Preface

This report, which has been prepared by the Chalmers University of technology, provides basic guidelines for evaluation of energy efficiency measures in local settings. Improved energy efficiency and savings of energy are important in order to reach global sustainability and the efforts from each individual municipality cannot be underestimated. Energy efficiency measures are often cost effective, increase security of supply and good for the environment. Energy efficiency improvements can be done in all parts of the energy system but this report has emphasis on improving energy efficiency within the sectors of final consumers (i.e. residential and public buildings, industries and transport). There is a large technical potential of improvements in the final consumption sector, which, if realized would be advantageous not only for sustainable development but also for economic development of the individual municipality. However, there are several obstacles that have to be overcome before the improvement potential can be utilized to any larger extent. An important aim with this report is to describe some of the most common obstacles and to provide some guidelines to help facilitate implementation of energy efficiency improvements. An important ambition with these guidelines is to provide a supporting tool for the case studies and their road map work.

The report is not explicitly built on the case studies, although these have provided important input on a general basis.

Acknowledgement

Besides the case study representatives, we would also like to thank Mr Håkan Sköldberg and Mr John Johnsson at Profu in Mölndal and Mr Frank Kärrå at LFF in Göteborg for fruitful discussions and advices given.

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Jonas Lodén
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1 Introduction

The main purposes of this report are to:

- To discuss prospects for energy efficiency and the possibilities of efficiency measures in a local energy system.
- Provide recommendations (as far as possible) for identification and evaluation of energy efficiency measures in a local system.
- Serve as a guideline to case studies in the upcoming work and as input to the development and assessment of the 7-step checklist later on.

This report builds to some extent on the previous report D3.1 “Technology assessment methodology”. Several of the proposed evaluation criteria for different technologies described in D3.1 are also appropriate in order to evaluate efficiency measures from a technical perspective. However, there are some further aspects that must be considered for efficiency measures. In particular, it is difficult to evaluate and quantify the impact from efficiency measures on the demand side. Furthermore, it is not straightforward to assure that all measures actually are implemented, even if they are cost efficient. Energy efficiency measures are often associated with what is called “high transaction costs”. Thus, in spite of being cost efficient the efficiency measures may not be implemented due to other reasons such as lack of information and institutional barriers. However, the importance of improved energy efficiency is high and therefore the difficulties should not be taken as a reason for not making improved energy efficiency an important part of the pathways/roadmap. As for the D3.1 report, the ambition is that the major parts of the evaluations of different measures described in this report should be applicable without expert knowledge. As in all other contexts of Path-To-RES it is assumed that a description of the present energy system including its structure as well as the quantification of energy supply, energy conversion and demand side use are pre-requisite for the analyses of the system and evaluation of efficiency measures for the region of the case studies. Without the knowledge on the present system it cannot be concluded what consequences a certain efficiency measure will have on other parts of the system.

2 Efficiency measures in a local energy system

This chapter gives an introduction to the term energy efficiency and the context of energy efficiency from the perspective of a municipal/regional energy system. An important background source for this chapter is the report “Widened view of energy efficiency and resource management” from the Nordic Energy Perspective research group. Further on this source will be referred to as NEP in this report.

What is energy efficiency? – A brief discussion

In literature, there are several terms used in the area of energy efficiency and demand side management such as “Energy efficiency”, “Energy management”, “Energy conservation” and “Energy saving”. It should be born in mind that these terms are not always used in a consistent manner when different sources are compared. Thus, it is necessary with a short discussion on these terms. The European Commission has provided the following definitions for energy end-use efficiency:

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1 NEP research group: Widened view of energy efficiency and resource management. www.nordicenergyperspectives.org
• **Energy efficiency**: a ratio between an output of performance, service, goods or energy, and an input of energy.

• **Energy efficiency improvement**: an increase in energy end-use efficiency as a result of technological, behavioural and/or economic changes.

Two typical examples of measures for energy efficiency improvement could be:

- Insulation of doors and windows in a single family dwelling
- Replace all electricity light bulbs with new low energy bulbs in the same dwelling

Obviously these measures reduce the need of input energy whereas the energy service for the user remains the same and thereby the efficiency has been improved. On the other hand, consider the following three measures:

- Reduction of the indoor temperature from 22°C to 20°C in a single family dwelling.
- Installation of motion sensors for lighting in a public building.
- Switch off all home electronic equipment instead of leaving it in stand-by mode when it not is in use.

