel time or stops.

Urban traffic control systems are either fixed time, using programs such as TRANSYT, or real time, such as SCOOT (32). Widespread experiments have demonstrated the benefits of such systems, i.e. efficiency gains improve the environment, queues and safety, with typical reductions in accidents of the order of 10 %. However, it is important to bear in mind that the potential for these benefits may be eroded by induced traffic.

In addition, the control systems may be used for the regulation of priorities of different 'interest groups' such as pedestrians, cyclists, disabled persons or buses. For instance, these control systems can distinguish whether a bus is on time or late and to what degree. Depending on this analysis, the priorities of traffic regulation will be readjusted in order to minimise delays and make public transport by bus more effective.

Another possibility offered by control systems in big cities is 'Ramp Metering' which consists in a traffic management tool that regulates the flow of vehicles joining the motorway during busy periods. The aim is to prevent or delay the onset of flow breakdown. Benefits include ease of congestion and improvement in traffic flows, higher throughput during peak periods, smoother, more reliable journey times and improved energy consumption.

(32) *TRL – Transport Research Foundation based in UK* ***www.trl.co.uk***

Additional resources

1. European Commission Transport Webpage – Clean Urban Transport
   This webpage covers a big range of information on policies, programmes and tools about Urban Mobility and Clean and Energy Efficient Vehicles.
   http://ec.europa.eu/information_society/activities/ict_psp/cf/expert/login/index.cfm
2. Eltis, Europe's web portal on transport
   ELTIS supports the transfer of knowledge and exchange of experience in urban and regional transport. The database currently contains more than 1500 good practice case studies, including cases from other initiatives and databases like EPOMM, CIVITAS, SUGRE, LINK, ADD HOME, VIANOVA, etc.
   http://www.eltis.org
3. The CIVITAS Initiative
   The CIVITAS Initiative, launched in 2002, helps local authorities to achieve a more sustainable, clean and energy-efficient urban transport system by implementing and evaluating an ambitious, integrated set of technology and policy-based measures. On the website, examples of successful implementation of sustainable transport initiatives can be found.
   http://www.civitas-initiative.org
   The GUIDEMAPS handbook is designed to support transport decision-makers and designers in European cities and regions. A particular emphasis of the handbook is on using stakeholder engagement tools and techniques to overcome communication barriers in the transport decision-making process. It provides examples and Indications of the relative costs of different tools and techniques related to project management and stakeholders' engagement.
   http://www.civitas-initiative.org/docs1/GUIDEMAPSHandbook_web.pdf
4. BESTUFS project
   This project aims to maintain and expand an open European network between urban freight transport experts, user groups/associations, ongoing projects, the relevant European Commission Directorates and representatives of national, regional and local transport administrations and transport operators in order to identify, describe and disseminate best practices, success criteria and bottlenecks with respect to City Logistics Solutions.
   http://www.bestufs.net/
5. COMPRO project
   This project aims at contributing to the development of a common European market of clean vehicles, taking action on the demand side in order to homogenise the products' technical requirements and creating a buyer consortium of local authorities to pool together and reach the critical mass needed to ensure a swift market development.
   http://www.compro-eu.org
6. LUTR-PLUME
   The LUTR website hosts the PLUME project (Planning and Urban Mobility in Europe), aiming at developing strategic approaches and methodologies in urban planning that all contribute to the promotion of sustainable urban development. The website contains state-of-the-art reports and synthesis report related to many transport and mobility issues.
   http://www.lutr.net/index.asp
7. HITRANS
   HiTrans is a European project, with the aim of facilitating the development of high quality public transport in medium sized European cities (pop 100 000-500 000). The project has produced best practice guides and guidelines for use by local authorities.
   http://www.hitrans.org

8.3 Renewable energy sources (RES) and distributed energy generation (DG)

This chapter is aimed at providing examples of municipal policies and strategies to promote local electricity production (renewable or not), the use of renewable energy resources to produce thermal energy and the promotion of district heating and cooling (33) (DHC).

Renewable Energy technologies offer the possibility to produce energy with a very low impact on the environment. DHC and cogeneration (or CHP – Combined Heat and Power) offer an energy-efficient way of producing heat and electric power for urban areas. To be cost-effective and maximise impact, policies should focus on measures targeting areas with high heating and cooling loads. In addition, DHC provides a proven solution to make an efficient use of the many kinds of RES (biomass, geothermal, solar thermal) on a large scale and recycle surplus heat (from electricity production, fuel and biofuel-refining, waste incineration and from various industrial processes).

Distributed electricity generation allows to reduce electricity transport and distribution losses and to use microcogeneration and low-scale renewable energy technologies. Distributed energy generation associated with unpredictable (cogeneration, solar photovoltaic, wind, biomass…) renewable energy sources is becoming an important issue in the European Union. The electricity grid must be able to distribute this energy to the final consumers when the resources are available, and rapidly adapt the demand, or cover the energy required using more adaptable (for example hydro or biomass) technologies when the former are not available.

Although there are a wide range of policies to promote RES and DG, some of them are under national or regional competences. For this reason, all the policies proposed in this chapter should be complemented by a close cooperation with the different public administrations playing a role in this sector.

(33) *IEA, 2004, 'Coming in from the Cold. Improving District Heating Policy in Transition Economies,'* ***http://www.iea.org/textbase/nppdf/free/2004/cold.pdf*** *and IEA, 2009, 'Cogeneration and District Energy – Sustainable energy technologies for today… and tomorrow',* ***http://www.iea.org/files/CHPbrochure09.pdf***

Local Energy Generation Policies

1. **Give a good example and support the development of local energy generation**

- Perform an analysis of the legal, physical (resources), social and economical barriers hindering local energy generation, and provide corrective actions (subsidies, regulation, campaigns…).

> **Some examples:**
> Evaluation of geothermal energy potential considering legal and technical barriers of ground perforation and the environmental effect on the underground water layer.
>
> With regard to the use of biomass, make a technical and economical evaluation of the potential of the biomass harvested in public spaces, companies and citizens´ properties.
>
> Bring waste incineration closer (as close as permitted by the local regulation) to cities rather than establishing them on the green field, in order to make possible covering heat demands by recovering the heat from the incineration plant in a District Heating and Cooling plant.

- Identify public and private high thermal energy consuming buildings/facilities and design a high replication strategy to replace old heating plants by cogeneration or renewable energy installations (or a combined installation). Consider in the strategy not only technical aspects but also propose innovative financing schemes. Typical highly energy consuming public facilities are: Swimming pools, sports facilities, office buildings, hospitals or retirement homes. For instance, the following actions (high replication potential) are proposed:

> Substitution of a swimming pool's old heating plant by an installation of a combined solar thermal and biomass boilers, financed through an ESCO scheme.
>
> Substitution of the old heating and cooling plants by trigeneration installations to provide the base demand of heat and cold throughout the year in municipal buildings.

These actions have a high replication potential in some private sectors such as food industry, or hotels among others. For this reason a strong communication policy is essential to share the results with the private sector.

- Introduce renewable energy installations' requirements (such as space for biomass supply and storage facilities of raw material to the biomass boiler or free space on flat roofs to facilitate the use of solar systems) in the design of new public buildings. When it is possible, implement DHC grids in public buildings areas.
- Show publicly the successes of renewable energy measures implemented in public buildings.

> Install visual consoles indicating the amount of CO_2 emissions avoided is a simple and graphic way to show the immediate effects of the action.

- Integrate the utilities companies in the new projects of distributed energy generation in order to take advantages of their experience, facilitate the access to the grid and to a large amount of individual consumers.
- Promote pilot projects to test and show technologies and attract the interest of stakeholders.

> Test non-spread technologies such as low-power absorption chillers or microcogeneration. Show the pilots installations and results (positive and negative) to the stakeholders.

- Implement or make compulsory district heating/ cooling, integrated renewable energy sources (solar thermal, solar PV and biomass) or microcogeneration in social housing. This entails adapting the design of social buildings to the requirement of these technologies.

2. **Provide information and support to the stakeholders**

- Organise informative meetings with stakeholders to demonstrate the economic, social and environmental advantages of energy efficiency and renewable energy sources. Provide financial resources to consumer associations and NGOs to disseminate these benefits to final consumers. Consider promoting distributed energy generation as a marketing project in which it is essential that final consumers trust this product.
- Reach agreements with other public entities or associations, providing training courses focused on technical, environmental and financial issues to installers, consulting and engineering companies. As an example, training materials (34) may be found on European projects´ web-pages funded under Intelligent Energy Europe.
- Create an info-portal on the renewable energies and energy-efficiency sectors in your city, with practical and timely information for citizens (where to buy biomass, where are the best areas to install wind energy or solar thermal/photovoltaic collectors, list of installers and equipment…). Such database may include information on best practices in your city.

(34) *Training material may be downloaded from: ACCESS project* ***www.access-ret.net***

- Offer free advice and support to stakeholders. More than 350 local and regional Energy Agencies all over Europe are already offering many relevant services. Therefore, take advantage of their knowledge and get in touch with the closest one.
- Motivate citizens to put aside organic waste, providing specific rubbish bin. Use it to produce biogas in the waste treatment plants. Do the same in the water treatment plants. Make use of the biogas produced in a cogeneration plant or in a biogas/natural gas public vehicles fleet (35).

3. **Set up regulations and actions that promote local energy generation projects**

- Modify urban planning regulation to consider the necessary infrastructures required to conduct heat pipelines through public spaces in new urban development projects. In the case of DHC, apply the criteria used to install water, electricity, gas and communication pipelines.
- Adapt the administrative procedures to shorten the time required to obtain permits, and reduce local taxes when energy-efficiency improvements or renewable energies sources are included in the proposals. Declare these projects as 'Public Interest' and apply them advantageous administrative conditions with respect to non-energy efficient projects. The development of a DHC implies not only major investments but also compliance with authorisation and licensing procedures. Long and uncertain negotiations with authorities can become a barrier. Administrative procedures for developing infrastructures should be clear, transparent and quick enough to facilitate the development of DHC projects.
- Contact networks of other local authorities or European/ national/regional local authorities and produce a common proposal of new regulation for the promotion of distributed energy generation addressed to the relevant public authorities.
- When needed, set up rules (regulate) to clarify roles and responsibilities of all parts involved in selling and buying energy (for example in those countries without experience and regulation on district heating and cooling). Check that duty and responsibilities have been clearly identified and that each part is aware of them. In the energy-selling sector, make sure the measurements of energy are in accordance with a recognised standard (for example IPMVP). Transparency is a key aspect from the point of view of consumers and investors. It is suggested that the 'rules of the games' be in force as soon as possible. Convoke all stakeholders in order to obtain their views and have a good understanding of their interest and concerns.

4. **Ensure the availability of space to achieve projects**

- If needed, provide public space to install local energy generation installations. Some European local authorities offer a piece of land to private companies to rent with the aim of producing energy by means of photovoltaic collectors. The contract duration is established beforehand and the objective is to exploit large unused spaces to promote renewable energies.

CONCRETE EXAMPLE ON PROMOTING SOLAR ENERGY

In 2005 the City of Munich (Germany) received the 'Capital of energy-efficiency' award. As part of a comprehensive climate protection programme, the city offers the roof surfaces of its public buildings (mainly schools) for private photovoltaic investments. The city has developed a tendering scheme to select the investors.

Half of the scheme is reserved to citizens' groups. If there are several applicants for one roof, the winner is selected through a draw. The roofs are free of rent, but users sign a contract allowing them to use the roof under certain conditions. The users are required to pay a deposit over the contract period, are responsible for checking the condition of the roof surface and required to display the system to the public.

The last two calls allowed generating more than 200 000 kWh/year of photovoltaic electricity. The challenge of the call is to produce around 400 000 kWh/year of photovoltaic electricity, using the schools' buildings roofs (around 10 000 m^2 available for this call).

*Source: Guide for local and regional governments 'Save the Energy, save the climate, save money' (CEMR, Climate Alliance, Energie-Cités 2008) – **http://www.ccre.org/bases/T_599_34_3524.pdf***

Additional resources

1. International Energy Agency (IEA)
   IEA's Programme of Research, Development, and Demonstration on District Heating and Cooling, including the integration of Combined Heat and Power.
   http://www.iea-dhc.org/index.html
2. ELEP Project
   ELEP (European Local Electricity Production) is a European Project supported by Intelligent Energy Europe that offers technical and policies information, tools and best practices on local electricity generation.
   www.elep.net
3. ST-ESCOs Project
   ST-ESCOs (Solar Thermal Energy Services Companies) offers technical and economical software tools aimed at studying the feasibility of ST-ESCO projects, guiding information and best practices examples. Supported by Intelligent Energy Europe.
   www.stescos.org

(35) *Further information in the NICHES + project webpage **www.niches-transport.org**. This project is funded by the European Commission DG Research through the 7th Framework Programme (FP7). The mission of NICHES+ is to promote innovative measures for making urban transport more efficient and sustainable and to move them from their current 'niche' position into a mainstream urban transport application.*

4. Intelligent Energy – Europe programme
   The **Intelligent Energy** – **Europe programme** is the EU's tool for funding action to improve market conditions on terms of energy efficiency and usage of renewable energy sources. Local energy generation is part of the target areas.
   http://ec.europa.eu/energy/intelligent/index_en.html
5. ECOHEATCOOL Project
   The overall purpose of this project is to communicate the potential of district heating and cooling to offer higher energy efficiency and higher security of supply with the benefit of lower carbon dioxide emissions. Supported by Intelligent Energy Europe.
   www.ecoheatcool.org
6. Euroheat & Power
   Euroheat & Power is an association uniting the combined heat and power, district heating and cooling sector throughout Europe and beyond, with members from over thirty countries.
   www.euroheat.org

8.4 Public procurement (36)

1. Green Public Procurement

Public procurement and the way procurement processes are shaped and priorities are set in the procurement decisions, offer a significant opportunity for local authorities to improve their overall energy consumption performance.

Green public procurement means that public contracting authorities take environmental considerations into account when procuring goods, services or works. **Sustainable public procurement** goes even further and means that the contracting authorities take into account the three pillars of sustainable development – the effects on environment, society and economy – when procuring goods, services or works.

Energy efficient public procurement allows improving energy efficiency by setting it as relevant criteria in the tendering and decision-making processes related to goods, services or works. It applies to the design, construction and management of buildings, the procurement of energy consuming equipment, such as heating systems, vehicles and electrical equipments, and also to the direct purchase of energy, e.g. electricity. It includes practices such as life-cycle costing (37), the setting of minimum energy-efficiency standards, the use of energy efficient criteria in the tendering process, and measures to promote energy efficiency across organisations.

Energy-efficient procurement offers public authorities, and their communities, social, economic and environmental benefits:

- By using less energy, public authorities will reduce unnecessary costs, and save money.
- Some energy-efficient goods, such as light bulbs, have a longer lifetime and are of higher quality than their cheaper alternatives. Purchasing them will reduce valuable time and effort involved in frequently replacing equipment.
- Reducing CO_2 emissions as a result of energy-efficient procurement will help public authorities to decrease their carbon footprint.
- Through leading by example, public authorities help to convince the general public and private businesses of the importance of energy efficiency.

The interest in developing Green Public Procurement is not only its impact in terms of CO_2 emission reduction, whose average (see study 'Collection of statistical information on Green Public Procurement in the EU' (38) carried out for the European Commission-DG Environment) is 25 %, but also in terms of its financial impact, whose average is 1.2 % of savings. Here are some examples of energy-efficient measures proposed in high-priority product groups:

PRODUCT GROUP	EXAMPLES OF PUBLIC PROCUREMENT REQUIREMENT
Public transport	Purchase low-emission buses and public fleet vehicles. The buses have to be equipped with driving-style meters to monitor fuel usage.
Electricity	Increase the share of electricity from renewable sources going beyond national support schemes. This measure can be completed by including the purchase of energy-efficiency services. For example ESCOs.
IT products	Purchase of environmentally friendly IT goods that meet the highest EU energy standards for energy performance. Provide training to users on how to save energy using their IT devices.
Building construction/ renovation	Use of localised renewable energy sources (RES). Impose high efficiency standards that reduce the building's energy consumption (see chapter on building policies).

(36) *Source: European Commission DG ENV* ***http://ec.europa.eu/environment/gpp/index_en.htm*** ***www.iclei-europe.org/deep and www.smart-spp.eu***

(37) *Life-cycle costing refers to the total cost of ownership over the life of an asset. This includes acquisition (delivery, installation, commissioning), operation (energy, spares), maintenance, conversion and decommissioning costs.*

(38) *This study can be downloaded from* ***http://ec.europa.eu/environment/gpp/study_en.htm****. The report presents the statistical information and conclusions about the investigation done in the 7 most advanced European Countries in Green Public Procurement. It was found that the CO_2 emissions savings was in the range -47 %/-9 % and the financial impact was in the range -5.7 %/+0.31 %.*

Green, sustainable or energy-efficient public procurement are highly recommended. However, in the context of the Covenant of Mayors, only measures related to energy-efficient public procurement will be reflected in the CO_2 emission inventories. In fact the Covenant of Mayors is mainly focusing on energy consumption and on emissions that occur on the territory of the local authority.

The new Directive 2009/33/EC on the promotion of clean and energy efficient vehicles requires that lifetime impacts of energy consumption, CO_2 and pollutant emissions are taken into account in all purchases of public transport vehicles. Member States shall bring into force the necessary laws to comply with this directive by 4 December 2010.

Purchases of public transport vehicles represent a key market of high visibility. The application of this Directive therefore can promote a broader market introduction of clean and energy efficient vehicles in the cities and reduce their costs through economies of scale, resulting in a progressive improvement of the whole vehicle fleet.

2. Joint Public Procurement (39)

'**Joint procurement**' (JP) means combining the procurement actions of two or more contracting authorities. The key defining characteristic is that there should be only one tender published on behalf of all participating authorities. Such JP activities are not new – in countries such as the UK and Sweden public authorities have been buying together for a number of years – though in many European countries, especially in the South, there is often very little or no experience in this area.

There are several very clear benefits for contracting authorities engaging in JP arrangements:

- **Lower prices** – Combining purchasing activities leads to economies of scale. This is of particular importance in the case of a renewable energy project whose costs may be higher than conventional projects.
- **Administrative cost savings** – The total administrative work for the group of authorities involved in preparing and carrying out one rather than several tenders can be substantially reduced.
- **Skills and expertise** – Joining the procurement actions of several authorities also enables the pooling of different skills and expertise between the authorities.

This model for Public Procurement requires agreement and collaboration among different contracting authorities. Therefore, a clear agreement on needs, capacities, responsibilities and the common and individual legal framework of each part is a must.

GOOD PRACTISE EXAMPLE: JOINT PROCUREMENT OF CLEAN VEHICLES IN STOCKHOLM (40)

The City of Stockholm and other Public Administrations organised a joint procurement of clean cars. The city worked to introduce a large number of clean vehicles and mopeds to the fleet of vehicles used for city purposes. In 2000 there were around 600 clean vehicles operating in the city. There is a plan to increase the number of clean vehicles in the region to about 10 000 by around 2010. The most common fuels are ethanol and biogas and the clean vehicles are expected to use 60 % environmental fuels and the remainder petrol or diesel and electricity. More filling stations for environmental fuel will be required to enable clean vehicles to use fuels other than petrol and diesel. By 2050, it is expected that all cars will be replaced by clean vehicles.

Carbon dioxide reduction: 2005 1 600 tons per year – 2030/2050 480 000 tons per year.

Costs: SEK 6M per year (around 576 000€).

3. Green Electricity Purchasing (41)

The liberalisation of the European energy market offers local authorities the possibility of choosing freely their energy provider. According to the Directive 2001/77/EC electricity produced from renewable energy sources or Green Electricity can be defined as: 'electricity produced by plants using only renewable energy sources, as well as the proportion of electricity produced from renewable energy sources in hybrid plants also using conventional energy sources and including renewable electricity used for filling storage systems, and excluding electricity produced as a result of storage systems'.

In order to be sure that the electricity supplied comes from a renewable energy source, consumers have the possibility to request guarantees of origin certificates of the electricity. This mechanism has been foreseen in the Directive 2001/77/EC. The supplier has also the possibility to provide independent proof of the fact that a corresponding quantity of electricity has been generated from renewable sources, or produced by means of high-efficiency cogeneration.

(39) *Guidelines for the implementation of Green Public Procurement and Joint Public Procurement can be found in the webpage of LEAP project* ***www.iclei-europe.org/index.php?id=3113****. This project is funded by the European Commission's DG ENV through a project LIFE.* ***http://ec.europa.eu/environment/life/index.htm***

(40) *From Stockholm's action programme against Greenhouse Gas Emissions (2003).*

(41) *Further information on* ***www.procuraplus.org***

PREVIOUS EXPERIENCE OF GREEN ELECTRICITY PURCHASE PERFORMED BY THE GERMAN PUBLIC ADMINISTRATION INCLUDED THE FOLLOWING SPECIFICATIONS IN THE CALL FOR TENDERS

1. 100 % of electricity to come from renewable energy sources as defined by European Directive 2001/77/EC.
2. The RES-E supply to be combined with certified CO_2 reduction during the delivery period, meaning that:
   a. CO_2 reduction achieved during the delivery period has to amount to at least 30 % of the amount of average power supply during the same period; and
   b. proof of the levels of CO_2 reduction realised through new plants, i.e. plants coming into operation in the year of actual supply, must be provided. Proof must be given through the provision of specific data record sheets.
3. Guarantee of Origin: The origin of the electricity must be clearly traceable and based on identifiable sources. In case there are various sources, the split between the sources must be clearly explained. Special data record sheets serve to provide proof of the origin of the electricity and the expected CO_2 reduction achieved during the delivery period. The bidder may supply renewable electricity from plants that are not mentioned in the contract, however, must also meet the targeted levels of CO_2 reductions indicated in the bid.
4. Exclusion of subsidised supply: The supplier is required to confirm in the form of a self declaration that the power supply has not been subsidised, either entirely or partly at domestic or international level.
5. During the award phase, additional points were awarded to the supplier whose bid went beyond the minimum requirement of achieving CO_2 reductions of 30 %, compared to the existing energy mix in Germany at that time. The most economically advantageous bid was determined from the best price-performance ratio.

Price differences between conventional and green electricity depend on the status of liberalisation, the features of the national support schemes and the existence of green electricity suppliers. Green electricity is often more expensive, although price differences are narrowing substantially, and there are cases where green electricity is even available at a cheaper rate. Green electricity has proved to be a product group which is available for public procurement on a competitive basis.

Additional resources

1. European Commission – DG Environment
   The webpage of DG Environment of the European Commission offers guidelines, good practices, previous experiences, links and FAQs concerning Green Public Procurement.
   http://ec.europa.eu/environment/gpp/index_en.htm
2. ICLEI – Procura+
   Procura+ is an initiative of ICLEI that provides further information on Green Public Procurement.
   www.procuraplus.org
3. SENTERNOVEM
   SenterNovem has developed criteria and practical instruments to implement Sustainable Procurement to incorporate sustainability in procurement processes and tendering procedures.
   http://www.senternovem.nl/sustainableprocurement/index.asp
4. CLIMATE ALLIANCE – PRO-EE
   The project Pro-EE ('Public procurement boosts Energy Efficiency') aims to improve energy efficiency through sustainable public procurement. It develops model procedures and networking approaches that can be implemented by any public authority in Europe.
   http://www.pro-ee.eu/materials-tools.html

8.5 Urban & land use planning

Land use planning has a significant impact on the energy consumption in both the transport and building sectors. Strategic decisions concerning urban development, such as avoiding urban sprawl, influence the energy use within urban areas and reduce the energy intensity of transport. Compact urban settings may allow more cost-effective and energy-efficient public transport. Balancing housing, services and work opportunities (mixed use) in urban planning have a clear influence on the mobility patterns of citizens and their energy consumption. Local and regional governments can develop sustainable mobility plans and encourage a modal shift towards more sustainable transport modes.

Building shape and orientation play an important role from the point of view of heating, cooling and lighting. Adequate orientation and arrangement of buildings and built-over areas make it possible to reduce recourse to conventional air conditioning. Planting trees around buildings to shade urban surfaces, and green roofs to reduce their temperature, can lead to substantial reductions in energy consumption for air-conditioning. Proportion between width, length and height, as well as its combination with the orientation (42) and proportion of glazed surfaces, should be studied in detail when new urban developments are proposed. In addition, sufficient green areas and planting trees next to the building can lead to reduction in the energy needs and then reduce greenhouse gases.

(42) *A. Yezioro, Isaac G. Capeluto, E. Shaviv – Design guidelines for appropriate insolation of urban squares – Renewable Energy 31 (2006) 1011-1023.*

There are also examples of local authorities that have started to develop CO_2 free settlements or even set up an overall objective to become 'fossil fuel free'. CO_2 free settlements mean retrofitting districts in such a way that they do not consume fossil fuels.

Urban density is one of the key issues influencing energy consumption within urban areas. In the table below, the effects (both positive and negative) of density are considered. As it can be seen in the table, urban density may have conflicting effects.

Urban planning is a key instrument allowing the establishment of energy-efficiency requirements for new and renovated buildings.

TABLE 1. POSITIVE AND NEGATIVE EFFECTS OF URBAN DENSITY ON ENERGY CONSUMPTION (43)

PARAMETERS	POSITIVE EFFECTS	NEGATIVE EFFECTS
Transport	Promote public transport and reduce the need and length of trips by private cars.	Congestion in urban areas reduces fuel efficiency of vehicles.
Infrastructure	Shorten the length of infrastructure facilities such as water supply and sewage lines, reducing the energy needed for pumping.	–
Vertical transportation	–	High-rise buildings involve lifts, thus increasing the need for electricity for the vertical transportation.
Ventilation	–	A concentration of high-rise and large buildings may impede the urban ventilation conditions.
Thermal performance	Multiunit buildings could reduce the overall area of the building's envelope and heat loss from the buildings. Shading among buildings could reduce solar exposure of buildings during the summer period.	–
Urban heat island	–	Heat released and trapped in urban areas may increase the need for air conditioning The potential for natural lighting is generally reduced in high-density areas, increasing the need for electric lighting and the load on air conditioning to remove the heat resulting from the electric lighting.
Energy systems	District cooling and heating systems which are usually more energy efficient, are more feasible as density is higher.	–
Use of solar energy	–	Roof and exposed areas for collection of solar are limited.
Ventilation energy	A desirable air-flow pattern around buildings may be obtained by proper arrangement of high-rise building blocks.	–

(43) *This table has been extracted from: Sam C.M. Hui – Low energy building design in high-density urban cities – Renewable Energy 24 (2001) 627-640.*

GRONINGEN (THE NETHERLANDS)

Since the 1960s, the municipality of Groningen has been way ahead in its traffic plans and spatial planning policies; implementing urban policies which have lead to a car free city centre and a mixed public space, with all areas easily reachable by bicycle.

The basic concept used in urban planning was based on the 'compact city' vision, which placed an integrated transport system high on the municipal agenda. The main objective was to keep the distances between home and work, or home and school relatively short, so that the use of public transport forms a good alternative to the private car in terms of travelling time The residents should have the opportunities to shop for their everyday needs in their own neighbourhoods, while the city centre should serve as the main shopping centre. Sport facilities and schools should be closed to the living areas.

A series of sound transportation policies has been developed to favour walking, public transport and predominantly cycling. A traffic circulation plan divided the city centre into four sections and a ring road was built encircling the city and reducing access to the centre by car. During the 1980s and 1990s a parking policy was strictly implemented. Car parking with time restrictions was introduced in a broad radius around the city centre. Park and ride areas were created combined with city buses and other high quality public transport. Investments in cycling infrastructure have been made to expand the network of cycling lanes, improving the pavements, bridges for cyclists, many more bike parking facilities etc. Co-operation and participation by the local population, or particular social groups has been sought in relation to various actions. In addition, an extension of the travel management policy, based on a regional mobility plan, has been prepared in co-operation with provincial and national decision makers. This has resulted in a city centre which is entirely closed off to cars; it is only possible to travel between sectors by walking, bicycle or public transport.

Concrete results? See here:
http://www.fietsberaad.nl/library/repository/bestanden/document000113.pdf

*Sources: EAUE database 'SURBAN – Good practice in urban development' and the 'Fiets Beraad' website (**www.fietsberaad.nl**).*

Urban regulations should be devised in such a way not to deter energy efficiency and RES. For instance, long and complex authorisation procedures will be a clear obstacle to RES and energy-efficiency promotion and should be avoided. Such considerations should be integrated into the local authorities' urban planning schemes.

QUICK TIPS

- Introduce energy criteria in planning (land use, urban, mobility planning).
- Promote mixed use (housing, services and jobs).
- Plan to avoid urban sprawl:
  - control the expansion of built areas;
  - develop and revitalize old (deprived) industrial areas;
  - position new development areas within the reach of existing public transport lines;
  - avoid 'out-of-town' shopping centres.
- Plan car free or low car use areas by closing areas to traffic or introducing congestion charge schemes, etc.
- Promote solar oriented urban planning, for example by planning new buildings with an optimum sun-facing position.

Additional resources

1. Land Use Planning and Urban Renewal examples are available on **http://www.eukn.org/eukn/themes/index.html**
2. Document: 'Community Energy; Urban Planning for a low carbon future'. **http://www.chpa.co.uk/news/reports_pubs/Community%20Energy-%20Urban%20Planning%20For%20A%20Low%20Carbon%20Future.pdf**

8.6 Information and communication technologies (ICT)

In developing your SEAP, it is essential to take advantage of the key role that can be played by ICT in the creation of a low carbon society.

ICTs play a key role in the dematerialisation of our daily way of life. The substitution of high carbon products and activities with low carbon alternatives, e.g. replacing face-to-face meetings with videoconferencing, or paper with e-billing, could play a substantial role in reducing emissions. Like e-commerce, e-government could have a significant impact on reducing GHG emissions.

Currently the largest opportunity identified within dematerialisation is teleworking – where people work from home rather than commute into an office. Dematerialisation could also reduce emissions indirectly by influencing employees' behaviour, building greater awareness of climate change and creating a low-carbon culture throughout businesses, though these impacts are less quantifiable. Dematerialisation at the very least provides alternatives, allowing individuals to control their carbon footprint in a very direct way.

Finally, ICT has also a key role in enabling efficiency: consumers and businesses cannot manage what they cannot measure. ICT provides solutions that enable us to 'see' our energy and emissions in real time and provide the means for optimising systems and processes to make them more efficient.

Here are some examples of measures that could be implemented at local level:

- Stimulate an open debate with relevant stakeholders in relevant areas with a high potential impact like energy-smart homes and buildings, smart lighting, personalised public transport…
- Bring together stakeholders in the ICT and energy domains to create synergies and new forms of collaboration. For example, liaise with the utilities company in order to ensure adequate promotion and usage of smart-metering. Make sure the selected smart-meters provide a proper balance between additional cost to the customer and potential benefits in terms of energy savings, or promote the delivery of broadband infrastructure and collaborative technologies enabling the widest and most efficient usage of the e-technologies.
- Develop e-government, tele working, teleconferencing, etc. within the local administration and promote its usage.
- Integrate ICT to improve energy efficiency in public building, public lighting and transport control.
- Better management of the local authority's vehicle fleet: implement eco-driving, (real-time [44]) route optimisation and fleet management and supervision.
- Monitor and make more visible GHG emission and other environmental data to citizens. This real-time monitoring provides the means to study emissions patterns, track progress and interventions [45].
- Demonstrate that local authorities can lead by practical example by ensuring that a city's own ICT infrastructure and digital services have the smallest possible carbon footprint. Promote these practices towards the private sector and wider community.

It is important to appreciate that ICT itself has a carbon footprint, however green ICT policies need to be in place to ensure that ICT remains a solution to, and not a part of, the climate change problem.

Additional resources

1. The European Commission's DG INFSO webpage contains a large amount of information about the possibilities of ICT in SMART Buildings.
   http://ec.europa.eu/information_society/activities/sustainable_growth/index_en.htm
2. The Climate Group and the Global eSustainability Initiative (2008) published a report promoting the advantages of ICT: 'SMART 2020: Enabling the Low Carbon Economy in the Information Age'.
   http://www.theclimategroup.org/assets/resources/publications/Smart2020Report.pdf

(44) *With information on traffic density, weather, alternative routes…*

(45) *Contact details and further information available on* ***www.eurocities.eu*** *and* ***www.clicksandlinks.com***

CHAPTER 9
Financing sustainable energy action plans

9.1 Introduction

A SEAP´s successful implementation requires the sufficient financial resources. It is therefore necessary to identify available financial resources, as well as the schemes and mechanisms for getting hold of these resources in order to finance the SEAP actions.

Energy-efficiency financing decisions must be compatible with public budgeting rules. For example, the cash generated by energy-efficiency improvements and reductions in the energy bill may lead to a reduction of financial resources in the following budgeting period. This is due to the fact that most often EE projects are financed via capital expenditure budgets, where energy bills are paid from operational budgets.

The local authority should allocate the necessary resources in the annual budgets and make firm commitments for the years to come. As municipality resources are scarce, there will always be competition for available financial funding. Therefore, efforts should be continuously made to find alternative sources of resources. Regarding multi-annual commitment, different political parties should give their approval by consensus in order to avoid disruption in the development of the SEAP when a new administration is elected.

Successful SEAP actions will reduce the long-term energy costs of the local authority, the inhabitants, companies, and in general all stakeholders. In considering the costs of SEAP actions, local authorities should also consider their co-benefits: benefits to health, quality of life, employment, attractiveness of the city, etc.

9.2 Initial considerations

Local authorities may be tempted to opt for energy-efficiency projects with short paybacks. However, this approach will not capture the majority of potential savings available through energy retrofits. Instead, it is recommended that all profitable options are included and in particular those that yield a rate of return higher than the interest rate of the investment capital. This approach will translate into greater savings over the long term.

Quick paybacks on investments mean too often that organisations do not pay attention to 'life-cycle costing'. Payback time shall be compared with the lifespan of the goods to be financed. For instance, a 15 years payback time cannot be considered long when it comes to building with a lifespan of 50-60 years.

9.3 Creating bankable projects (46)

A bankable project is a clearly documented economically viable project. Building a bankable project starts with sorting out the pieces that make a project economically attractive. Initially, it is required to examine the project's key components, make sure that each aspect is properly assessed and that the plan to effectively manage that aspect is clearly presented. Each component carries a risk factor, and each risk factor carries a price tag. An effective ESCO or financial consulting expert knows how to assess each part of a financial project.

When a financing project is studied by a bank, the objective is to know the level of risk through an assessment procedure. A technical energy audit is not enough for this purpose. Other aspects such as the engineering skills (of an ESCO or the municipal energy agency for instance) or the level of commitment of each part are crucial to making this project attractive for the bank. For instance, some general requirements may be that the technology is well-proven, well adapted to the region and to produce an Internal Interest Rate greater than 10 % (47).

9.4 Most relevant financing schemes

This point describes the most frequent and general financing mechanism used for renewable energy sources and energy efficiency. Other specific programmes such as European funding are also available. Wide and updated information about these programmes can be found in the webpage of the Covenant of Mayors Office **www.eumayors.eu**

9.4.1 Revolving funds (48)

This is a financial scheme aimed at establishing sustainable financing for a set of investment projects. The fund may include loans or grants and aims at becoming self-sustainable after its first capitalisation.

(46) *Further information on financing* ***http://sefi.unep.org/fileadmin/media/sefi/docs/publications/pfm_EE.pdf***

(47) *Further information on how to produce bankable energy-efficiency projects may be found in the 'Bankable Energy-Efficiency Projects (BEEP) – Experiences in Central and Eastern Europe' brochure. Downloadable from:* ***http://www.dena.de/fileadmin/user_upload/Download/Dokumente/Publikationen/internationales/BEEP_Project_Brochure.pdf***

(48) *Further information on the EBRD-Dexia-Fondelec Revolving Fund can be found in* ***www.ebrd.com/new/pressrel/2000/17feb15x.htm*** *and in the document 'Financing Energy Efficient Homes' of the International Energy Agency (IEA)* ***http://www.iea.org/Papers/2008/cd_energy_efficiency_policy/2-Buildings/2-FinancialBarrierBuilding.pdf***

The objective is to invest in profitable projects with short payback time, be repaid, and use the same fund to finance new projects. It can be established as a bank account of the owner or as a separate legal entity. The interest rate generally applied in the capitalisation of revolving funds is lower than the market one or even 0%. Grace periods are also frequent for the periodic payment of revolving funds, …

There are several parties in a revolving fund: The owners can be either public or private companies, organisations, institutions or authorities. The operator of the fund can be either its owner or an appointed authority. External donors and financiers provide contributions to the fund in the form of grants, subsidies, loans or other types of repayable contributions. The borrowers can be either the project owners or contractors. According to the conditions of the revolving fund, savings or earnings gained from projects should be paid back to the fund within a fixed period of time, at certain time intervals.

9.4.2 Third party financing schemes

Perhaps the easiest way for municipalities to undertake comprehensive building energy retrofits is to allow someone else to provide the capital and to take the financial risk. With these alternative methods of financing, high financing costs may be expected to reflect the fact that the debt is registered on someone else's balance-sheet. However, the interest rate is only one factor among many that should be considered in determining the suitability of a project-financing vehicle.

9.4.3 Leasing (49)

The client (lessee) makes payments of principal and interest to the financial institution (lessor). The frequency of payments depends on the contract. The stream of income from the cost savings covers the lease payment. It can be an attractive alternative to borrowing because the lease payments tend to be lower than the loan payments; it is commonly used for industrial equipment. There are two major types of leases: capital and operating.

- **Capital leases** are instalment purchases of equipment. In a capital lease, the lessee owns and depreciates the equipment and may benefit from associated tax benefits. A capital asset and associated liability appears on the balance sheet.
- In **operating leases** the owner of the asset owns the equipment and essentially rents it to the lessee for a fixed monthly fee. This is an off-balance sheet financing source. It shifts the risk from the lessee to the lessor, but tends to be more expensive for the lessee.

9.4.4 Energy services companies (50)

Energy Services Companies (ESCO) are described in 'Technical measures' Part III of this guidebook. The ESCO usually finances the energy-saving projects without any up-front investment costs for the local authority. The investment costs are recovered and a profit is made from the energy savings achieved during the contract period. The contract guarantees a certain amount of energy savings for the local authority, and provides the possibility for the city to avoid facing investments in an unknown field. Once the contract has expired, the city owns a more efficient building with less energy costs.

Often, the ESCO offers a performance **'guarantee'** which can take several forms. The guarantee can revolve around the actual flow of energy savings from a retrofit project. Alternatively, the guarantee can stipulate that the energy savings will be sufficient to repay monthly debt service costs. The key benefit to the building owner is the removal of **project non-performance risk**, while keeping the operating costs at an affordable level.

Financing is arranged so that the energy savings cover the cost of the contractor's services and the investment cost of the new and more energy efficient equipment. The repayment options are negotiable.

Measurements and verification of the energy and savings produced are critical for all the parts involved in the project. Therefore, a protocol (51) aimed at working with common terms and methods to evaluate performance of efficiency projects for buyers, sellers and financiers will be essential. As mentioned in a previous chapter, the International Performance Measurement and Verification Protocol (IPMVP) is an international set of standardised procedures for the measurement and verification (M&V) of savings in Energy-Efficiency projects (also in water efficiency). This protocol is widely accepted and adapted.