These measurements decrease the output performance and thus they cannot be considered as efficiency improvement according to the previous definitions. However, if applied they most likely will not have any negative impact on the comfort for the user. Therefore they are also important in order to reduce need of energy. Yet, these measurements are more appropriate to describe as “energy management” or “energy savings” rather than improvements in efficiency. *The critical aspect to be aware of is if an energy saving- or an energy management measure actually do decrease the comfort for the user, in such case it should perhaps be considered if the measure is appropriate.*

There can be confusion between energy conversion measures on the one hand and efficiency or saving measures on the other hand. Consider the following examples of conversion measures:

- A house owner replaces all electricity radiators with a ground water heat pump and a waterborne heating system (central heating) in the house, thus the need of electricity is reduced.
- Another house owner installs a panel of solar heating cells on the roof as a complement to an oil fuelled heat boiler, thus the need of light fuel oil is reduced.

These measures are of course important in order increase the share of renewable energy sources in an energy system. However, none of them reduce the need of energy input and therefore they should be considered neither as energy efficiency improvements nor energy savings.

Conclusively, both energy efficiency measures and energy savings are important in order to reduce the need of energy, but for some saving measures it must be clear how they affect the comfort and performance for the end users. Another conclusion is that changes in conversion technology should be considered with big caution in this context, since the main purpose of such a replacement is to change the input source of energy and therefore it is neither certain that such a change reduces the need of energy nor that it results in an increase in output performance.

This report has its emphasis on implementation of measures that reduce the need of primary energy, i.e. measures of energy savings, energy efficiency and energy management.
Energy efficiency from a system perspective

When the total energy efficiency in an energy system should be analysed, it is usually not sufficient to only consider the final consumption and use of energy, other parts of the system must be considered as well. Figure 1.1 illustrates an example of the supply chain from primary energy to useful energy in a single family dwelling.

Energy efficiency: How much should be included?

Possible components when adding up energy efficiency results:

1. Better insulation, better control systems
2. Better appliances
3. Better boilers, better heatpump COP etc
4. Decreased primary energy due to converting to other heating systems in the houses
5. Better efficiency in energy transformation (new/better generation, more CHP, new/better distribution)

Figure 2.1. Potential energy efficiency measures in the system. (Source NEP)

From Figure 2.1 it can be seen that there are several possibilities to achieve improved energy efficiency in the supply chain from primary energy to useful energy for the house owner. In the case that the house is heated with a domestic biomass pellet fuelled boiler, the conversion losses are more or less included taking the building as system border. But in case the house is heated with electricity or district heat from the local network most of the conversion losses are outside the building itself, for example in a combined heat and power plant (CHP) or Heat only Boiler (HB) plant. Thus, the most efficient solution depends on how electricity or district heat is produced and the efficiency and cost of competing alternatives of local heating technologies. One way to evaluate the total efficiency is to base the calculations on the change of primary energy instead of end use of energy. On the other hand, the most efficient solution for the overall system is not always the best solution for the final consumer (the house owner in this example) in terms of economy and/or technical performance. Thus, there may be conflict of interest between the consumer interest and the overall goals and interest for society (as defined in energy municipal, national and EU policies). Typical ways to deal with such conflicts are policy measures of different kinds such as taxes and subsidies, which aim to influence the consumer’s choice of technologies in a way that have a positive impact on the efficiency for the total system. In conclusion, both primary energy and final energy use must be considered.
System consideration at the local level

The example in Figure 2.1 does not specify the level of aggregation of the system considered. The main level of aggregation that is considered in Path-To-RES is the municipal/regional setting. There are several ways to describe an energy system and in this project RES-diagram has been applied in order to describe the energy systems of each of the six case studies. An example of a RES-diagram, from the case study of Valencia, can be seen in Appendix A. The RES diagram divides the energy system into four parts from supply to end use:

<table>
<thead>
<tr>
<th>Primary energy supply</th>
<th>Energy conversion- and fuel modification units</th>
<th>Distribution networks</th>
<th>Final consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Examples:</em></td>
<td><em>Examples:</em></td>
<td><em>Examples:</em></td>
<td><em>Examples:</em></td>
</tr>
<tr>
<td>• Imported electricity</td>
<td>• Power plants</td>
<td>• Electricity</td>
<td>• Dwellings (single family)</td>
</tr>
<tr>
<td>• Natural gas</td>
<td>• Heat plants</td>
<td>• Natural gas</td>
<td>• Dwellings (multifamily)</td>
</tr>
<tr>
<td>• Coal</td>
<td>• Combined heat &amp; power plants</td>
<td>• District heat</td>
<td>• Public buildings and services</td>
</tr>
<tr>
<td>• Biogas</td>
<td>• Gasification plants</td>
<td></td>
<td>• Industries</td>
</tr>
<tr>
<td>• Wind power</td>
<td>• Heat exchangers for waste heat</td>
<td></td>
<td>• Transports</td>
</tr>
<tr>
<td>• Oil products</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The diagram is a way to facilitate structured quantification of quantities and links between flows of energy and the overall energy balance of the system as well as to define the system boundary. Thus, the RES-diagram is a useful tool in order to analyse the total impact of proposed efficiency measures in the system. The diagram is rather detailed and therefore the sectors of final consumers are usually not described at a detailed level with specific end use technologies and useful energy included. Instead, a more appropriate solution is to design separate diagrams for the end use sectors. Figure 2A in Appendix A is an example of a diagram which categorizes and quantifies the final use of energy in the residential buildings in Gothenburg. From the examples in Appendix A, it can be realized that it is a comprehensive work to categorize and finding relevant data for all types of end use of energy for all consuming sectors for an entire system.

Examples of efficiency measures from the case studies

Efficiency measures can be carried out in all parts of the local system. There are several examples among the case studies in PATH-TO-RES of efficiency measures that already have been implemented in the systems, some examples are:

- Combined heat and power plants, where the heat that cannot be used for the electricity production is used in the district heating network (*Göteborg, Dunkerque, Gdansk and Arnhem*).
- Recovery of industrial waste heat for district heating networks, (*Göteborg, Dunkerque*).
- Recovery of industrial waste for cogeneration of electricity (*Valencia*).
- Waste incineration plants (household garbage) for electricity and/or heat (*Göteborg, Dunkerque*).
- Improved insulation in buildings (*most of the case have some activities*).
- Retrofitting of the district heating network which has improved the overall efficiency in the network and thus, the overall consumption of primary has been reduced. (*Gdansk*).

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1 RES = Reference Energy System (in this context). Do not confuse with PATH-TO-RES!
Experiences from the work within PATH-TO-RES so far indicates that it has been easier to identify efficiency measures in the sectors of energy supply (most measures are identified in the conversion sector) than in the sectors of final consumers.

**Different decision making processes in different parts of the energy system**

In general it is assumed to be easier to make decisions and establish actions in the supplying parts of the energy system such as large scale conversion, distribution than on the level of final energy users. The example in Figure 2.2 with a supply chain and a single family dwelling are used to illustrate this.

As it can be seen from Figure 2.2, large projects such as building of new power- or heat plants are typically based on a few rational decisions in professional organisations, whereas the measures among the house owners normally involve numerous decisions from people who only have energy as one of many issues on their agenda. This observation agrees well with the experiences this far from PATH-TO-RES. It can be assumed that such decision mechanisms to a large extent are valid also for other energy end-use sectors such as transport, buildings/services and industries.