(49) ***www.leaseurope.org/*** *is an association of car leasing European Companies.*

(50) *Extended information available in the 'publications' section of* ***http://re.jrc.ec.europa.eu/energyefficiency/*** *and* ***http://www.worldenergy.org/documents/esco_synthesis.pdf***

In addition, the International Energy Agency's Task XVI offers a large range of information about competitive Energy Services in ***http://www.ieadsm.org/ViewTask.aspx?ID=16&Task=16&Sort=0#ancPublications3***

(51) *May be downloaded free from* ***www.ipmvp.org***

9.4.5 ESCO intracting model or public internal performance commitments (PICO) (52)

Besides the large private ESCO sector, a public ESCO sector called 'Interacting model', or Public Internal Performance Commitments (PICO), has mainly been used in Germany.

In the PICO model a department in the public administration acts as a unit similar to an ESCO in function for another department. The ESCO department organises, finances and implements energy-efficiency improvements mostly through a fund made up of municipal money, and using existing know-how. This allows larger cost savings and implementation of less profitable projects, which would be ignored by a private ESCO (53). However, these projects lack the energy savings guarantee, because there are no sanction mechanisms within a single organsation (even though PICO includes saving targets). This can result in lower effectiveness of the investments. Nevertheless, this scheme increases activity for energy savings.

SPECIFIC EXAMPLE IN THE CITY OF STUTTGART

The internal contracting was set up in 1995 under the direction of the Stuttgart Environmental Agency with the specific aim of establishing pre-financing for measures to conserve energy and water more rapidly, as well as implementing the measures themselves. The costs saved through these measures flow back to the Environmental Agency from the energy cost budgets of the individual departments and locally-owned utilities until the investments have been paid off. After this, the funds then become available again.

Since the concept was launched, more than 220 measures have been implemented and 8.1 million Euro invested. Both small (improvements to control technology) and large-scale (building of wood-pellet heating systems) projects have been implemented. The average period of return on invested capital is 7 years. Annual savings meanwhile amount to over 1.2 million Euro, which represents some 32 000 m^3 of water, 15 000 MWh of heat energy and 2 000 MWh of electricity. In addition to an increase in energy efficiency, city-internal contracting has also allowed the construction of systems for the use of renewable energy sources (27 % of investments). (54)

9.4.6 Public-private partnerships (PPP)(55)

In this case the local authority uses a concession scheme under certain obligations. For instance, public administration promotes the construction of a zero-emission swimming pool, or a district heating and cooling installation, by allowing a private company to run it revolving the profits on the initial investment. This kind of contract should be flexible in order to allow the private company to extend the contract in case of unexpected payback delays. Moreover, a frequent due diligence is also recommended in order to follow up the evolution of incomes.

An example of government-led third party financing is the Spanish IDAE model, which has been financing renewable projects in Spain since the late 1980s. IDAE identifies a project, provides the capital to a developer to construct it (or install the new energy-efficient equipment), and recovers its investment, plus the cost of its services, out of the energy production or savings. In other words, IDAE finances all the costs and assumes the technical responsibility of the investment. At the end of the contract, the project developer and user of the installation owns all the capital assets. In most instances the government agency IDAE works as an ESCO and has invested 95 M€ in renewable energy projects and leveraged another 104 M€ for 144 projects under the third-party finance mechanism.

(52) ***www.eceee.org/EEES/public_sector/PROSTappendix8.pdf***

(53) *Irrek et al. 2005 – PICOlight project is a project supported by the European Commission through the programme SAVE. More information on **http://www.iclei-europe.org/?picolight***

(54) *Example from a publication: Solutions for Change – How local governments are making a difference in climate protection (Climate Alliance 2008).*

(55) *Successful worldwide Public-Private Partnerships example can be found in the document 'Public-Private Partnerships: Local Initiatives 2007' on **www.theclimategroup.org/assets/resources/ppp_booklet.pdf***

CHAPTER 10
SEAP implementation

The implementation of the SEAP is the step that takes the longest time, efforts and financial means. This is the reason mobilisation of stakeholders and citizens is critical. Whether the SEAP will be successfully implemented or will remain a pile of paperwork depends to a high extent on the human factor. The SEAP needs to be managed by an organisation that supports people in their work, where there is an attitude of ongoing learning, and where mistakes and failures are opportunities for the organisation and individuals to learn. If people are given responsibility, encouragement, resources and are motivated, things will happen.

During the implementation phase, it will be essential to ensure both good internal communication (between different departments of the local authority, the associated public authorities and all the persons involved (local building managers…) as well as external communication (citizens and stakeholders). This will contribute to awareness-raising, increase the knowledge about the issues, induce changes in behaviour, and ensure wide support for the whole process of SEAP implementation (see chapter about the communication process).

Monitoring of progress and energy/CO_2 savings should be an integral part of SEAP implementation (see next chapter). Finally, networking with other local authorities developing or implementing a SEAP, will provide additional value towards meeting the 2020 targets by exchanging experience and best practices, and establishing synergies. Networking with potential CoM signatories, and encouraging their involvement in the Covenant of Mayors is also recommended.

SOME TIPS TO PUT A SEAP INTO PRACTICE

- Adopt a Project Management approach: deadline control, financial control, planning, deviations analysis and risk management. Use a quality management procedure (56).
- Divide the project into different parts and select persons responsible.
- Prepare specific procedures and processes aimed at implementing each part of the project. A quality system is a useful tool to make sure that procedures are in accordance with the objectives.
- Establish a score-card system for tracking and monitoring your plan. Indicators such as percentage of compliance with deadlines, percentage of budget deviations, percentage of emissions reduction with the measures already implemented and other indicators deemed convenient by the local authority may be proposed.
- Plan the follow-up with the stakeholders establishing a calendar of meetings in order to inform them. Interesting ideas could arise during these meetings or possible future social barriers could be detected.
- Anticipate future events and take into account negotiation and administrative steps to be followed by the Public Administration to start a project. Public projects usually require a long time to obtain authorisation and approvals. In this case, a precise planning including security factors is convenient mainly at the beginning of the SEAP implementation.
- Propose, approve and put into operation a training programme at least for those persons directly involved in the implementation.
- Motivate your team. This point is highly connected to the 'building support' chapter. Internal people are important stakeholders.
- Inform frequently the city council (or equivalent body) and politicians in order to make them an important part of successes and failures and get their commitment. This point has been considered as very important during experts' consultations, prior to developing this guidebook.
- Some measures proposed in the SEAP may need to be tested before a massive implementation. Tools such as pilot or demonstration projects can be used to test the suitability of these measures.

(56) *The European Energy Award (EEA)* ***www.european-energy-award.org***

CHAPTER 11
Monitoring and reporting progesses

Monitoring is a very important part of the SEAP process. Regular monitoring followed by adequate adaptations of the plan allows initiating a continuous improvement of the process. As mentioned before, CoM signatories are committed to submit an 'Implementation Report' every second year following the submission of the SEAP 'for evaluation, monitoring and verification purposes'. **A specific monitoring and reporting guidebook will be published by the European Commission in 2010.**

Such implementation report should include an updated CO_2 emission inventory (MEI, monitoring emission inventory). Local authorities are encouraged to compile CO_2 emission inventories on an annual basis (see part II, chapter 5: Reporting and documentation).

However if, the local authority considers that such regular inventories put too much pressure on human or financial resources, it may decide to carry out the inventories at larger intervals. But local authorities are recommended to compile an MEI and report on it at least every fourth year, which means submitting alternatively every 2 years an **'Action Report'** – without MEI' – (years 2, 6, 10, 14…) and an **'Implementation Report'** – with MEI (years 4, 8, 12, 16…). The **Implementation Report** contains quantified information on measures implemented, their impacts on energy consumption and CO_2 emissions, and an analysis of the SEAP implementation process, including corrective and preventive measures when this is required. The **Action Report** contains qualitative information about the implementation of the SEAP. It includes an analysis of the situation and qualitative, corrective and preventive measures. **The European Commission will provide a specific template for each type of report.**

As previously mentioned, some indicators are needed in order to assess the progress and performance of the SEAP. Even if a specific monitoring and reporting guidebook will be published by the JRC, some indicators are suggested in this guidebook to give an orientation on the type of monitoring parameters that may be used.

TABLE 2. POSSIBLE INDICATORS TO MONITOR THE SEAP IMPLEMENTATION

INDICATORS	DATA COLLECTION DIFFICULTY (*)	DATA COLLECTION	POSITIVE TREND
SECTOR: Transport			
Number of public transport passengers per year.	1	Agreement with a public transport company. Select representative lines to monitor.	↑
Kms of biking ways.	1	City Council.	↑
Kms of pedestrians streets/ Kms of municipal roads and streets.	1	City Council.	↑
Number of vehicles passing fixed point per year/month (set a representative street/ point).	2	Install a car counter in representative roads/streets.	↓
Total energy consumption in public administration fleets.	1	Extract data from fuel supplier's bills. Convert to energy.	↓
Total energy consumption of renewable fuels in public fleets.	1	Extract data from biofuels suppliers' bills. Convert to energy. Sum this indicator with the previous one and compare values.	↓
% of population living within 400 m of a bus service.	3	Carry out surveys in selected areas of the municipality.	↑
Average Kms of traffic jams.	2	Performs an analysis of traffic fluidity in specific areas.	↓
Tons of Fossil fuels and biofuels' sold in representative selected gas stations.	1	Sign an agreement with selected gas station located within the municipality.	↓

(*) *1-EASY, 2-MEDIUM, 3-DIFFICULT.*

SECTOR: Buildings			
% of households with energetic label A/B/C.	2	City Council, national/regional energy agency, etc.	↑
Total energy consumption of public buildings.	1	See part II, chapter 4, energy data collection City Council.	↓
Total surface of solar collectors.	3	See part II, chapter 4, energy data collection City Council, Regional/National Public Administrations (from grants) and selected areas door-to-door surveys.	↑
Total electricity consumption of households. (*)	2	See part II, chapter 4, energy data collection Selected areas door-to-door surveys.	↓
Total gas consumption of households. (*)	2	See part II, chapter 4, energy data collection Selected areas door-to-door surveys.	↓
SECTOR: Local Energy Production			
Electricity produced by local installations. (*)	2	See part II, chapter 4, energy data collection Regional/National Public Administrations (feed-in tariffs of certificates).	↑
SECTOR: Involvement of the private sector			
Number of companies involved in energy services, energy efficiency and renewable energies business. Number of companies involved in energy services, energy efficiency and renewable energies business.	2	City Council and Regional/National Public Administrations.	↑
SECTOR: Citizens involvement			
Number of citizens attending to energy efficiency/renewable energies events.	1	City Council and Consumers Associations.	↑
SECTOR: Green Public Procurement (GPP)			
Establish an indicator for each category and compare with the typical value before implementing GPP. For example compare $kgCO_2/kWh$ of green electricity with the previous value. Use the data collected from all purchases to produce a single indicator.	2	City Council.	↑

Data collection frequency may be every 12 months (57) by default.

ILLNAU-EFFRETIKON (15,'600 INHABITANTS, SUBURBAN MUNICIPALITY, EUROPEAN ENERGY AWARD® SINCE 1998)

The city of Illnau-Effretikon in Switzerland set up a baseline emissions inventory in 2001 and approved an activity plan (similar to SEAP), based on the results of an initial energy review on the basis of the European Energy Award®. Within a project group with other eea® municipalities, an evaluation of 44 out of 87 measures of the eea assessment tool of potential CO_2 reductions and energy savings was carried out to monitor the GHG emissions. The implementation of the activity plan/SEAP is monitored in real-time by recording the CO_2 reduction as soon as a measure has been implemented and inserted in the eea assessment tool. Therefore, the assessment of the quality is accompanied by a quantitative analysis.

(*) *This data can be collected from utilities, tax offices (calculation of electricity consumption patterns analysing taxes paid for electricity) of the Public Administration or performing surveys in selected areas. Data collection from taxes can be feasible or not depending on the taxing mechanisms of each country.*

(57) *In some cases, more frequent data collection may be better. In these cases, seasonal effects must be considered in order to perform a real analysis of the situation. Once the first year has been concluded, a monthly or quarterly inter-annual analysis may be carried out.*

ANNEX I
Suggestions of aspects to be covered in the baseline reviews

SCOPE	KEY ASPECTS FOR ASSESSMENT
Energy structure and CO_2 emissions	• Level and evolution of energy consumption and CO_2 emissions by sector and by energy carrier (see part II). Global and per capita.
Renewable energies	• Typology of existing facilities of production of renewable energies. • Renewable energy production and trends. • Use of agricultural and forest biomass as renewable energy sources. • Existence of bio-energetic crops. • Degree of self-supplying with renewable energies. • Potentialities for renewable energy production: solar thermal and photovoltaic, wind, mini-hydraulics, biomass, others.
Energy consumption and energy management in the local administration	• Level and change in the energy consumption of the local administration by sector (buildings and equipment, public lighting, waste management, waste water treatment, etc.) and by energy carrier (see Part II). • Assessment of the energy efficiency of buildings and equipmen using efficiency indexes of energy consumption (for example: kWh/m^2, kWh/m^2 – user, kWh/m^2 hours of use). This allows identifying the buildings where there are more improvement potentialities. • Characterisation of the largest energy consumers among municipal buildings and equipment/facilities. Analysis of key variables (for instance: type of construction, heating, cooling, ventilation, lighting, kitchen, maintenance, solar hot water, implementation of best practices…). • Assessing the types of lamps, lighting and energy-related issues in public lighting. • Assessment of energy efficiency using efficiency indexes of energy consumption. • Degree and adequacy of energy management in public buildings/equipment and public lighting (including energy accounting and audits). • Established initiatives for improving energy saving and efficiency and results obtained to date. • Identification of potentialities for improvement in energy savings and efficiency in buildings, equipment/facilities and public lighting.
Energy consumption of the municipal fleet	• Evaluation of the composition of the municipal fleet (own vehicles and of externalised services), annual energy consumption (see Part II). • Composition of the urban public transport fleet, annual energy consumption. • Degree of the energy management of the municipal fleet and public transport. • Established initiatives for improving reducing energy consumption and results obtained to date. • Identification of potentialities for improvement in energy efficiency.
Energy infrastructures	• Existence of electricity production plants, as well as district heating/cooling plants. • Characteristics of the electricity and gas distribution networks, as well as any district heat/cold distribution network. • Established initiatives for improving energy efficiency of the pants and of the distribution network and results obtained to date. • Identification of potentialities for improvement in energy efficiency.
Buildings	• Typology of the existing building stock: usage (residential, commerce, services, social…), age, thermal insulation and other energy-related characteristics, energy consumption and trends (if available, see Part II), protection status, rate of renovation, tenancy, … • Characteristics and energy performance of new constructions and major renovations. • What are the minimal legal energy requirements for new constructions and major renovations? Are they met in practice? • Existence of initiatives for the promotion of energy efficiency and renewables in the various categories of buildings. • What results have been achieved? What are the opportunities?

SCOPE	KEY ASPECTS FOR ASSESSMENT
Industry	• Importance of industry sector in the energy balance and CO_2 emissions. Is it a target sector for our SEAP? • Existence of public and private initiatives address to promote energy saving and efficiency in industry. Key results achieved. • Degree of integration of energy/carbon management in industry businesses? • Opportunities and potentialities on energy saving and efficiency in industry.
Transport and mobility	• Characteristics of the demand of mobility and modes of transport. Benchmarking and major trends. • What are the main characteristics of the public transportation network? Degree of development and adequacy? • How is the use of public transportation developing? • Are there problems with congestion and/or air quality? • Adequacy of public space for pedestrians and bicycles. • Management initiatives and mobility planning. Initiatives to promote public transport, bicycle and pedestrian.
Urban planning	• Characteristics of existing and projected 'urban spaces', linked to mobility: urban density, diversity of uses (residential, economic activity, shopping, …) and building profiles. • Degree of dispersion and compactness of urban development. • Availability and location of the main services and facilities (educational, health, cultural, commercial, green space, …) and proximity to the population. • Degree and adequacy of integration of energy-efficiency criteria in urban development planning. • Degree and adequacy of integration of sustainable mobility criteria in urban planning.
Public procurement	• Existence of a specific policy commitment on green public procurement. • Degree of implementation of energy and climate change criteria in public procurement. Existence of specific procedures, usage of specific tools (carbon footprint or others).
Awareness	• Development and adequacy of the activities of communication and awareness to the population and stakeholders with reference to energy efficiency. • Level of awareness of the population and stakeholders with reference to energy efficiency and potential savings. • Existence of initiatives and tools to facilitate the participation of citizens and stakeholders in the SEAP process and the energy and climate change policies of the local authority.
Skills and expertise	• Existence of adequate skills and expertise among the municipal staff: technical expertise (energy efficiency, renewable energies, efficient transport…), project management, data management (lack of skills in this field can be a real barrier!), financial management and development of investment projects, communication skills (how to promote behavioral changes, etc.), green public procurement…? • Is there a plan for training staff in those fields?

Source: Methodology Guide for the revision of the Local Agenda 21 Action Plans in the Basque Country – UDALSAREA21 (Basque Network of Municipalities for Sustainability) ***www.udalsarea21.ent***

ANNEX II
Benefits of SEAP

The local (political) authorities can obtain the following benefits in supporting SEAP implementation:

- contribute to the global fight against climate change – the global decrease of greenhouse gases will also protect the city against climate change;
- demonstrate commitment to environmental protection and efficient management of resources;
- participation of civil society, improvement of local democracy;
- improve the city's image;
- political visibility during the process;
- revive the sense of community around a common project;
- economic and employment benefits (retrofitting of buildings…);
- better energy efficiency and savings on the energy bill;
- obtain a clear, honest and comprehensive picture of budgetary outflows connected with energy use and an identification of weak points;
- develop a clear, holistic and realistic strategy for improvement in the situation;
- access to National/European funding;
- improve citizens well-being (reducing energy poverty);
- local health and quality of life (reduced traffic congestion, improved air quality…);
- secure future financial resources through energy savings and local energy production;
- improve long-term energetic independence of the city;
- eventual synergies with existing commitments and policies;
- preparedness for better use of available financial resources (local, EU grants and financial schemes);
- better position for implementation of national and/or EU policies and legislation;
- benefits from networking with other Covenant of Mayors signatories.

ANNEX III
Key european affecting climate and energy policies at local level

1. The Energy Performance of Buildings Directive (2002/91/EC), which establishes the following obligations for Member States:
   - setting up a method to calculate/measure the energy performance of buildings;
   - setting minimum energy performance standards for new/renovated buildings;
   - setting up a certification scheme that informs potential buyers/renters of buildings (residential, commercial, …) about the energy performance of the building in question;
   - displaying an energy performance certificate in all 'public' buildings;
   - setting up an inspection scheme of the cooling and heating systems above a certain size.

This regulation was supposed to be in force in all Member States as of January 2006 (with some possible delay till January 2009 for some of the chapters), but many Member States have been late in adopting the necessary measures and laws.

2. Communication COM (2009) 490 'Action Plan on Urban Mobility' aimed at establishing the actions to be implemented through programmes and instruments.

3. Directive 93/116/EC of 17 December 1993 adapting to technical progress Council Directive 80/1268/EEC relating to the fuel consumption of motor vehicles.

4. Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

5. Directive 2003/30/EC on the promotion of the use of biofuels for other renewable fuels for transport.

6. Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.

PART II
Baseline emissions inventory

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Acronyms

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

1. Introduction

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

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

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

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

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

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

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

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

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

2. Setting up an inventory

2.1 Key concepts

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

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

2.2 Boundaries, scope and sectors

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The advantages of both approaches are summarised in Table 2.