**Main division of efficiency measurements in the local energy system**

Apart from the difficulties with the decision making processes in the consuming sectors, it is also more difficult to get a detailed overview over the detailed end use technologies as it was previously discussed and also illustrated in Appendix A. From the discussion above it seems reasonable to divide efficiency measures between **Energy supply** (primary energy, energy conversion, fuel modification, networks.) and **Consuming** (Residential buildings, Public buildings and services, Industries, Transports, agriculture, etc.) since the conditions for establishing changes differ between these two sectors. Large scale energy efficiency measures in the supply side are usually comprehensive and cost intensive (high upfront cost), therefore the project times from proposal to start of production is often a question of several years. Furthermore, depending on the stake holder structure and comprehension on the project, the municipal government may have limited possibilities to take such decisions themselves. In the consuming sectors on the other hand there are a number of less cost intensive technologies, where many decisions can be taken on the local level and with short lead times. Thus, even if
there are several difficulties related to energy efficiency improvement in the consuming sector, this sector also appears to represent a large technically “easy achievable” potential.

It should be clarified that the industrial sector is somewhat of a grey area in this discussion. Depending on company size, type of production and products, organisation, etc. it is likely that large and energy intensive industries such as steel- or concrete plants often have an organisation which is better adapted to handle energy topics, whereas in smaller and less energy intensive industries there are often other topics that are given higher priority and thus the decision processes are more comparable to other consuming sectors. Another grey area issue with the industrial sector is when there are large amounts of heat and/or electricity sold to networks (See previous examples with industrial cogeneration in Valencia and recovered heat from the steel plant in Dunkerque). Also such industries are more comparable to the sectors of energy supply. However, a fair share of the discussions of energy efficiency in this report is believed to be relevant for the industrial sectors as well.

3 Evaluation of efficiency measures

This chapter describes some basic aspects which are believed to be particularly useful to understand in order to perform evaluations of efficiency measures. Even if several examples refer to buildings (residential/non-residential) it is believed that they to a large extent are relevant for considerations on other parts of the energy system as well. The NEP-report is an important source also in this chapter. There is also an example from the case study of Göteborg, which is included since it is believed to be representative for some common obstacles with implementation of energy efficiency measures and how some of these can be handled.

The gross potential of efficiency measures and the “Energy efficiency gap”

Figure 3.1 shows the results from an investigation of efficiency measures in the Swedish building stock. It shows the private economical gross potential of energy efficiency measures in the residential building sector. The results build on net present value calculations (6% interest rate and 2% increase of energy price per year) and include all kinds of measures that are profitable from a private economical perspective. Replacement of heating technologies (conversion measures) is not included in the calculations. Thus, the gross potential illustrates an ideal condition where all possibilities are identified, decision makers have access to correct calculations and all measures are implemented.
**Figure 3.1 Gross potential of efficiency measures in the Swedish residential building stock.** (Picture modified from NEP)

The conclusion from the NEP-report is that despite the fact that all measures are not implemented in practice, a calculation of the gross potential is still useful in order to have a starting point and a quantification of the theoretical possibilities for the upcoming analysis.

*Note: the diagram in Figure 3.1 is based on calculations from a decision maker perspective. The results from a socio economic calculation differs slightly (different basis for energy prices, taxes, etc.).*

According to the NEP report, there are several studies and investigations which all conclude that in reality there is only a small part of the gross potential that is implemented. From Figure 3.1 it can be seen that only 15% (~5 000 of 33 000 GWh) of all potential actions is estimated to be completed during 2016 in a “business as usual” scenario. This difference between the gross potential and what is actually implemented is often referred to as **“the energy efficiency gap”**. Other terms for the gap such as **“the energy efficiency paradox”** can be found in some sources as well.

Also in a general context it appears like the main obstacles for implementing energy efficiency measures are not of a technical character. For example, the Mayor's Climate Change Action Plan for London 2007\(^1\) contains an overall goal to decrease the CO\(_2\) emission levels from 1990 with 60% until 2025\(^2\) and different efficiency measures are of course an important part in order to reach this goal. One of the main conclusions in the plan is that there are no technical barriers in order to reach the goals, whereas there must be changes in national policy measures in order to address the changes required to meet the goals. Before policy measures are discussed it is necessary to discuss the reasons behind the gap. In Figure 3.1 it is assumed that a fair level of the gross potential can be reached with rather “simple measures” in the buildings, some examples given are:

- Adaptation of airflows and operating times for ventilation and lighting against the utilization of the buildings. It is often enough to adjust available timers, etc.

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\(^{2}\) For comparison, the national goal for UK is 60% reduction of CO\(_2\) emissions until 2050.
“Best practice” in electrical/electronic appliances. Exchange of light bulbs to low-energy bulbs is a typical example.