TABLE 2. COMPARISON OF STANDARD AND LCA EMISSION FACTORS

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

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

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

3.2 Greenhouse gases included: CO_2 or CO_2 equivalent emissions

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

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

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

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

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

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

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

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

3.3 Fuels and renewable heat

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

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

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

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

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

BOX 1. SUSTAINABILITY OF BIOFUELS/BIOMASS

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

1. Sustainability in relation to CO_2 concentration in the atmosphere

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

2. Life cycle emissions, biodiversity and other sustainability issues

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.4 Electricity

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

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

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

3.4.1 National or European emission factor

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

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

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

TABLE 5. NATIONAL AND EUROPEAN EMISSION FACTORS FOR CONSUMED ELECTRICITY

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

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

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

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

3.4.2 Local electricity production

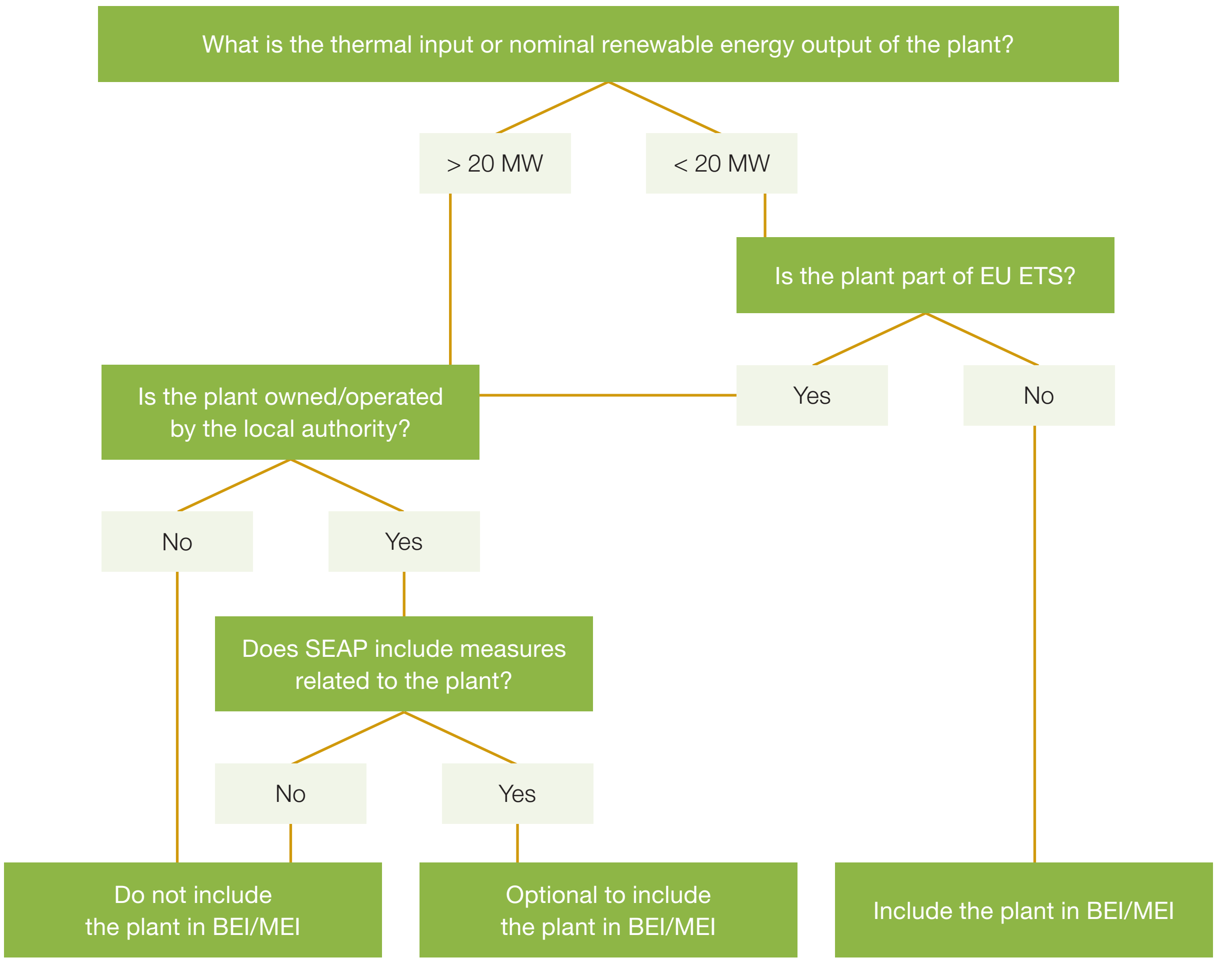
Reducing CO_2 emissions through improvement of energy efficiency and local renewable energy projects is a priority of the Covenant. However, also other actions to reduce CO_2 emissions in the supply side can be accounted for. First, the local authority has to decide whether to include local electricity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

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

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

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

BOX 3. DECISION TREE FOR INCLUSION OF LOCAL ELECTRICITY PRODUCTION



[7] 20 MW$_{fuel}$ refers to fuel input of the plant, and corresponds to the EU ETS threshold for combustion installations. The threshold 20 MW$_e$ set for other renewables refers to nominal electricity generation capacity, and is thus higher than the threshold for combustion installations.

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

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

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

The following electricity generation facilities are located in the territory of the local authority:
1. Wind power park owned by a private company
2. Solar panels on the roof of a building owned by the local authority
3. Solar panels on the roof of a building owned by a private company
4. CHP plant using natural gas
5. Gas turbine plant owned by a private company
6. A group of 3 wind turbines owned by a private company

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

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

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

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

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

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

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

TABLE 6. EMISSION FACTORS FOR LOCAL RENEWABLE ELECTRICITY PRODUCTION

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

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

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

3.4.3 Purchases of certified green electricity by the local authority

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

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

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

3.4.4 Calculation of local emission factor for electricity

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

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

Where

EFE = local emission factor for electricity [t/MWh$_e$]

TCE = total electricity consumption in the local authority (as per Table A of the SEAP template) [MWh$_e$]

LPE = local electricity production (as per table C of the template) [MWh$_e$]

GEP = green electricity purchases by the local authority (as per Table A) [MWh$_e$]

NEEFE = national or European emission factor for electricity [t/MWh$_e$]

CO2LPE = CO_2 emissions due to the local production of electricity (as per table C of the template) [t]

CO2GEP = CO_2 emissions due to the production of certified green electricity purchased by the local authority [t]

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

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

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

3.5 Heat/cold

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

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

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

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

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

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

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

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

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

EFH = (CO2LPH + CO2IH – CO2EH) / LHC

Where

EFH =	emission factor for heat [t/MWh_{heat}]
CO2LPH =	CO_2 emissions due to the local production of heat (as per table D of the template) [t]
CO2IH =	CO_2 emissions related to any imported heat from outside the territory of the local authority [t]
CO2EH =	CO_2 emissions related to any heat that is exported outside of the territory of the local authority [t]
LHC =	local heat consumption (as per table A) [MWh_{heat}]

A similar formula may apply for cold.

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

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

3.5.1 Combined heat and power production (CHP)

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

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

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

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

Where

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

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

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

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

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

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

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

3.6 Other sectors

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

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

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

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

4. Activity data collection

4.1 Introduction

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

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

4.2 Final energy consumption

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

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

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

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

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

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

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

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

4.2.1 Buildings, equipment/facilities and industries

1. Municipal buildings and equipment/facilities

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

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

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

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

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

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

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

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

2. Municipal public lighting

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

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

3. Other buildings and facilities

This section covers:

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

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

1. **Get data from the market operators**

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

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

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

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

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

2. **Get data from other entities**

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

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

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

3. **Inquiries addressed to energy consumers**

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

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

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

Several options are possible:

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

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

What to ask?

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

Tips:

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

What to do with the data?

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

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

4. Making estimates

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

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

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

Notes

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

4.2.2 Road transportation

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

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

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

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

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

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

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

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

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

Mileage driven

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

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

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

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

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

Vehicle fleet distribution

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

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

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

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

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

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

Average fuel consumption per km

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

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

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

Calculation of activity data

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

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

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

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

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

BOX 6. EXAMPLE OF CALCULATION OF ACTIVITY DATA FOR ROAD TRANSPORTATION	PASSENGER CARS	LIGHT DUTY VEHICLES	HEAVY DUTY VEHICLES	BUSSES	TWO WHEELERS	TOTAL
Mileage (million km) from activity data collection						
Total						**2100**
Fleet distribution from activity data collection (as % of mileage)						
Total mileage	**80 %**	**10 %**	**2 %**	**4 %**	**4 %**	**100 %**
Gasoline	50 %	3 %			4 %	57 %
Diesel	30 %	7 %	2 %	4 %		43 %
Average fuel consumption from activity data collection (l/km)						
Gasoline	**0.096**	**0.130**			**0.040**	
Diesel	**0.069**	**0.098**	**0.298**	**0.292**		
Calculated mileage (million km)						
Gasoline	1 050	63			84	1 197
Diesel	630	147	42	84		903
Calculated consumption (million l fuel)						
Gasoline	100.8	8.19	0	0	3.36	
Diesel	43.47	14.406	12.516	24.528	0	
Calculated consumption (GWh)						
Gasoline	927	75	0	0	31	1 034
Diesel	435	144	125	245	0	949

Share of biofuels

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

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

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

4.2.3 Rail transportation

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

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

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

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

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

4.3 Local electricity production (if applicable)

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

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

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

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

4.4 Local heat/cold production

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

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

Note: the case of micro cogeneration

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

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

4.5 Other sectors

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

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

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

5. Reporting and documentation

5.1 Reporting of BEI/MEI

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

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

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

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

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

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

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

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

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

5.2 *Per capita* target

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

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

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

5.3 Temperature correction

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

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

LHC_TC = temperature corrected heat consumption in year x [MWh_{heat}]

LHC = actual heat consumption in the year x [MWh_{heat}]

HDD_{AVG} = heating degree days in an average year (defined over a certain time period) [K • d]

HDD = heating degree days in the year x [K • d]

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

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

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

BOX 7. CALCULATION OF HEATING DEGREE DAYS (HDD)

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

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

6. Use of existing tools and more advanced methodologies

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

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

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

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

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

7. Recalculations

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

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

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

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

BOX 8. RECALCULATION DUE TO INDUSTRY DELOCALIZATION

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

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

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

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

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

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

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

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

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

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ANNEX I
Conversion factor and IPCC emission factor tables

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

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

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

TABLE C. CO_2 EMISSION FACTORS FOR FUELS (IPCC, 2006)		
FUEL TYPE	CO_2 EMISSION FACTOR (Kg/ TJ)	CO_2 EMISSION FACTOR (t/MWh)
Crude Oil	73 300	0.264
Orimulsion	77 000	0.277
Natural Gas Liquids	64 200	0.231
Motor Gasoline	69 300	0.249
Aviation Gasoline	70 000	0.252
Jet Gasoline	70 000	0.252
Jet Kerosene	71 500	0.257
Other Kerosene	71 900	0.259
Shale Oil	73 300	0.264
Gas oil/diesel	74 100	0.267
Residual Fuel Oil	77 400	0.279
Liquefied Petroleum Gases	63 100	0.227
Ethane	61 600	0.222
Naphtha	73 300	0.264
Bitumen	80 700	0.291
Lubricants	73 300	0.264
Petroleum Coke	97 500	0.351
Refinery Feedstocks	73 300	0.264
Refinery Gas	57 600	0.207
Paraffin Waxes	73 300	0.264
White Spirit & SBP	73 300	0.264
Other Petroleum Products	73 300	0.264
Anthracite	98 300	0.354
Coking Coal	94 600	0.341
Other Bituminous Coal	94 600	0.341
Sub-Bituminous Coal	96 100	0.346
Lignite	101 000	0.364
Oil Shale and Tar Sands	107 000	0.385
Brown Coal Briquettes	97 500	0.351
Patent Fuel	97 500	0.351
Coke oven coke and lignite Coke	107 000	0.385
Gas Coke	107 000	0.385
Coal Tar	80 700	0.291
Gas Works Gas	44 400	0.160
Coke Oven Gas	44 400	0.160
Blast Furnace Gas	260 000	0.936
Oxygen Steel Furnace Gas	182 000	0.655
Natural Gas	56 100	0.202
Municipal Wastes (non-biomass fraction)	91 700	0.330
Industrial Wastes	143 000	0.515
Waste Oil	73 300	0.264
Peat	106 000	0.382

ANNEX II
SEAT template tables for baseline emission inventory

Baseline emission inventory

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

2. **Emission factors**
   Please tick the corresponding box:
   ☐ Standard emission factors in the line with the IPCC principles
   ☐ LAC (Life Cycle Assessment) factors

   Emission reporting unit
   Please tick the corresponding box:
   ☐ CO_2 emissions
   ☐ CO_2 equivalent emissions

3. **Key results of the Baseline Emission Inventory**
   ☐ Compulsory fields

A. FINAL ENERGY CONSUMPTION (MWh)

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

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

B. CO_2 OR CO_2 EQUIVALENT EMISSIONS (t)

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

C. LOCAL ELECTRICITY PRODUCTION AND CORRESPONDING CO_2 EMISSIONS

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

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

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

PART III
Technical measures for energy efficiency and renewable energy

Table of contents

Introduction

This chapter is intended to gather a collection of measures to improve energy efficiency and reduce the dependency on fossil fuels by using renewable energies. All measures collected in this chapter have been tested and successfully implemented by several cities in Europe.

As the reader will probably notice, each measure has not been described in depth, but rather a collection of references and links to more specific documents from reliable sources are given in each chapter.

The measures proposed in this document can be applied to the building, public services and the industry sectors. This represents around 65 % of the final energy consumption in the European Union [1]. Measures in the Transport sector, whose final energy consumption share is around 31 %, are described in Part I of these guidelines.

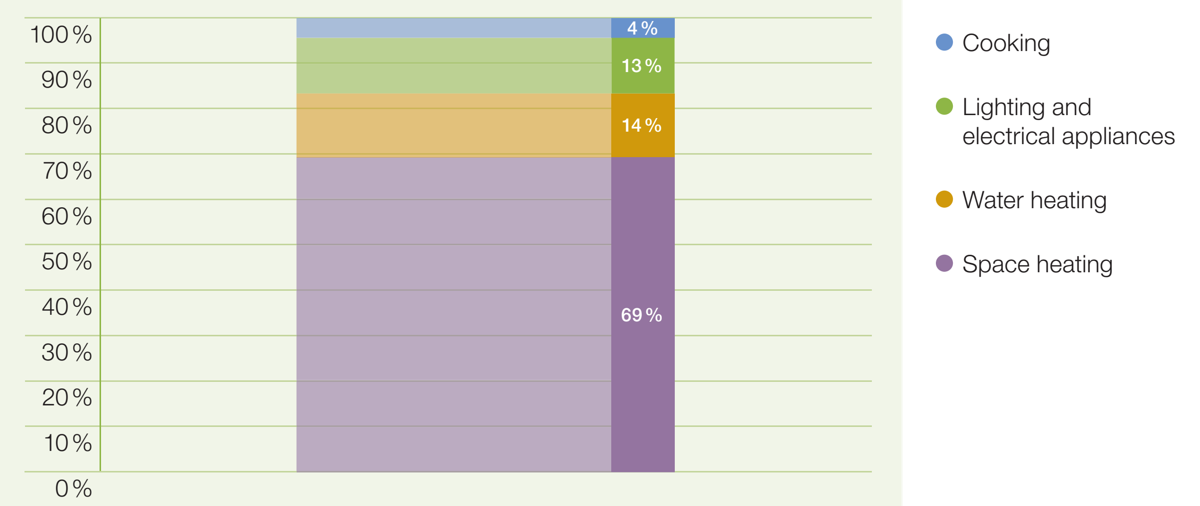
Some cities with a wide expertise in energy management will probably find these measures obvious. Even in this case, we think some measures, or the references provided in this guidebook, will help them to go beyond the objectives of the Covenant of Mayors.

(1) *EU Energy and Transport in Figures 2009. European Commission – DG TREN.*

1. Buildings (2)

In the European Union, the demand for energy in buildings represents 40 % of the whole final energy consumption. The high share of energy consumption, as well as the large potential for energy saving measures (3), implies that it should be a priority for the municipalities to reach the objectives.

HOUSEHOLD ENERGY CONSUMPTION IN EU-27 (2005)



Source: Odyssée database.

The demand for energy in buildings is linked to a significant number of parameters related to constructive design and the usage of the facilities. The variables on which it is convenient to undertake actions to reduce the energy consumption are:

- geometry of the building;
- insulation and functional design of the building;
- equipment, such as type of heaters, air conditioners and lighting;
- usage patterns;
- orientation of the building.

The Energy Performance of Buildings Directive – EPBD – (2002/91/EC) is a key regulatory instrument which is meant to boost the energy performance of the building sector. This Directive has recently undergone some changes after the recent EPBD recast. More information about the main elements of the recast can be found in Annex I.

1.1 Specific considerations related to different kinds of buildings

1.1.1 New buildings

New buildings will generally last 30-50 years before a major refurbishment is carried out. The choices made at the design stage will thus have crucial impact on the energy performance of the building for a very long period of time. This is why making sure new buildings are built according to highest energy efficiency standards is essential in order to reduce the energy consumption in the long term. It is therefore essential that the energy dimension is included as early as possible in the planning and design phases of new buildings.

The reduction of energy consumption in new buildings can be optimised with the use of information and communication technologies (ICT). 'Smart buildings' refer to more efficient buildings whose design, construction and operation is integrating ICT techniques like Building Management Systems (BMS) that run heating, cooling, ventilation or lighting systems according to the occupants' needs, or software that switches off all PCs and monitors after everyone has gone home. BMS can be used to collect data allowing the identification of additional opportunities for efficiency improvements.

(2) *A complete summary of EU legislation can be found on* ***http://europa.eu/legislation_summaries/energy/index_en.htm***

(3) *Further information in the document 'Analysis of Concerto Energy concepts and guidelines for a whole building approach' available on* ***http://www.ecocity-project.eu/PDF/D-2-3-1-1_Concerto_Energyconcepts_Final.pdf***

Note that even if energy efficiency has been incorporated at the start, a building's actual energy performance can be impaired if builders deviate from the plans or if occupants do not operate the BMS according to the plans or specifications. Assuming the building has been designed and built to specification, poor commissioning (ensuring that the building's systems function as specified), constant change of use and poor maintenance can significantly reduce the effectiveness of any BMS. Provide better training to building operators and information to users by simple devices such as visual smart meters or interfaces to influence behavioural change.

The Energy Services Companies' (ESCO) scheme to improve the energy efficiency performance may be applied to all types of buildings of this subchapter. This scheme is explained in Part I (How to Develop a Sustainable Energy Action Plan) financing chapter.

1.1.2 Existing buildings undergoing major refurbishments

When an existing building is subject to a major refurbishment, it is the ideal opportunity to improve its energy performance. In general between 1.5 % and 3 % of the building stock is renovated each year, so that if energy performance standards are applied to such refurbishments, in a few years the energy performance of the entire building stock shall improve accordingly.

This basic evidence has been translated into the Energy Performance of Buildings Directive and Member States have to set up minimum standards for buildings subject to major renovations. As for new buildings, the local authority could play a role to improve the energy efficiency of renovated buildings.

When considering large investments or refurbishments, it is recommended to make an energy audit in order to identify the best options, allowing the reduction of the energy consumption and preparation of an investment plan. Investments may be limited to a building component (replacement of an inefficient heating boiler) or may be related to the complete refurbishment of a building (including building envelope, windows …). It is important that the investments are planned in a proper manner (e.g. first reducing heat demand by dealing with the envelope and then placing an efficient heating system, otherwise the dimensioning of the heating system will be inappropriate, which results in unnecessary investment costs, reduced efficiency and greater energy consumption).

1.1.3 Public buildings

Public buildings are those owned, managed or controlled by the local, regional, national or European public administration.

The buildings owned, controlled or managed by the local authority itself are those on which the local authority has the greatest control. Therefore, it is expected that the local authority will adopt exemplary measures in its own buildings.

When planning new constructions or renovations, the local authority should set the highest energy standards possible and ensure that the energy dimension is integrated into the project. Energy performance requirements or criteria should be made mandatory in all tenders related to new constructions and renovations (see the public procurement policies point in Part I).