Improved window insulations.

The example in Figure 3.1 refers to the building sector, but it is assumed that there are simple measures available in other consuming sectors as well. The American organisation Natural Capitalism Solutions (NCS) has developed a climate protection manual for cities\(^1\). The manual is based on a large number of case studies in America and Europe. Nine measures called “Best bets” have been identified which are assumed to be easy to implement in most local settings and they are relevant for several of the common consuming sectors as well. “Best bets” examples can be seen in detail in Appendix B.

In summary, there appear to be many cost efficient and easy achievable measures in the area of energy efficiency. Yet, these are often not completed for different reasons, as discussed below.

**Obstacles for energy efficiency measures – Reasons for the gap**

There are several reasons why efficiency measures are not implemented in spite of the fact that there are no obvious technical obstacles and besides that they are often also profitable for the decision maker. Such reasons are:

- Lack of knowledge of the existence of the measure(s).
- Hesitation whether a certain measure is cost efficient.
- Too strict requirements of pay-off, or problems to finance a certain measure (upfront cost issue).
- Too short-sighted profit expectations.
- Uncertainties in a company (or organisation) that considers a certain measure with respect to if they will remain in their present form.
- Lack of time to deal with questions on energy efficiency measures.
- Insufficient investigations, calculations, inquiries, etc.
- Lack of knowledge in the organisation (or individual decision maker has too little knowledge)
- Other topics than energy efficiency are given higher priority.

Besides the obstacles above, there are other barriers which are more complex and often more difficult to overcome. Two common examples which often occur for public buildings and multifamily dwellings are:

- **Organisation and “split incentives”** (Another common denomination is “principal agent problems”). The owner of the building are responsible for most measures on the energy system in the building, but those who rent and/or utilize the building have no incentive to use the energy in an efficient way. Furthermore the end users often do not get any feedback on their energy behaviour.

- **Ambitions of the investment market.** For many large investment companies it is more important to increase the customers value in order maximize the overall profit rather than reducing the operational costs, such as energy consumption.

\(^{1}\) Source: Climate Protection Manual FOR CITIES, [http://www.climatemanual.org/Cities/index.htm](http://www.climatemanual.org/Cities/index.htm)
Profitability of improved energy efficiency

From the previous sections it can be concluded that there is significant potential for measures on energy efficiency that are not utilized for different reasons, i.e. there is currently an “energy efficiency gap”. This section extends the discussion of the reasons for the energy gap by looking at the gap both from an engineer’s perspective as well as from an economist’s perspective. Furthermore profitability is also discussed from the perspectives of decision maker’s profitability and socioeconomic profitability. Besides the NEP report a main source for this section is the report Energy efficiency in the building stock¹ (EnEff).

The results in Figure 3.1 are from an engineer’s perspective. An example of the engineer’s perspective is: If a house owner receives a suggestion from an engineer of five conventional measures which each is profitable from the house owner’s perspective, there should be no reason why these are not implemented.

From the economist’s perspective it is no surprise that measures are not implemented and other factors must be considered in the analysis. Typical factors are:

- The house owner’s cost for consulting an engineer is not considered in the engineer’s calculation and it is not even sure that he/she will consult an engineer.
- The house owner’s time for consulting an engineer, taking decision, contracting craftsmen, etc. are not included.
- It is not even sure that the house owner will implement any of these measures from different reasons (insecurity, lack of time, lack of interest, lack of money for investments in energy efficiency measures, etc.).

Thus, if the measures are not realized, they are usually seen as non-profitable from the economist’s point of view.

The costs which the economists want to include are usually called transaction costs. A common way to include these costs in the calculation work is called Cost Benefit Analysis (CBA). In a CBA all costs and benefits of a measure or a project is considered. Thus, both “engineering costs” and transaction costs are included. Besides from transactions costs, which can be quantified, there are often other obstacles or benefits for the measure which cannot be quantified in monetary units such as lack of interest. A common way to put CBA into practice is the “T-account model”, which can be established with common softwares such as MS Excel. Table 3.1 shows a very simplified T-account model for investment of low-electricity light bulbs in a single family house (The values in the table are fictitious and only used to exemplify).