Different possibilities do exist, which can be combined:

- Refer to the global energy performance norms existing at national/regional level [4] and impose strong minimum global energy performance requirements (i.e. expressed in kWh/m^2/year, passive, zero energy, …). This leaves all the options open to the building designers to choose how they will reach the objectives (provided they know how to do it). In principle, architects and building designers should be familiar with those norms, as they apply to the entire national/regional territory.
- Impose a certain quantity of renewable energy production.
- Request an energy study that will help to minimise the energy consumption of the building considered by analysing all major options to reduce energy, as well as their costs and benefits (reduced energy bill, better comfort, …).
- Include the building's projected energy consumption as an award criterion in the tender. In this case, energy consumption should be calculated according to clear and well defined standards. A transparent system of points could be included in the tender: (ex: zero kWh/m^2 = 10 points; 100 kWh/m^2 and above = 0 points).
- Include the cost of energy consumption over the next 20-30 years in the cost criteria in the tender (do not consider the building construction cost alone). In this case, hypotheses related to future energy prices have to be set and energy consumption should be calculated according to clear and well defined standards.

(4) *In the context of the Energy Performance of Buildings Directive (2002/91/EC), all member States are obliged to set up a method to calculate/measure the energy performance of buildings and to set minimum standards.*

1.1.4 Historical buildings ([5])

The case of buildings that possess a historical (or cultural, aesthetical…) value is complex. Some of them may be protected by law, and options to improve energy efficiency may be quite limited. Each municipality has to establish an adequate balance between the protection of its built heritage and the overall improvement of the energy performance of the building stock. No ideal solution exists, but a mixture of flexibility and creativity may help to find a proper compromise.

1.2 Improvement of the envelope

Space heating and cooling are responsible for almost 70 % ([6]) of the total final energy consumption in European buildings. Therefore effective key actions intended for reducing gains and losses will have a significant influence on the reduction of CO_2 emissions. The losses of energy through the envelope may be reduced through the implementation of the following measures:

Building Shape and Orientation

Building shape and orientation play an important role from the point of view of heating, cooling and lighting. An adequate orientation also reduces recourse to conventional air conditioning or heating.

As the energy consumption reduction due to the building's geometry may attain 15 %, the proportion between width, length and height, as well as its combination with the orientation ([7]) and proportion of glazed surfaces, should be studied in detail when new buildings are in development. As the energy consumption of heating and cooling systems or lighting will be linked to the amount of radiation collected by the building, the street's width is also a parameter to be analysed during the urban planning phase.

Glazing

A suitable choice of the building's glazing is essential as gains and losses of energy are four to five times higher than the rest of the surfaces. The choice of adequate glazing shall consider both the daylight provision and gaining or protecting from solar radiation penetration.

A typical thermal transmittance value of 4.7 W/(m^2•K) for single glazed windows can be reduced to 2.7 W/(m^2•K) (reduction of more than 40 % of energy consumption per m^2 of glazed surface due to heat transmission) when they are substituted by double air-filled glazed windows. The transmittance can be improved with the use of *Low-Emissivity Argon filled double glazing up* to 1.1 W/(m^2•K), and up to 0.7 W/(m^2•K) for triple glazing. In addition the g-value ([8]) should also be taken into account to select the most suitable glazing or window system.

The replacement of glazing may be avoided by use of a low emissivity (low-e) film that can be applied manually on the window. This solution is less expensive that the glazing replacement, but also achieves lower energy performance and shorter lifetime.

Frames

Frame thermal transmittance affects the global window thermal transmittance proportionally to the rate of frame to glazed area of the window. As this rate is typically 15-35 % of the whole window's surface, gains and losses produced by this part are not negligible. In new types of insulated frames the heat losses has been reduced by help of integrated parts of the construction which breaks the cold bridges.

Due to the high thermal conductivity of metal materials, plastic and wooden frames have always better thermal performance, even if new metal frames designed with a thermal break may be a good cost-effective compromise.

Thermal transmittance of walls

Thermal transmittance of walls can be reduced by applying adequate insulation. This is generally achieved by placing an additional slab or cover of insulating material. Commonly-used types of insulation in building construction include: Fibreglass, Polyurethane foam, Polystyrene foam, Cellulose insulation and Rock wool.

MATERIAL	THERMAL CONDUCTIVITY (W/m•K)
Fibreglass	0.05
Polyurethane foam	0.024
Polystyrene foam	0.033
Cellulose insulation	0.04
Rock wool	0.04

A vapour barrier is often used in conjunction with insulation because the thermal gradient produced by the insulation may result in condensation which may damage the insulation and/or cause mould growth.

(5) *Further information in the document 'Energy and Historic Buildings: Recommendations for the improvement of the energy performance' elaborated by the Swiss Federal Office of Energy available on* ***http://www.bfe.admin.ch/energie/00588/00589/00644/index.html?lang=fr&msg-id=28129***

(6) *ODYSSEE database* ***www.odyssee-indicators.org***

(7) *A. Yezioro, Design guidelines for appropriate insolation of urban squares, Renewable Energy 31 (2006) 1011-1023.*

(8) g-value solar factor *is the fraction of incident solar energy which is transmitted to the interior of the building.* Low values *reduce solar gains.*

Shading Devices

Shading devices can be used to reduce cooling loads by reducing solar radiation penetration. Different types of shading devices are classified and presented below.

- **Movable devices** have the advantage that they can be controlled manually or through automation, adapting their function to the position of the sun and other environmental parameters.
- **Internal blinds** are very common window protection schemes. They are very easy to apply, but their main effect is to help control lighting level and uniformity. They are generally ineffective in reducing the summer heating load, as radiation is blocked once inside the room.
- **External blinds** offer the advantage of stopping solar radiation before penetrating into the room. For this reason it is an effective strategy in solar control.
- **Overhangs** are relatively widespread in hot climates. Their major advantage is that if correctly positioned, they admit direct radiation when the sun is low in winter, while blocking it in summer. The main limitation of their use is that they are appropriate only for south-facing windows.
- **Solar Photovoltaic Modules** building integration offer the possibility to avoid solar radiation penetration, while producing electricity from a renewable energy source.

Avoid Air infiltration

Air infiltration reduction may account up to 20 % of energy saving potential in heating dominated climates. Windows and doors are usually weak points which need to be well designed. Therefore an air tightness test is recommend is order to trace so as to avoid any uncontrolled airflow through the building. A well controlled ventilation system is necessary in order to ensure suitable internal air quality.

1.3 Other measures in buildings

Here are some simple measures that may reduce energy consumption:

- Behaviour: adequate behaviour (9) of building occupants may also generate significant savings. Information and motivation campaigns could be organised in order to get support of the occupants. In such cases, it is important that a good example is also given by the hierarchy and by the authorities in charge of the building management. Sharing the savings between occupants and the local authority could be a good way of motivating action.

EXAMPLE

In October 1994, it was decided that the schools in Hamburg were using too much energy. In an attempt to conserve some of the energy that was being wasted, the Fifty-Fifty Project was started in a number of the schools.

The key element of the Fifty-Fifty Project (10) is a system of financial incentives that enables the schools to share the saving in energy and water costs that they have achieved themselves. Fifty per cent of the money saved in energy conservation is returned to the school, where it can be reinvested into new energy saving devices, equipment, materials and extra curricular activities. For instance, the Blankenese School bought solar panels with the money they saved on energy consumption and installed them themselves.

- Building management: Great savings can be achieved by very simple actions related to proper operation and management of the technical installations: make sure heating is turned off during week-ends and holidays, make sure lighting is off after work, fine tuning of the heating/cooling operation, adequate set points for heating and cooling. For simple buildings, a technician or an energy manager could be appointed for such tasks. For complex buildings, the help of a specialised company may be necessary. Therefore, it may be necessary to renew or set up a new contract with a competent maintenance company with adequate requirements in terms of energy performance. Be aware that the way the contract is drafted could highly influence the motivation of such a company to effectively find out ways of reducing energy consumption.
- Monitoring: implement a daily/weekly/monthly monitoring system of energy consumption in main buildings/facilities, allowing the identification of abnormalities and taking immediate corrective action. Specific tools and software exist for this purpose.

(9) *Further information on behavioural changes is exposed in chapter 7.*

(10) *This scheme is being used in the Euronet 50-50 (supported by Intelligent Energy Europe) project in development from May 2009 to May 2012.* ***http://www.euronet50-50.eu/index.php/***

- The adaptation and regulation of the technical installations to the current uses and owner's requirement (bring equipment to its proper operational state, improve indoor air quality, increase equipment lifespan, improve maintenance operations…) is called *Retro-commissioning* ([11]). Small investments related to the control and regulation of the technical installations may generate great savings: presence detection or timer for lighting or ventilation, thermostatic valves for radiators, simple but efficient regulation system for heating, cooling and ventilation, etc. …
- Maintenance: good maintenance of the HVAC systems may also reduce their energy consumption with little cost.
- Locations with winter climates are especially suitable to incorporating passive solar heating strategies that will reduce the heating loads. In contrast, buildings located in summer climates will require active protection against solar radiation in order to minimise cooling loads. The specific site behaviour of wind should be studied so that natural ventilation strategies are incorporated into the building design.
- The heat gains from building occupants, lights, and electrical equipment are directly linked to the location, and the type and intensity of the activity to be developed, among others. Therefore, during the early planning of the project, the heat gains anticipated from these sources should be quantified for the various spaces to which they apply. In some cases, such as in storage buildings and other areas with relatively few occupants and limited electrical equipment, these heat gains will be minor. In other instances, such as office buildings or restaurants, the presence of intensive and enduring internal heat gains may be a determining factor in HVAC (Heating, Ventilation and Air Conditioning) systems design. These systems will play an important role in winter for dimensioning the heat installations and in summer for air conditioning. The recovery of heat in this type of buildings is highly recommended as an energy-efficient measure.
- When estimating a building's lighting needs, various spaces shall be considered separately, both quantitatively and qualitatively. Depending on the type of work developed, the frequency of use and the physical conditions of such space, the lighting installations will require different designs. Very efficient electrical lighting systems, use of natural lighting or integrated occupancy sensors and other controls are frequently used tools for the design of low consumption lighting systems. The performance indicators of energy-efficient bulbs are indicated afterwards in this document.
- Hours of Operation are also an aspect to consider. The most energy-intensive building types are those in continuous use, such as hospitals. In these buildings, the balance of heating and heat removal (cooling) may be altered dramatically from that of an office building with typical working hours. For example, the around-the-clock generation of heat by lights, people, and equipment will greatly reduce the amount of heating energy used and may even warrant a change in the heating system. Intensive building use also increases the need for well-controlled, high-efficiency lighting systems. Hours of use can also enhance the cost effectiveness of low-energy design strategies. In contrast, buildings scheduled for operations during abbreviated hours, should be designed with limited use clearly in mind.

Most of these measures, along with renewable energy production, are frequently implemented in low energy buildings (Examples: Building of WWF in Zeist or the Dutch Ministry of Finance building in The Hague). The energy-saving potential for this type of building is in the range 60-70 %.

(11) *Book:* Energy Efficiency Guide for Existing Commercial Buildings: The Business Case for Building Owners and Managers *published by ASHRAE.*

2. Lighting [12]

2.1 Domestic and professional buildings lighting

Depending on the initial situation of the installation, the most cost-efficient and energy consumption solution may be different for a direct substitution of lamps and a new installation. In the former, initial luminaires will be maintained and only the lamps will be changed. In the latter, designers must consider the type of application. As a side-effect of the energy saving in lighting, designers should take into account the reduction of cooling needs due to the decrease of heat emitted by bulbs.

Direct substitution

INITIAL LAMP	LUMINOUS EFFICIENCY [13]	RECOMMENDED LAMP	LUMINOUS EFFICIENCY
Incandescent lamps [14]	11-19 lm/W	Compact fluorescent lamp (CFL)	30-65 lm/W
		LED	35-80 lm/W
		Incandescent Halogen lamp	15-30 lm/W

Example: calculate the amount of electricity saved by replacing a 60W incandescent lamp whose luminous flux is 900 Lumen by a CFL, LED or incandescent. Technical characteristics are supposed to be average values of the typical ones collected in the table above. The luminance distribution diagram of each lamp is supposed to be suitable in all cases of the application studied.

	INCANDESCENT LAMPS	INCANDESCENT HALOGEN LAMP	CFL	LED
Luminous efficiency	15	22.5	47.5	57.5
Luminous flux (lm)	900	900	900	900
Power (W) = Energy consumption per hour (kWh)	60	40	18.9	15.6
Energy saved (%)	-	-33.3 %	-68.5 %	-74 %

(12) *The Greenlight project's webpage contains wider information about lighting* **http://www.eu-greenlight.org/index.htm** *Further information on lighting technologies and policies in OECD countries can be found in the document 'Lights Labour's Lost: Policies for Energy-Efficient Lighting'. Can be downloaded from* **www.iea.org/textbase/nppdf/free/2006/light2006.pdf**

(13) *Only the luminous efficiency has been included as this is the parameter that allows an evaluation of the energy efficiency of the lamp. However, this parameter is not the only one to be taken into account to choose a lamp. Other characteristics like the Colour Temperature, the chromatic rendering index, the power or the type of luminaire will be essential to decide the more suitable lamp.*

(14) *As part of the implementation process of the Directive 2005/32/EC on Ecodesign of Energy Using Products, on 18 March 2008, the Commission adopted the regulation 244/2009 on non-directional household lamps which would replace inefficient incandescent bulbs by more efficient alternatives between 2009 and 2012. From September 2009, lamps equivalent in light output to 100W transparent conventional incandescent bulbs and above will have to be at least class C (improved incandescent bulbs with halogen technology instead of conventional incandescent bulbs). By the end of 2012, the other wattage levels will follow and will also have to reach at least class C. The most commonly used bulbs, the 60W will remain available until September 2011 and 40 and 25W bulbs until September 2012.*

New Lighting Installation

CRI (15) REQUIRED	RECOMMENDED LAMP	LUMINOUS EFFICIENCY
Very important 90-100	26 mm-diameter (T8) linear fluorescent lamp	77-100 lm/W
Very important 90-100 e.g: Art Galleries, precision works	Compact fluorescent lamp (CFL)	45-87 lm/W
	Very-low voltage tungsten halogen lamp	12-22 lm/W
	LED	35-80 lm/W
Important 80-89 e.g: Offices, schools…	26 mm-diameter (T8) linear fluorescent lamp	77-100 lm/W
	Compact fluorescent lamp (CFL)	45-87 lm/W
	Fitting-based induction lamp	71 lm/W
	Metal halide lamps	65-120 lm/W
	'White sodium' high pressure sodium lamp	57-76 lm/W
Secondary 60-79 e.g: workshops…	26 mm-diameter (T8) linear fluorescent lamp	77-100 lm/W
	Metal halide lamps	65-120 lm/W
	Standard high pressure sodium lamp	65-150 lm/W

CFL (Compact Fluorescent Lamps) have attracted great interest in households as they can easily be adapted to the existing installation. Due to their Mercury contents, this kind of lamp requires well-planned recycling management.

Lighting controls are devices that regulate the operation of the lighting system in response to an external signal (manual contact, occupancy, clock, light level). Energy-efficient control systems include:

- localised manual switch;
- occupancy linking control;
- time scheduling control;
- day lighting responsive control (16).

Appropriate lighting controls can yield substantial cost-effective savings in energy used for lighting. Lighting energy consumption in offices can typically be reduced by 30 % to 50 %. Simple payback (17) can often be achieved in 2-3 years.

2.2 Infrastructure lighting

2.2.1 LED (18) Traffic Lights

The replacement of incandescent halogen bulb traffic lights by more energy-efficient and durable LED yields a significant traffic light energy consumption reduction. Compact LED packages are available on the market so that the replacement of incandescent traffic balls can easily be done by the LED one. A LED array is composed by many LED unities. The main advantages of these traffic lights are:

1. The light emitted is brighter than the incandescent lights, making them more visible in adverse conditions.
2. A LED's lifespan is 100 000 hours, which makes 10 times more than incandescent bulbs that will reduce maintenance costs.
3. The energy consumption reduction is higher than 50 % with respect to incandescent bulbs.

(15) *Colour Rendering Index (CRI): ranging from 0 to 100, it indicates how perceived colours match actual colours. The higher the colour rendering index, the less colour shift or distortion occurs.*

(16) *Further information in the book 'Daylight in Buildings' published by the International Energy Agency Task 21 Daylight in Buildings. Available on* ***http://www.iea-shc.org/task21/source_book.html***
Determination of the energy saving by daylight responsive lighting control systems with an example from Istanbul. S. Onaygil. Building and Environment 38 (2003) 973-977.

(17) *Besides the payback time, the Internal Interest Rate (IRR) of the investment should also be taken into account.*

(18) *LED – Light Emission Diode.*

2.2.2 Public lighting [19]

Energy efficiency in public lighting presents a high energy-efficiency potential through the substitution of old lamps by more efficient ones, such as low pressure, high pressure lamps or LED. Here are some values of energy efficiency.

Direct substitution

INITIAL LAMP	LUMINOUS EFFICIENCY	RECOMMENDED LAMP	LUMINOUS EFFICIENCY
High pressure mercury lamps	32-60 lm/W	Standard high pressure sodium lamp	65-150 lm/W
		Metal Halide Lamp	62-120 lm/W
		LED	65-100 lm/W

New Lighting Installation

CRI REQUIRED	RECOMMENDED LAMP	LUMINOUS EFFICIENCY
Less than 60	Low pressure sodium lamp	100-200 lm/W
	Standard high pressure sodium	65-150 lm/W
More than 60	LED	65-100 lm/W

Changing lamps is the most effective way to reduce energy consumption. However, some improvements, such as the use of more efficient ballast or adequate control techniques, are also suitable to avoid the excess of electricity consumption.

In the choice of the most suitable technology, luminous efficiency, as well as other parameters such as CRI, duration, regulation or Life Cycle, must be included in the set or design parameters. For instance, when in a public-lighting project a high CRI is required, the use of LED technology is recommended. This technology is a suitable solution to reach a well-balanced equilibrium CRI versus Luminous efficiency. If CRI is not essential for a given installation, other technologies may be more appropriate.

Arc discharge lamps, such as fluorescent and HID (High Intensity Discharge) sources, require a device to provide the proper voltage to establish the arc and regulating the electric current once the arc is struck. **Ballasts** also compensate voltage variation in the electrical supply. Since the electronic ballast doesn't use coils and electromagnetic fields, it can work more efficiently than a magnetic one. These devices allow a **better power and light intensity control** on the lamps. The energy consumption reduction caused by electronic ballasts has been estimated around 7 % [20]. In addition, LED technology not only reduces the energy consumption, but also allows an accurate regulation depending on the needs.

Electronic photo-switches can also reduce the electricity consumption in public lighting by reducing night burning hours (turning on later and turning off earlier).

A **Telemanagement system** enables the lighting system to automatically react to external parameters like traffic density, remaining daylight level, road constructions, accidents or weather circumstances. Even if a Telemanagement system doesn't reduce the energy consumption in lighting by itself, it can reduce traffic congestion or detect abnormalities. Telemanagement systems can be used to monitor failed lamps and report their location. Maintenance expenses can be reduced by considering the remaining life of nearby lamps that might be replaced during the same service call. Finally, data collected by the Telemanagement system that tracks the hours of illumination for each lamp can be used to claim warranty replacement, establish unbiased products and supplier selection criteria, and validate energy bills.

(19) *Further information available at* ***www.eu-greenlight.org and www.e-streetlight.com*** *(European project supported by Intelligent Energy Europe).*

(20) *E-street project* ***www.e-streetlight.com****. Supported by Intelligent Energy Europe.*

3. Heating [21]/cooling [22] and electricity production

This chapter sets out some energy-efficient measures for the production of heat, cold or electricity. Further information is available in the GreenBuilding programme webpage **www.eu-greenbuilding.org**

Note that when significant renovation works are foreseen, it is important to plan the measures in a proper sequence, e.g. *first* reduce heating/cooling/electricity needs by means of thermal insulation, shading devices, daylight, efficient lighting, etc. , and *then* consider the most efficient way to produce the remaining heat/cold/electricity by means of properly dimensioned installations.

3.1 Solar thermal installations [23]

Solar thermal technology brings a significant CO_2 emission reduction as it entirely substitutes fossil fuels. Solar collectors can be used for domestic and commercial hot water, heating spaces, industrial heat processes and solar cooling. The amount of energy produced by a solar thermal installation will vary depending on its location. This option may be taken into account in most of the European countries due to the increase of fossil fuels and decrease of solar collector prices.

The performance of solar thermal collectors represents the percentage of solar radiation converted to useful heat. It can be calculated when the input and output average temperature ($T_{average}$), environment temperature ($T_{environment}$) and solar irradiation (I) are known. Coefficients a_0 and a_1 depend on the design and are determined by authorised laboratories. I is the solar irradiation at a given moment.

$$n = a_0 - a_1 \frac{(T_{average} - T_{environment})}{I}$$

At a certain environmental temperature, the lesser the average input/output temperature is, the higher the whole performance will be. This is the case of low temperature installations (swimming pools) or low solar fraction (30-40 %) installations. In these cases the energy production per square metre (kWh/m^2) is so high that the simple payback of the solar installation is significantly reduced. Designers must consider that for a given energy consumption, the energy yields per square metre (kWh/m^2) will decrease as the total surface of the collector is increased. As in this case the cost of the whole installation will go up, it will be required to estimate the most cost-efficient size.

Considering the positive effect on the profitability of low solar fraction and the effect of economies of scale in large plants, these installations might be implemented using an ESCO scheme [24] in swimming pools, district heating and cooling, laundries, car washing and industries [25], among others.

The JRC has created a database that contains solar radiation data all over Europe. These data may be used by the designers for the evaluation of the necessary collector's surface by using, for example, an f-chart or direct simulation model. The database is focused on the calculation of photovoltaic installations, but data linked to the solar radiation may also be used for solar thermal installations designs. **http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php#**

3.2 Biomass boilers [26]

Sustainably harvested biomass is considered a renewable resource. However, while the carbon stored in the biomass itself may be CO_2 neutral [27], the cropping and harvesting (fertilisers, tractors, pesticide production) and processing to the final fuel may consume an important amount of energy and result in considerable CO_2 releases, as well as N_2O emissions from the field. Therefore, it is imperative to take adequate measures to make sure that biomass, used as a source of energy, is harvested in a sustainable manner (Directive 2009/28/EC Art 17, Sustainability Criteria for Biofuels and Bioliquids).

As explained in Part II of this guidebook, biomass is considered as a renewable and carbon-neutral energy source when the territorial approach is used for the CO_2 accounting.

(21) *Technical and behavioural information about boiler and installations are available on the Ecoboiler webpage.* ***http://www.ecoboiler.org/*** *This project has been funded by the European Commission – DG TREN. Technical and economical information about the implementation of solar thermal energy in swimming pools can be found in* ***www.solpool.info*** *which is supported by Intelligent Energy Europe.*

(22) *Further information on renewable heating and cooling on the European Technology Platform on Renewable Heating & Cooling webpage* ***www.rhc-platform.org***

(23) *Further information on solar thermal strategies on European Solar Thermal Technology Platform webpage* ***www.esttp.org***

(24) *Further information on Solar Thermal ESCOs is available at* ***www.stescos.org*** *– Project supported by Intelligent Energy Europe.*

(25) *Minimizing greenhouse gas emissions through the application of solar thermal energy in industrial processes – Hans Schnitzer, Christoph Brunner, Gernot Gwehenberger – Journal of Cleaner Production 15 (2007) 1271-1286.*

(26) *Further information on Biomass Installation is available at* ***www.biohousing.eu.com*** *– Project supported by Intelligent Energy Europe. The project's webpage offer a tool aimed at comparing costs of biomass and other fossil fuels. Moreover a catalogue of product for the use of biomass is also available. See also* ***www.aebiom.org***

(27) *In some cases CO_2 emissions may be replaced by GHG (Greenhouse Gases) emissions which is a more general term that refer not only to CO_2 but also to other gases with greenhouse effect.*

If the LCA ([28]) approach is chosen for the CO_2 emissions inventory, the emission factor for biomass will be higher than zero (differences between both methodologies in the case of biomass may be very important). Following the criteria established in the 2009/28/EC Directive on the promotion of the use of energy from renewable energy sources, biofuels will be considered as renewable if they fulfil specific sustainability criteria, which are set out in paragraphs 2 to 6 of Article 17 of the Directive.

Biomass boilers ([29]) are available on the market from 2 kW onwards. During a building refurbishment, fossil fuel boilers can be replaced by biomass boilers. The heat distribution installation and radiators are the ones used with the previous installation. A biomass storage room must be foreseen for the accumulation of pellets or wood chips. The performance of the combustion and the quality of the biomass are critical in order to avoid the emissions of particles to the atmosphere. Biomass boilers must be adapted to the type of biomass to be used.

3.3 Condensing boilers

The advantage of condensing boilers is that they are able to extract more energy from the combustion gases by condensing the water vapour produced during the combustion. A condensing boiler's fuel efficiency can be 12 % higher than that of a conventional boiler'. Condensation of the water vapour occurs when the temperature of the flue gas is reduced below the dew-point. For this to occur, the water temperature of the flue gas exchanger must be below 60 °C. As the condensation process depends on the returning water temperature, the designer should pay attention to this parameter so as to ensure it is low enough when it arrives to the exchanger. In case this requirement is not fulfilled, condensing boilers lose their advantages over other types of boilers.

When a conventional boiler is replaced by a condensing one, the rest of the heat distribution installation will not undergo major changes. Regarding the price of a condensing boiler, it is not significantly different from that of a conventional one.

3.4 Heat pumps and geothermal heat pumps ([30])

The use of heat pumps for heating and cooling is very well known. This way of producing heat or cold is particularly efficient.

Heat pumps are composed by two heat exchangers. In winter the heat exchanger located outdoors will absorb heat from the environmental air. The heat is transferred to the indoor exchanger to heat the building. In summer the role of each part is inverted.

As the outdoor unit must transfer heat in summer and absorb it in winter, the performance of the heat pump is highly influenced by the outdoor temperature. In winter/summer, the lower/higher this temperature is the more the heat pump's performance will decrease.

As the performance of heat pumps depends on both the indoor and the outdoor temperatures, it is convenient to reduce the difference between them as much as possible to increase the performance. Accordingly, in winter season an increase of temperature in the heat pump's cold side (outside) will improve the performance of the cycle. The same reasoning can easily be applied to the hot (outside) part in summer.

A possible solution to increase typical performance value is to use the ground or ground water as a source of heat in winter and of cold in summer. This can be done due to the fact that, at a certain depth, the ground temperature doesn't suffer significant fluctuations throughout the year. Generally speaking COP or EER ([31]) values can be improved by 50 %. Seasonal Performance Indicators (SPF ([32])) can be improved by 25 % ([33]) with respect to an air-water cycle. This leads to the conclusion that the electricity consumption in this case could be 25 % lower than the case of an air-water conventional heat pump. This reduction is higher than the case of an air-air cycle for which general data is not available.

(28) *LCA – Life Cycle Analysis.*

(29) *Further information about biomass fuels, storage and maintenance is available in the GreenBuilding programme webpage* ***www.eu-greenbuilding.org***

(30) *Further information available at* ***www.egec.org*** */* ***www.groundreach.eu*** *project supported by Intelligent Energy Europe / Heating and Cooling With a Heat Pump, Natural Resources Canada's Office of Energy Efficiency* ***www.oee.nrcan-rncan.gc.ca*** */* ***www.groundmed.eu*** *Seventh Research Framework Programme /* ***www.groundhit.eu*** *Sixth Research Framework Programme.*

(31) *COP (Coefficient of Performance) and EER (Energy Efficiency Ratio) are both heat pumps performance indicators.*

(32) *Defined in 3.8.*

(33) *Further information about calculation principles for renewable heat is available on the webpage of the ThERRA project* ***www.therra.info*** *– project supported by Intelligent Energy Europe – Information about training on the Geotrainet project webpage* ***www.geotrainet.eu*** *and IGEIA project* ***www.saunier-associes.com*** *supported by Intelligent Energy Europe.*

The heat transfer process between the Ground Heat Exchanger (GHE) and surrounding soil is dependent on local conditions such as the local climatic and hydrogeological conditions, the thermal properties of soil, soil temperature distribution, GHE features, depth, diameter and spacing of borehole, shank spacing, materials and diameter of the pipe, fluid type, temperature, velocity inside the pipe, thermal conductivity of backfill and finally the operation conditions such as the cooling and heating load and heat pump system control strategy.

Geothermal energy systems can be used with forced-air and hydronic heating systems. They can also be designed and installed to provide 'passive' heating and/or cooling. Passive heating and/or cooling systems provide cooling by pumping cool/hot water or antifreeze through the system without using the heat pump to assist the process.

Example:
Let us compare the primary energy saved with a conventional boiler, a condensing one, a heat pump and a Ground Heat Exchanger Heat Pump to produce 1 kWh of final energy.

TECHNOLOGY	FINAL ENERGY KWH	PERFORMANCE RATIO (34)	COP (35)	PRIMARY ENERGY FACTOR (36)	PRIMARY ENERGY (kWh)	PRIMARY ENERGY SAVED (%) (37)
Conventional Boiler (natural gas)	1	92 %	-	1	1.08	-
Condensing Boiler (natural gas)	1	108 %	-	1	0.92	**-14.8 %**
Heat Pump (electricity)	1	-	3	0.25 – 0.5	1.32 – 0.66	**+22 % to -38.8 %**
Ground Heat Exchanger Heat Pump (electricity)	1	-	5	0.25 – 0.5	0.8 – 0.4	**-25.9 % to -62.9 %**

3.5 CHP – Combined heat and power generation (38)

A cogeneration plant, also known as Combined Heat and Power (39) (CHP) plant, is an energy production installation that simultaneously generates thermal energy and electrical and/or mechanical energy from a single input of fuel.

As CHP plants are usually very close to the electricity consumer, they avoid network losses during the transport and distribution to end-users. These plants are a part of the distributed generation scheme in which several small power plants are producing energy being consumed nearby.

The cogenerated heat may also be used to produce cold through absorption refrigeration chillers Other types of thermally driven chillers are commercially available although their market presence is more limited than that of absorption chillers. The plants that simultaneously produce electricity, heat and cooling are known as trigeneration (40) plants. A part of the trigeneration units offer significant relief to electricity networks during the hot summer months. Cooling loads are transferred from electricity to gas networks. This increases the stability of the electricity networks especially in Southern European countries that undergo significant peaks in summer (41).

(34) *Based on the Lower Heating Value (LHV).*

(35) *This ratio is a function of the outdoor or temperature or the ground temperature.*

(36) *The primary energy factor is 1 for a fossil fuel and 0.25-0.5 for electricity. This range represents the electricity generated in a coal cycle with a performance of 30 % or a combined cycle with a performance of 60 %. The transport and distribution losses have been estimated around 15 %.*

(37) *Seasonal effects are not considered in this calculation. (-) is saving and (+) is wasting in comparison with the first case of the table.*

(38) *The European GreenBuilding Programme* ***http://re.jrc.ec.europa.eu/energyefficiency/index.htm*** */* ***www.cogen-challenge.org***

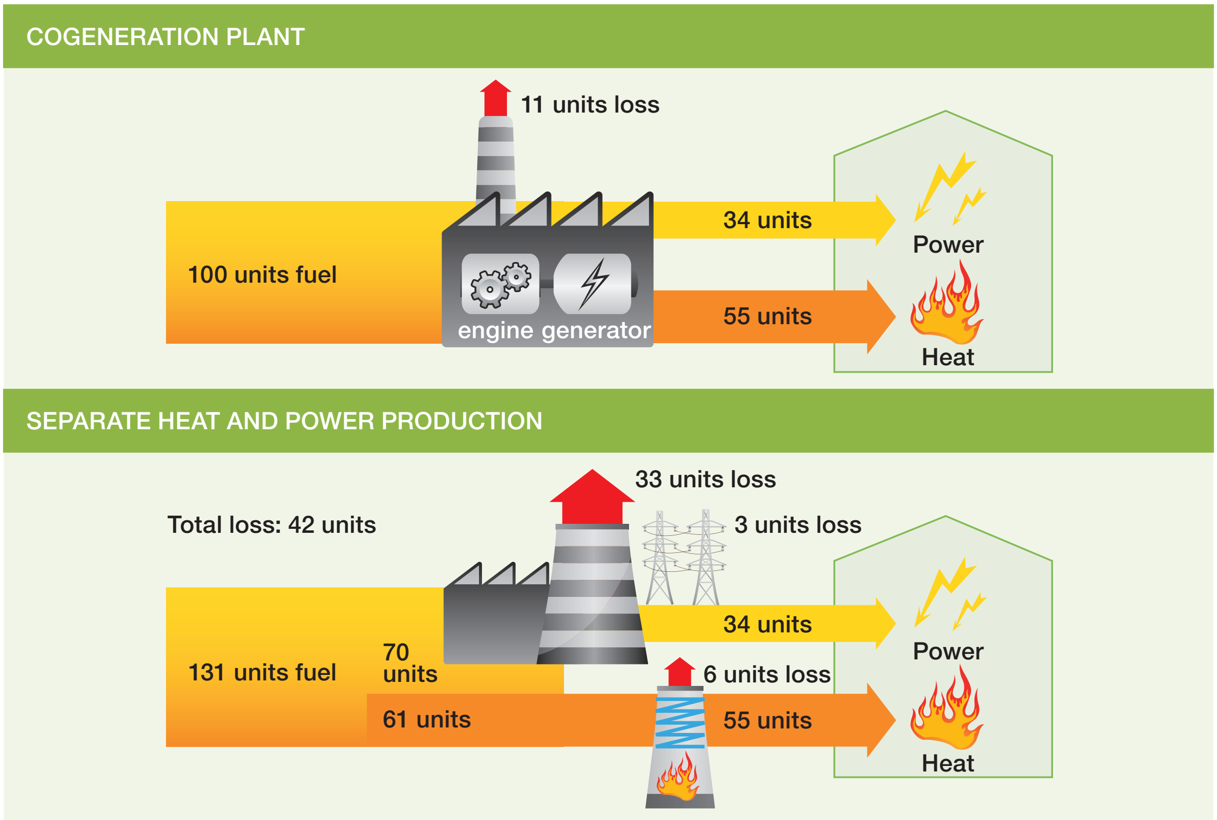
(39) *DIRECTIVE 2004/8/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC.*

(40) ***www.eu-summerheat.net*** *project supported by Intelligent Energy Europe –* ***www.polygeneration.org*** *and* ***www.polysmart.org*** *are financed by the 6th Framework Programme of the European Union.*

(41) *Project CAMELIA Concerted Action Multigeneration Energy systems with Locally Integrated Applications* ***www.cnam.fr/hebergement/camelia/***

CHP leads to a reduction of fuel consumption by approximately 10 - 25 % compared with conventional electricity and separate heat production. The reduction of atmospheric pollution follows the same proportion.

TECHNOLOGY	POWER RANGE	ELECTRIC EFFICIENCY	GLOBAL EFFICIENCY
Gas turbine with heat recovery	500 kWe – >100 MWe	32 – 45 %	65 – 90 %
Reciprocating engine	20 kWe – 15 MWe	32 – 45 %	65 – 90 %
Micro gas turbines	30 – 250 kWe	25 – 32 %	75 – 85 %
Stirling engines	1 – 100 kWe	12 – 20 %	60 – 80 %
Fuel Cells	1 kWe – 1 MWe	30 – 65 %	80 – 90 %



Source: COGEN ([42]) Challenge Project – Supported by Intelligent Energy Europe.

CHP may be based on a reciprocating engine, a fuel cell or a steam or gas turbine. The electricity produced in the process is immediately consumed by the users of the grid and the heat generated might be used in industrial processes, space heating or in a chiller for the production of cold water.

Small-scale heat and power installation can play an important role in the energy efficiency improvement in buildings such as hotels, swimming pools, hospitals and multi residential dwellings, among others. As compact systems, they are extremely simple to install. The system might be based on engines or gas micro-turbines.

The dimensioning of the micro-cogeneration installation will depend on the heat loads. Combined electrical and thermal efficiency varies between 80 and well above 90 %. Similar to electrical efficiency, capital costs per kW_{el} depend on the electrical capacity of the system. A significant decline of capital costs, due to scale effects, can be observed particularly as systems reach the 10 kW_{el} range ([43]). CO_2 emissions of micro cogeneration systems are in the range 300-400 g/kWh_e.

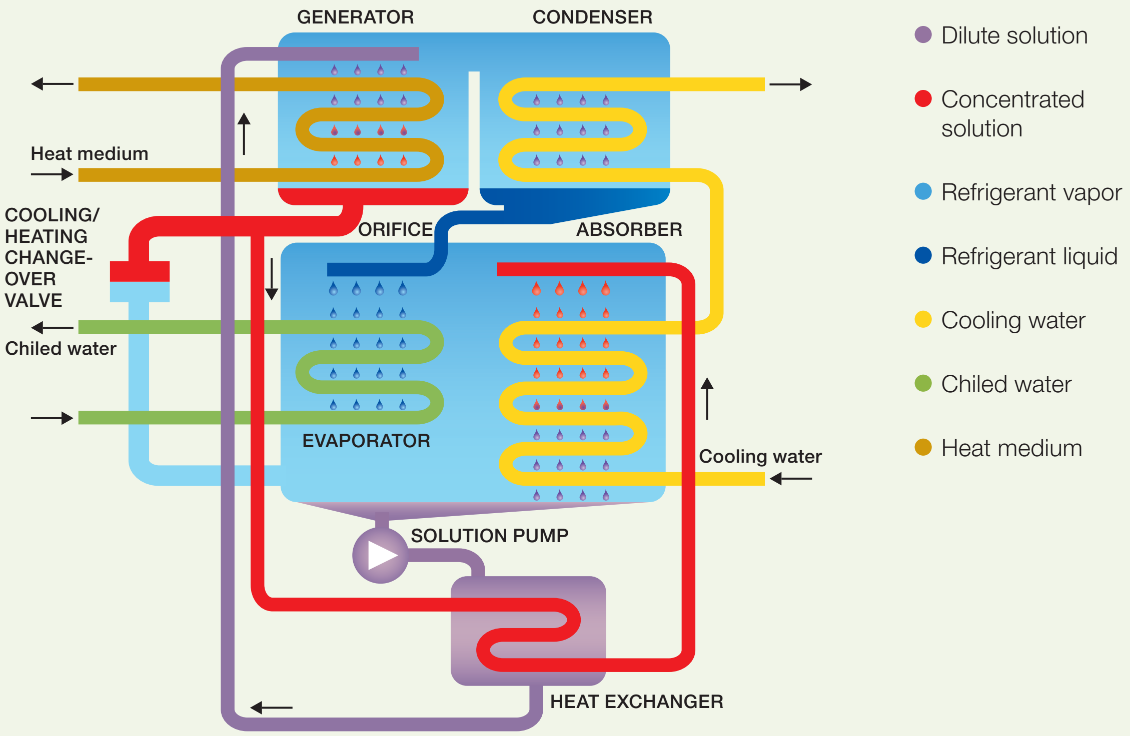
(42) ***www.cogen-challenge.org*** *project supported by Intelligent Energy Europe.*

(43) *Micro cogeneration: towards decentralized energy systems. Martin Pehnt, Martin Cames, Corinna Fischer, Barbara Praetorius, Lambert Schneider, Katja Schumacher, Jan-Peter Voss – Ed. Springer.*

3.6 The refrigerating absorption cycle

The main advantages of absorption chillers are that they use natural refrigerants, have a low decrease of performance at part load, nearly negligible electricity consumption, low noise and vibration and very few moving parts.

FIGURE 1: REFRIGERATION ABSORPTION CYCLE



In the absorption chiller the refrigerant is not compressed mechanically like in conventional chillers. In a closed circuit, the liquid refrigerant that turns into vapour, due to the heat removed from the circuit to be chilled, producing chilled water, is absorbed by a concentrated absorbent solution. The resulting dilute solution is pumped into the generator onto a higher pressure, where the refrigerant is boiled off using a heat source. The refrigerant vapour, which flows to the condenser, and the absorbent get separated. In the condenser, refrigerant vapour is condensed on the surface of the cooling coil. Subsequently the refrigerant liquid passes through an orifice into the evaporator, while the reconcentrated solution returns to the absorber to complete the cycle. Electric energy is only needed for pumping the dilute solution and for control units.

A simple effect absorption chiller will need at least an 80°C energy source and an energy sink under 30-35°C. Therefore the energy can be provided by solar thermal collectors ([44]) or residual heat. In order to maintain low electricity consumption, the sink of energy should be a cooling water tower, geothermal exchanger, a lake, river… A double-effect absorption chiller, that must be fed by a 160°C energy source, may be coupled to a cogeneration system (trigeneration) that will be able to offer this level of temperature. In both cases the electricity consumption is almost negligible.

Absorption cycle devices that are available from 5-10 kW to hundreds of kW can also be used to produce cold for industries ([45]), buildings and the tertiary sector. For this reason, simple effect absorption cycle can easily be installed in households. In this case the heat can be obtained from a renewable energy source like solar thermal collectors or biomass. The heat dissipation of the condensing circuit has to be foreseen during the designing phase (this is an essential aspect of this type of installation). There are some typical possibilities to dissipate the heat, like using it for sanitary water, to use a lake or swimming pool or a ground heat exchanger (GHE).

(44) *www.iea-shc.org/task38/index.html*

(45) *POSHIP The Potential of Solar Heat in Industrial Processes www.aiguasol.com/poship.htm*

3.7 Photovoltaic electricity generation (PV)

Photovoltaic modules permit the conversion of solar radiation to electricity by using solar cells. The electricity produced has to be converted from direct current to alternating current by means of an electronic inverter. As the primary energy used is the solar radiation, this technology does not emit CO_2 to the atmosphere.

According to an International Energy Agency study (46) the PV solar collectors´ lifespan is estimated at around 30 years. During the lifetime of the modules the potential for CO_2 mitigation in Europe can reach in the specific case of Greece 30.7 tCO_2/kWp in roof-top installations and 18.6 tCO_2/kWp in façade installations. If we focus on the life-cycle period of the module, the energy return factor (47) (ERF) varies from 8.0 to 15.5 for roof-top mounted PV systems and from 5.5 to 9.2 for PV façade installations.

The integration of solar modules has been improved by manufacturers over the past few years. Information about PV building integration can be found in the document 'Building integrated photovoltaics. A new design opportunity for architects' in the EU PV Platform webpage **www.eupvplatform.org**

3.8 HVAC system indicators

The aim of this point is to stress the need to choose HVAC systems, not only according to their instantaneous performance, but also the yearly average.

HVAC systems are those devices aimed at heating, ventilating and producing air conditioning. Performance Ratio may basically be divided into 2 groups. The Energy Efficiency Ratio (EER) measures the amount of electricity required by an A/C unit to provide the desired cooling level in the 'standard' conditions. The higher the EER, the more energy efficient the unit will be. When the whole cooling period is considered, the ratio is called seasonal performance factor (SPF).

$$EER = \frac{P_{cooling}}{P_{electric}} \qquad SPF = \frac{E_{cooling}}{E_{electric}}$$

$P_{cooling}$: cooling power (kW)
$P_{electric}$: electrical power (kW)
$E_{cooling}$: cooling energy during a period (kWh)
$E_{electric}$: electricity consumption during a period (kWh)

The same calculation may be performed for the heating season and/or the whole year. EER is provided under specific environmental conditions by the manufacturer of the A/C unit. The EER depends however on the load and environmental conditions of the operation. This means that a certain unit will have different performances depending on the location and demand of the building. Due to frequent start/stop and losses, SPF will necessarily be lower than EER. This indicator can be improved by ensuring long-working periods and minimising start/stop switches.

3.9 Heat recovery in HVAC systems

A Heat Recovery Ventilator (HRV) consists of two separate systems. One collects and exhausts indoor air and the other heats outdoor air and distributes it throughout the home.

At the core of an HRV is the heat-transfer module. Both the exhaust and outdoor air streams pass through the module and the heat from the exhaust air is used to pre-heat the outdoor air stream. Only the heat is transferred, therefore the two air streams remain physically separate. Typically, an HRV is able to recover 70 to 80 percent of the heat from the exhaust air and transfer it to the incoming air. This dramatically reduces the energy needed to heat outdoor air to a comfortable temperature.

3.10 Building energy management systems (BEMS)

BEMS are generally applied to the control of systems such as heating, ventilation, and air-conditioning (HVAC). It uses software to control energy-consuming plant and equipment, and can monitor and report on the plant's performance. The performance of the BEMS is directly related to the amount of energy consumed in the buildings and the comfort of the building's occupants. BEMS are generally composed by:

- controllers, sensors (temperature, humidity, luminance, presence…) and actuators (valves, switches…) for different types of parameters;
- HVAC central system with local controllers for each area or room in the building (zoning) and central computer assisted control;
- central control management software for areas or rooms;
- monitoring through energy consumption measurement devices.

According to scientific experiences (49), the energy saving achieved after the installation of a BEMS can reach at least 10 % of the whole energy consumption.

(46) *'Compared assessment of selected environmental indicators of photovoltaic electricity in OECD countries' report of the International Energy Agency PVPS task 10.* ***www.iea-pvps-task10.org***

(47) *Energy Return Factor (ERF): ratio of the total energy input during the system life cycle and the yearly energy generation during system operation.*

(48) *Low-energy cooling and thermal comfort (ThermCo) project –* ***www.thermco.org****. Inspection and audit of an air conditioning facilities document* ***http://ieea.erba.hu/ieea/fileshow.jsp?att_id=3638&place=pa&url=http://AUDITACTrainingPackP_V.pdf&prid=1439*** *of the AUDITAC project. Both projects are supported by Intelligent Energy Europe.*

(49) *Intelligent building energy management system using rule sets. H. Doukas. Building and Environment 42 (2007) 3562-3569.*

4. District heating [50] and cooling [51] (DHC)

District heating and/or cooling consists in using a centralised plant to provide thermal energy for external customers. Energy may be supplied by fossil fuel or a biomass boiler, solar thermal collectors, a heat pump, cooling systems (thermally driven or compression chillers) or from a combined heat and power plant (CHP). A combination of the mentioned technologies is also possible and may even be advisable depending on the technologies, the fuel used and other technical issues.

Energy-efficiency characteristics´ advantages of DHC are based on high SPF (Seasonal Performance Factor) due to an intensive operation of the installation, introduction of highly efficient equipment, proper insulation of the distribution network, and on efficient operation and maintenance. As an example, the seasonal performance (defined as the total amount of supplied heat over the total primary energy consumption) can be improved from 0.615 for individual heat pumps to 0.849 for district heating heat pumps. Absorption chiller seasonal performance can be improved from 0.54 for an individual absorption chiller and boiler to 0.608 for the same type of installation in a district heating network [52]. As each installation is operating under different conditions, detailed engineering studies will be necessary to evaluate the percentage of distribution losses in the network and overall efficiency. In addition, the use of environmentally-friendly energy resources such as biomass or solar energy allows the emissions of CO_2 [53].

DHC open the possibility to better exploit existing production capacities (use of surplus heat not only from industries, but also from solar thermal installations used in winter for heating), reducing the need for new thermal (condensing) capacities.

From an investment perspective, the specific production capacity (€/kW) that has to be invested in it is radically reduced in a large-scale district cooling system compared to individual systems (one per household). The investment reduction is due to the simultaneous factor and avoided redundancy investments. Estimations from cities where district cooling has been introduced indicate up to 40 % reduction in total installed cooling capacity.

District Heating systems offer synergies between energy efficiency, renewable and CO_2 mitigation, as they can serve as hubs for surplus heat which otherwise would be wasted: for instance, from electricity production (CHP) or industrial processes in general.

District Cooling can make usage of alternatives to conventional electricity cooling from a compression chiller. The resources can be: natural cooling from deep sea, lakes, rivers or aquifers, conversion of surplus heat from industry, CHP, waste incineration with absorption chillers or residual cooling from re-gasification of LNG. District Cooling systems can greatly contribute to avoiding electricity peak loads during summer.

(50) *SOLARGE project database contain good examples of large solar district heating. Most of them are located in Denmark and Sweden.* ***http://www.solarge.org/index.php?id=2***

(51) *ECOHEATCOOL project* ***www.euroheat.org****. Supported by Intelligent Energy Europe / Danish Board for District Heating* ***www.dbdh.dk***

(52) *These data that reflect the real operation of 20 district heating networks in Japan have been extracted from the article: Verification of energy efficiency of district heating and cooling system by simulation considering design and operation parameters – Y. Shimoda et al. / Building and Environment 43 (2008) 569-577.*

(53) *Some data about CO_2 emissions from district heating are available on the EUROHEAT project webpage.*

5. Office appliances (54)

Energy savings in office appliances are possible through the selection of energy-efficient products.

Only an assessment of the systems and the needs can determine which measures are both applicable and profitable. This could be done by a qualified energy expert with IT experience. The assessment conclusions should include hints for procurement of the equipment, via purchase or leasing.

The definition of energy-efficiency measures in IT in the early planning stage can result in a significant reduction of loads for air conditioning and UPS, and thus, can optimise the efficiency for both investments and operation costs. Additionally the duplex printing and paper saving in general are important measures for saving energy for paper production, as well as reducing operation costs.

The following tables show the potentially significant energy savings measures which might be applicable to your IT landscape. In each table the measures are presented, beginning with those that have a large potential impact and are the easiest to implement.

Step 1: Selection of energy efficient product – Examples

DESCRIPTION OF MEASURE	SAVING POTENTIAL
Flat-screen monitors (LCD) replacing equivalent conventional monitors save energy	About 50 %
Centralised multi-function devices replacing separate single-function devices save energy, but only if the multi-function is used	Up to 50 %
Centralised printer (and multi-function devices) replacing personal printers save energy, when well dimensioned for the application	Up to 50 %

Step 2: Selection of energy-efficient devices in a defined product group – Examples

DESCRIPTION OF MEASURE	SAVING POTENTIAL
The specific appliance dimension for the realistic application is the most relevant factor for energy efficiency	Not quantified
Use of Energy-Star criteria as a minimum criterion for call for tender will prevent the purchase of inefficient devices	0 – 30 % compared to state of the art
Make sure that the power management is part of the specification in the call for tender and that it is configured by installation of the new appliances	Up to 30 %

Step 3: Check power management and user-specific saving potentials – Examples

DESCRIPTION OF MEASURE	SAVING POTENTIAL
The power management should be initiated in all devices	Up to 30 %
Screensavers do not save energy and thus, should be replaced by a quick start of standby/sleep mode	Up to 30 %
Use of a switchable multi-way connector can avoid power consumption in off-mode for a set of office equipment for night and absence	Up to 20 %
To switch off monitors and printers during breaks and meetings reduce energy consumption in stand-by mode	Up to 15 %

The label ENERGY STAR (55), available for energy-efficient office equipment, covers a wide range of products from simple scanners to complete desktop home computer systems. The requirements and specifications of a product to be labelled can be found at **www.eu-energystar.org**. A product-comparison tool is available that allows the user to select the most energy-efficient equipment. For instance, it can be seen that depending on the choice of monitor, the power consumption varies from 12W to 50W. In this case the energy consumption in 'on' mode is reduced by ~75 %.

(54) *The European GreenBuilding Programme* **http://re.jrc.ec.europa.eu/energyefficiency/index.htm**, **http://www.eu-energystar.org/** *and the Efficient Electrical End-Use Equipment International Energy Agency Programme* **www.iea-4e.org** *Information on Office Equipment procurement available on* **http://www.pro-ee.eu/**

(55) *Further information available at* **www.eu-energystar.org** *According to the Regulation (EC) 106/2008, central government authorities shall specify energy-efficiency requirements not less demanding than the Common Specifications for public supply contracts having a value equal to or greater than the thresholds laid down in Article 7 of the Directive 2004/18/EC.*

6. Biogas (56)

Biogas is a naturally occurring by-product of the decomposition of organic waste in sanitary landfills or from sewage and residual waters. It is produced during the degradation of the organic portion of waste.

Biogas essentially contains methane (CH_4), which is a highly combustible gas. Therefore, biogas is a valuable energy resource that can be used as in a gas turbine or a reciprocating engine, as a supplementary or primary fuel to increase the production of electric power, as a pipeline quality gas and vehicle fuel, or even as a supply of heat and carbon dioxide for greenhouses and various industrial processes. The most usual ways to obtain biogas are from landfills or from sewage and residual waters.

In addition, methane is also a greenhouse gas whose global warming is 21 times higher than carbon dioxide (CO_2). Therefore, biogas recovery is also a valid option to contribute to the reduction of greenhouse gas emissions (57).

6.1. Landfill biogas recovery (58)

Waste disposal in landfills (59) can generate environmental problems, such as water pollution, unpleasant odours, explosion and combustion, asphyxiation, vegetation damage, and greenhouse gas emissions.

Landfill (60) gas is generated under both aerobic and anaerobic conditions. Aerobic conditions occur immediately after waste disposal due to entrapped atmospheric air. The initial aerobic phase is short-lived and produces a gas mostly composed of carbon dioxide. Since oxygen is rapidly depleted, a long-term degradation continues under anaerobic conditions, thus producing a gas with a significant energy value that is typically 55 % methane and 45 % carbon dioxide with traces of a number of volatile organic compounds (VOC). Most of the CH_4 and CO_2 are generated within 20 years of landfill completion.

Landfills comprise an important source of anthropogenic CH_4 emissions, and are estimated to account for 8 % of anthropogenic CH_4 emissions globally. The Directive 1999/31/EC states in Annex I that 'Landfill gas shall be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected cannot be used to produce energy, it must be flared'.

6.2. Biogas from sewage and residual waters

Another possibility to produce biogas is through the installation of a biodigester in a sewage an residual waters facility. The residual waters are conducted to the sewage plant where the organic matter is removed from the waste water. This organic matter decays in a biodigester in which the biogas is produced through an anaerobic process. Around 40 % to 60 % of the organic matter is transformed in biogas with a methane content of around 50 % to 70 % (61). The biodigester can also be fed by vegetable or animal wastes. Therefore, it can be used in the food industry such as in big municipal sewage facilities.

Modern plants can be designed to reduce odours to a minimum extent. Biogas plants may be designed to fulfil the prerequisites for approval by the food industry to use the bio-fertilizer in agriculture.

(56) *Some examples of biogas projects may be found in the webpage* ***http://ec.europa.eu/energy/renewables/bioenergy/bioenergy_anaerobic_en.htm***

(57) *See chapters 2 and 3 of the part II of this guidebook.*

(58) *Study of the energy potential of the biogas produced by an urban waste landfill in Southern Spain. Montserrat Zamorano, Jorge Ignacio Pérez Pérez, Ignacio Aguilar Pavés, Ángel Ramos Ridao. Renewable and Sustainable Energy Review 11 (2007) 909-922 // The impact of landfilling and composting on greenhouse gas emissions – A review. X.F. Lou , J. Nair. Bioresource Technology 100 (2009) 3792-3798 // International Energy Agency Bioenergy – Task 37 Energy from Biogas and landfill gas.* ***www.iea-biogas.net***

(59) *The information given may not be relevant for countries where landfills are no longer allowed.*

(60) *Further information in the document 'Feasibility study sustainable emission reduction at the existing landfills Kragge and Wieringermeer in the Netherlands Generic report: Processes in the waste body and overview enhancing technical measures' available online at* ***http://www.duurzaamstorten.nl/webfiles/DuurzaamStortenNL/files/R00001_Final_generic_report.pdf***

(61) *Joan Carles Bruno et al. Integration of absorption cooling systems into micro gas turbine trigeneration systems using biogas: Case study of a sewage treatment plant. Applied Energy 86 (2009) 837-847.*

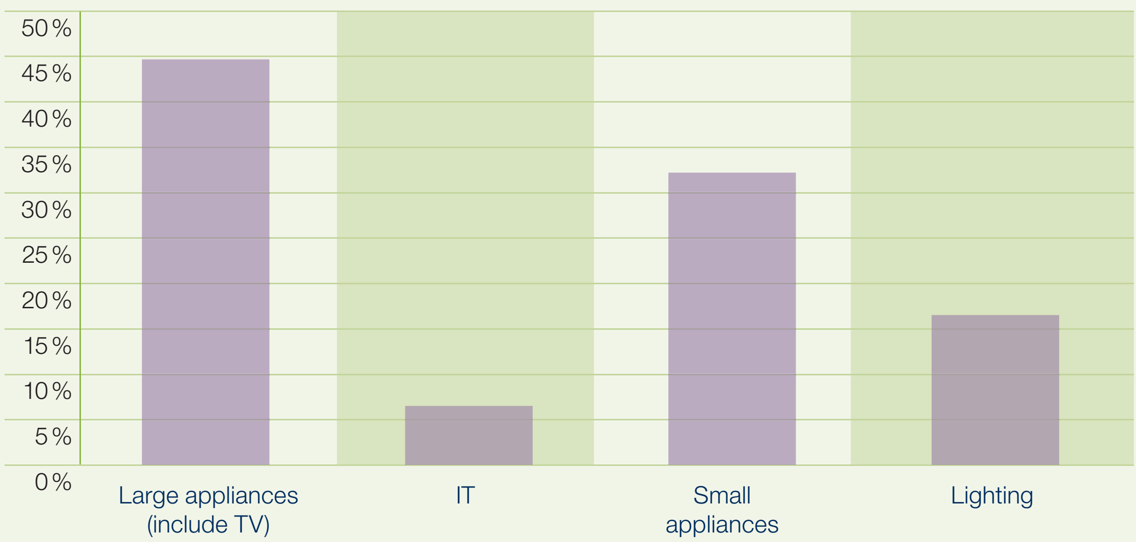
7. Additional demand side management ([62]) measures

The purchase of Green Electricity ([63]) (as explained in Part I, chapter 8.4, point 3) by the Public Administration, Households and Companies, is a great incentive for companies to invest in the diversification of clean energy generation power plants. There is some experience of municipalities buying Green Electricity from power plants owned by a municipal company.

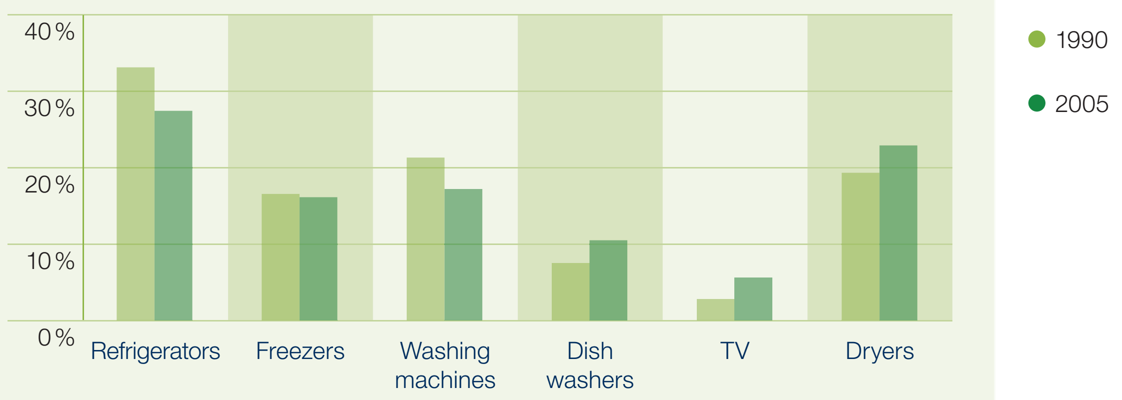
Directives 1992/75/EEC and 2002/31/EC oblige domestic appliance producers to label their products, offering to the customers the possibility to know the energy efficiency of these devices. The appliances included in these regulations are: refrigerators, freezers and their combinations, washing machines, driers and their combinations, dishwashers, ovens, water heaters and hot-water storage appliances, lighting sources, air-conditioning appliances. It is highly recommended to choose A+ or A++ labeled appliances.

The combination of behavioral changes and the implementation of straightforward energy efficient measures (this does not include refurbishment) at homes can reduce the energy consumption by up to 15 % after the second year ([64]).

CONSUMPTION OF HOUSEHOLD ELECTRICAL APPLIANCES PER DWELLING PER TYPE OF APPLIANCES (EU-15) – 2005



CONSUMPTION OF LARGE ELECTRICAL APPLIANCES BY TYPE



Source: Odyssée database – ***www.odyssee-indicators.org***

([62]) *Demand Side Management Information available on the International Energy Agency Demand Side Management webpage* ***www.ieadsm.org***

([63]) *The Topten websites provide a selection of best appliances from the energy point of view* ***www.topten.info*** *(project supported by Intelligent Energy Europe).*

([64]) *Further information in the document 'Green electricity – making a different' by PriceWaterhouseCoopers.* ***http://www.pwc.ch/de/dyn_output.html?content.cdid=14918&content.vcname=publikations_seite&collectionpageid=619&backLink=http%3A%2F%2Fwww.pwc.ch%2Fde%2Funsere_dienstleistungen%2Fwirtschaftsberatung%2Fpublikationen.html***

Raising citizens' levels of awareness is a powerful way to reduce the energy consumption at work and at home. A 2006 scientific study has proved that positive behaviour at home may significantly reduce power consumption ([65]). This study made a quantitative analysis with an on-line interactive 'energy consumption information system' that was installed in nine residential houses. The main findings were:

- installation of the system led to a 9 % reduction in power consumption;
- comparisons of daily-load curves and load-duration curves for each appliance, before and after installation, revealed various energy-saving forms of behaviour of the household members, such as the reduction of stand-by power and better control of appliance operation;
- energy-conservation awareness affected not only the power consumption of the appliances explicitly shown on the display monitor, but also other household appliances.

Some student-oriented projects ([66]) aimed at teaching them good practices have been developed or are now under development. These projects propose including positive-energy patterns in curricula in order to make students aware of the benefits of energy-efficient behaviour. These initiatives are not only focused on students, but also on parents. In fact, the idea is to bring energy efficiency to the home from school.

EXAMPLE

Significant energy saving reduction through motivation and information in a citizen competition can be seen from the IEE Project Energy Neighbourhood **http://www.energyneighbourhoods.eu/gb/**

Water supply ([67]) is also a field in which the municipality can actively reduce the fossil fuels-based energy consumed through the implementation of two groups of measures:

- Those oriented to the energy consumption reduction of the water supply. Typical measures are the reduction of leaks, control of pumps with frequency inverters, or the water consumption reduction.
- Due to the scarcity of water, some European regions are obliged to use desalination. As this process requires a considerable amount of energy, the use of renewable energy technologies in which relevant progresses have been made over the last years is an alternative to be considered by the technical staff.

([65]) *Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data – Tsuyoshi Ueno, Fuminori Sano, Osamu Saeki, Kiichiro Tsuji – Applied Energy 83 (2006) 166-183.*

([66]) *Further information on energy efficiency at school available on* ***www.pees-project.eu****. Project supported by Intelligent Energy Europe. A Scientific research on energy efficiency at school has been performed in Greece. Results can be found in the article: Effective education for energy efficiency – Nikolaos Zografakis, Angeliki N. Menegaki, Konstantinos P.Tsagarakis. Published in Energy Policy 36 (2008) 3226-3232.*

([67]) *Further information on DG Environment webpage* ***http://ec.europa.eu/environment/water/quantity/scarcity_en.htm#studies***

8. Energy audits ([68]) and measurements

The purpose of Energy Audits is to perform an analysis of energy flows in buildings or processes that allows understanding how efficient the use of energy is. In addition, it should propose corrective measures in those areas with poor energy performance. The characteristics of the building or equipment to be audited, as well as the energy consumption and performance data, are collected by means of surveys, measurements or energy consumption bills provided by utilities and operators or simulations performed, using validated software. As measurement and data acquisition are an important issue in energy-efficiency projects, the way to do it has to be planned in advance. More information on energy measurements can be found on the IPMVP webpage **www.evo-world.org**. Once these data are collected and correctly analysed, it is possible to propose corrective measures aimed at improving the energy efficiency of the building/installation. The outcomes of energy audits should at least be:

- identification and quantification of energy-saving potentials;
- energy-efficiency corrective/improvement measure recommendations;
- quantification of investments to improve energy-efficiency effectiveness;
- a plan/programme to implement measures.

The energy audit is the first step before taking the final decision on which type of measures will be taken in order to increase the energy efficiency. Regardless of measures, an energy audit can reveal bad energy consumption practices.

From the point of view of energy efficiency, showing energy consumption and progress to people has an awareness effect that can lead to additional saving, due to the change of behaviour.

During the decision process of the financing scheme (i.e. programmatic carbon crediting – financing schemes chapter), the method used to measure savings or energy produced plays an essential role. In fact, this can be a requirement from the bank or fund to access financing. Moreover, when a project is based on an ESCO scheme, the contract should clearly specify how the energy will be measured (heat, electricity or both) and the payment deadlines and penalisation are based on these measurements. In addition, monitoring the energy consumption/savings allow investors and engineering offices to check the accuracy of forecasts and implement corrective measures in case of non-expected deviations.

(68) *Further information and guidelines are available on the GreenBuilding Webpage* ***http://re.jrc.ec.europa.eu/energyefficiency/greenbuilding/pdf%20greenbuilding/GBP%20Audit%20Guidelines%20final.pdf***

9. Specific measures for industry

9.1. Electric Motors ([69]) and Variable Speed Drives (VSD)

Motor driven systems account for approximately 65 % of the electricity consumed by EU industry. A significant amount of energy is consumed by electric motor in cities. In addition, they are used in buildings to pump water to end-users, in water treatment and distribution or in heating and cooling installations among others. This chapter is addressed to all sectors of activity in which electric motors are present.

A label used by the main European Manufacturer is available for electric motors. This label proposes 3 level of efficiency: EFF1, EFF2, and EFF3. It is recommended to use the most efficient motors which are labelled with EFF1. The efficiency value of two motors labelled with EFF1 and EFF3 with identical electrical power may be at least between 2 % and 7 %.

When a motor has a significantly higher rating than the load it is driving, the motor operates at partial load. When this occurs, the efficiency of the motor is reduced. Motors are often selected that are grossly under-loaded and oversized for a particular job. As a general rule, motors that are undersized and overloaded have a reduced life expectancy with a greater probability of unanticipated downtime, resulting in loss of production. On the other hand, motors that are oversized and thus lightly loaded suffer both efficiency and power factor reduction penalties.

The adjustment of the motor speed through the use of Variable Speed Drives (VSD) can lead to better process control, and significant energy savings. However, VSD can have some disadvantages such as electromagnetic interference (EMI) generation, current harmonics introduction into the supply and the possible reduction of efficiency and lifetime of old motors. The potential energy savings produced by VSD in electric motors have been estimated around 35 % ([70]) in pumps and fans and 15 % in air compressors, cooling compressors and conveyors.

9.2. The Energy Management standard EN 16001

The European standard for Energy Management Systems – EN 16001 – is a tool for all kinds of companies to review their energy situation and improve their energy efficiency in a systematic and sustainable way. This standard is compatible with and complements other standard such as ISO 14001. It is intended to apply to all types and sizes of organizations and industries, including transport and buildings.

The norm doesn't define specific performance energy criteria. Its aim is to help companies to organize their process so as to improve energy efficiency. This standard follows the Plan-Do-Check-Act (PDCA) approach.

9.3. Best Available Techniques Reference Document (BREF) ([71]) in Industry

The Best Available Technology (BAT) Reference Document (BREF) aims to exchange information on BAT, monitoring and developments under the article 17(2) ([72]) of the IPPC Directive 2008/1/EC. These documents give information on a specific industrial/agricultural sector in the EU, techniques and processes used in this sector, current emission and consumption levels, techniques to consider in the determination of BAT, the best available techniques (BAT) and some emerging techniques.

(69) *The Motor Challenge Programme – European Commission* **http://re.jrc.ec.europa.eu/energyefficiency/motorchallenge/index.htm** *and the Electric Motor System Task of the Internation al Energy Agency* **http://www.motorsystems.org/**

(70) *From the report: VSDs for electric motor systems. These data have been estimated for the industrial sector. The report is available on* **http://re.jrc.ec.europa.eu/energyefficiency/motorchallenge/index.htm**

(71) *Energy Efficiency BREF is available on:* **ftp://ftp.jrc.es/pub/eippcb/doc/ENE_Adopted_02-2009.pdf**

(72) *'The Commission shall organise an exchange of information between Member States and the industries concerned on best available techniques, associated monitoring, and developments in them.'*

ANNEX I
Key elements of the EPBD recast

- Elimination of the **1 000 m² threshold** for the renovation of existing buildings: minimum energy performance requirements are required for all existing buildings undergoing a major renovation (25 % of building surface or value).
- Minimum energy performance requirements are required **for technical building systems** (large ventilation, AC, heating, lighting, cooling, hot water) for new built and replacement.
- Minimum energy performance requirements have also to be set **for renovation of building elements** (roof, wall, etc.) *if technically, functionally and economically feasible*.
- A **benchmarking methodology** framework for calculating **cost-optimal levels** of minimum requirements shall be developed by the Commission by 30 June 2011.
- Cost-optimal level mean minimised lifecycle cost (including investment costs, maintenance and operating costs, energy costs, earnings from energy produced and disposal costs).
- Benchmarking methodology shall help MS in setting their requirements.
- In case of >15 % gap between cost-optimal and the actual national standard, Member States will have to justify the gap or plan measures to reduce it.
- Better visibility and quality of information provided by **Energy Performance Certificates**: mandatory use of the energy performance indicator in advertisements; recommendations on how to improve cost-optimally/cost-effectively the energy performance, it can also include indication on where to obtain information about financing possibilities.
- Certificates to be issued to all new buildings/building units and when existing buildings/building units are rented/sold.
- Public authorities occupying office space of > 500 m² will have to display the certificate (lowered to > 250 m² after 5 years).
- Commission to develop a **voluntary common European certification scheme** for non-residential buildings by 2011.
- MS to establish **regular inspection** of accessible parts of heating system (> 20kW) and of AC system (> 12kW).
- Inspection reports issued after each inspection (includes recommendations for efficiency improvement) and handed over to owner or tenant.
- Certificates and inspection to be carried out by independent and qualified and/or accredited experts.
- MS to set up **independent control system** with random verification of certificates and inspections reports.
- MS to establish penalties for non-compliance.
- Requirement to consider **alternative systems** for new buildings (such as RES, district heating and cooling, CHP…).
- All new buildings in the EU as from December 2020 (2018 for public buildings) will have to be **nearly zero energy buildings**.
- The ***nearly zero or very low*** amount of energy required should to a very significant level be covered by energy from renewable source.
- MS to **take measures**, **such as targets**, to stimulate the transformation of buildings that are refurbished into nearly zero energy buildings.
- EPBD recast **underlines crucial role of financing for EE**.
- MS have to draw up lists of national (financial) measures by 30 June 2011.
- MS to take into account cost-optimal levels of energy performances in funding decisions.

ANNEX II
Costs and emissions of some technologies

TABLE 2-2: ENERGY TECHNOLOGY FOR POWER GENERATION – HIGH FUEL PRICE SCENARIO (a)

Power generation technology	PRODUCTION COST OF ELECTRICITY (COE) State of the art 2007 €$_{2005}$/MWh	PRODUCTION COST OF ELECTRICITY (COE) Projection for 2020 €$_{2005}$/MWh	PRODUCTION COST OF ELECTRICITY (COE) Projection for 2030 €$_{2005}$/MWh	NET EFFICIENCY 2007	LIFECYCLE GHG EMISSIONS Direct (stack) emissions $kgCO_2$ (eq)/MWh	LIFECYCLE GHG EMISSIONS Indirect emissions $kgCO_2$ (eq)/MWh	LIFECYCLE GHG EMISSIONS Lifecycle emissions $kgCO_2$ (eq)/MWh	FUEL PRICE SENSITIVITY
ENERGY SOURCE: NATURAL GAS								
Open Cycle Gas Turbine (GT)								
-	80 + 90 (b)	145 + 155 (b)	160 + 165 (b)	38 %	530	110	640	Very high
Combined Cycle Gas Turbine (CCGT)								
-	60 + 70	105 + 115	115 + 125	58 %	530	70	420	Very high
CCS	n/a	130 + 140	140 + 150	49 % (c)	60	85	145	Very high
ENERGY SOURCE: OIL								
Internal Combustion Diesel Engine								
-	125 + 145 (b)	200 + 220 (b)	230 + 250 (b)	45 %	595	95	690	Very high
Combined Cycle Oil-fired Turbine (CC)								
-	115 + 125 (b)	175 + 185 (b)	200 + 205 (b)	53 %	505	80	580	Very high
ENERGY SOURCE: COAL								
Pulverised Coal Combustion (PCC)								
-	40 + 55	80 + 95	85 + 100	47 %	725	95	820	High
CCS	n/a	100 + 125	100 + 120	35 % (c)	145	125	270	Medium
Circulating Fluidised Combustion (CFBC)								
-	50 + 60	95 + 105	95 + 105	40 %	850	110	960	High
Integrated Gasification Combined Cycle (IGCC)								
-	50 + 60	85 + 95	85 + 95	45 %	755	100	855	High
CCS	n/a	95 + 110	90 + 105	35 % (c)	145	125	270	Medium
ENERGY SOURCE: NUCLEAR								
Nuclear fission								
-	55 + 90	55 + 90	55 + 85	35 %	0	15	15	Low
ENERGY SOURCE: BIOMASS								
Solid biomass								
-	80 + 195	90 + 215	95 + 220	24 % + 29 %	6	15 + 36	21 + 42	Medium
Biogas								
-	55 + 125	50 + 200	50 + 190	31 % + 34 %	5	1 + 240	6 + 245	Medium
ENERGY SOURCE: WIND								
On-shore farm								
-	75 + 110	55 + 90	50 + 85	-	0	11	11	nil
Off-shore farm								
-	85 + 140	65 + 115	50 + 95	-	0	14	14	nil
ENERGY SOURCE: HYDRO								
Large								
-	35 + 145	30 + 140	30 + 130	-	0	6	6	nil
Small								
-	60 + 185	55 + 160	50 + 145	-	0	6	6	nil
ENERGY SOURCE: SOLAR								
Photovoltaic								
-	520 + 880	270 + 460	170 + 300	-	0	45	45	nil
Concentrating Solar Power (CSP)								
-	170 + 250 (d)	130 + 180 (d)	120 + 160 (d)	-	120 (d)	15	135 (d)	Low

(a) *Assuming fuel prices as in DG TREN 'Scenarios on high oil and gas prices' (barrel of oil 54.5$$_{2005}$ in 2007, 100$$_{2005}$ in 2020 and 119$$_{2005}$ in 2030).*
(b) *Calculated assuming base load operation.*
(c) *Reported effiencies for carbon capture plants frefer to first-of-a-kind demonstration installations that star operating in 2015.*
(d) *Assuming the use of natural gas for backup heat production.*

Source: COMMISSION STAFF WORKING DOCUMENT. AN EU ENERGY SECURITY AND SOLIDARITY ACTION PLAN. Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport. European Commission. ***http://setis.ec.europa.eu/***

TABLE 2-4: ENERGY SOURCES FOR HEATING – HIGH FUEL PRICE SCENARIO (a)						
EU-27 MARKET SHARE BY ENERGY SOURCE (RESIDENTIAL SECTOR) (b)	FUEL RETAIL PRICE (INC.TAXES)	PRODUCTION COST OF HEAT (INC.TAXES)		LIFECYCLE GHG EMISSIONS		
		Running cost	Total cost	Direct (stack) emissions	Indirect emissions	Lifecycle emissions
	$€_{2005}$/toe	$€_{2005}$/toe	$€_{2005}$/toe	tCO_2 (eq)/toe	tCO_2 (eq)/toe	tCO_2 (eq)/toe
ENERGY SOURCE: FOSSIL FUELS						
Natural gas						
45.4 %	1 010	1 125 + 1 400	1 425 + 1 750	2.5	0.7	3.2
Heating oil						
20.0 %	1 030	1 200 + 1 600	1 775 + 2 525	3.5	0.6	4.1
Coal						
3.1 %	590	975 + 1 025	1 775 + 2 100	5.4	0.7	6.1
ENERGY SOURCE: BIOMASS, SOLAR AND OTHER						
Wood chips						
11.6 %	410	725 + 925	1 575 + 2 675	0.0	0.3	0.3
Pellets						
11.6 %	610	925 + 1 350	1 700 + 4 175	0.0	0.7	0.7
Solar						
11.6 %	-	275 + 300	1 350 + 9 125	0.0	0.3	0.3
Geothermal						
11.6 %	-	650 + 1 100	1 150 + 3 775	0.0	0.2 + 5.9	0.2 + 5.9
ENERGY SOURCE: ELECTRICITY						
12.3 %	1 875	1 925 + 1 975	2 025 + 2 900	0.0	0.7 + 15.2	0.7 + 15.2

(a) *Assuming high fuel prices as in DG TREN 'Scenarios on high oil and gas prices' (barrel of oil 100$$_{2005}$).*
(b) *District heating has an additional share of 7.6 % of the market.*

Source: COMMISSION STAFF WORKING DOCUMENT. AN EU ENERGY SECURITY AND SOLIDARITY ACTION PLAN. Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport. European Commission. ***http://setis.ec.europa.eu/***

TABLE 2-5: ENERGY SOURCES FOR TRANSPORT – MODERATE AND HIGH FUEL PRICE SCENARIO			
ENERGY SOURCE FOR ROAD TRANSPORT	COST OF FUEL TO THE EU		LIFECYCLE GHG EMISSIONS (c)
	Moderate fuel price scenario (a) $€_{2005}$/toe	High fuel price scenario (b) $€_{2005}$/toe	tCO_2 (eq)/toe
Petrol and diesel	470	675	3.6 + 3.7
Natural gas (CNG) (d)	500	630	3.0
Domestic biofuel (e)	725 + 910	805 + 935	1.9 + 2.4
Tropical bio-ethanol	700 (f)	790 (f)	0.4
Second-generation biofuel (e)	1 095 + 1 245	1 100 + 1 300	0.3 + 0.9

(a) *Value are given for 2015, assuming oil prices of 57.9$$_{2005}$ /barrels as in 'Europe Energy and Transport: Trends to 2030 – Update 2007'.*
(b) *Value are given for 2015, assuming oil prices of 83.3$$_{2005}$ /barrels as in DG TREN 'Scenarios on high oil and gas prices'.*
(c) *Data subject to revision pending on an agreement on an appropriate methodology for calculating indirect land use change.*
(d) *Require a specially adapted vehicle, which is not accounted for in the reported values.*
(e) *Ranges is between cheapest wheat-ethanol and biodiesel.*
(f) *Values are based on an assumed competitive market price of biofuels imported in the EU.*

Glossary

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

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

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

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

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

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

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

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

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

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

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

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

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

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