Table 3.1. Simplified example of a T-account model for investment of low-electricity light bulbs. (Table modified from EnEff)

<table>
<thead>
<tr>
<th>Measure: Exchange to low-electricity light bulbs in single family dwelling (DM=Decision Maker, SE=Socio Economic)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
</tr>
<tr>
<td>Engineering costs</td>
</tr>
<tr>
<td>-New bulbs, approx: 20 €</td>
</tr>
<tr>
<td>-Savings (no new conventional bulbs that have shorter life length): -20 €</td>
</tr>
<tr>
<td><strong>∑ Engineering costs</strong></td>
</tr>
<tr>
<td>Transaction costs</td>
</tr>
<tr>
<td>-Gathering information, etc: 8 €</td>
</tr>
<tr>
<td><strong>∑ Engineering + Transaction costs:</strong></td>
</tr>
<tr>
<td>Other costs and benefits</td>
</tr>
<tr>
<td>-Experience of reduced light quality, etc. b1 b1</td>
</tr>
<tr>
<td>-Insecurity about the promised life-length of the new bulbs b2 b2</td>
</tr>
<tr>
<td><strong>→ Total Costs...</strong></td>
</tr>
<tr>
<td>(Cost with policy measure included)</td>
</tr>
</tbody>
</table>

The Cost Benefit Analysis and the T-account model can be done both from a decision maker perspective and from a socio economic perspective. The basic principles for the calculation are more or less the same, but some of the input data such as interest rates and energy prices differ between the two perspectives. For example, energy prices for the decision maker are taken from consumer pricelists, whereas the energy prices in the socio economic calculation are based on actual costs for the community i.e. a nation, region or municipality (depending on level of aggregation). The T-account model can also be used in order to evaluate different policy measures, for example a tax increase for a certain energy carrier.

The intention here is not to penetrate deeper into calculation methods, but rather to point to that both the economic and the engineering perspectives must be considered and the importance of each perspective depends on the context. In discussions and analysis of energy efficiency measures, the term “profitable” should be used carefully and with subsequent explanation in order to avoid misunderstandings.

It can also be useful to study a “package” of energy efficiency measures in order to decide which and how many measures that is profitable for a decision maker to implement. Figure 3.3 shows a simplified example of a package with 5 measures available for the decision maker, each of them with different costs (transaction costs included) and levels of efficiency improvement. The profitable amount of measures depends on the energy price. At the energy price $p_1$ it is profitable for the decision maker to invest in measures 1 to 3, whereas if the energy price would increase to $p_2$ it is profitable to include measure 4 as well in the package.
From this and the previous section it is obvious that the decision makers often need “help” to overcome different obstacles. Authorities apply different policy measures as tools to realise efficiency measures. In the example of Figure 3.2 there are several opportunities to influence the decision maker to invest in Measure 4. One possibility is to increase the tax of a certain fuel/energy carrier in order to reach level $p_0$ for the consumers. Another way could be to establish a subsidy program, which makes an investment of Measure 4 more achievable for the consumers. A third way could be to institute a regulation which thereby “forces” the consumers to invest in Measure 4. The final option is to influence the consumer by providing information, i.e. campaigns, education, etc.

**Policy measures**

*This section provides a categorizing of different types of policy measures and some information of sources for more detailed information of specific measures.*

From the previous sections it is obvious that different policy measures are necessary in order to realize as much as possible of the gross potential of energy efficiency. The term “Market failures” is often used when governmental institutions have to regulate the market with policy measures in order to direct it in a certain way. However, from a socio-economic point of view the benefits of the introduction of a policy measure must always be larger than the costs of it. Conclusively, the authorities must try to balance between a less regulated market and more policy measures. This holds for individual member states as well as for the EU level. For this report it has not been investigated or confirmed to what extent municipalities and/or regions can decide over different policy measures themselves. However, for each case study it is possible that a considerable part of the available policy measures are implemented on national (or EU) level and thus, the policy cannot be directly influenced by the municipality itself.

The categorisation of policy measures vary slightly between different membership countries but Table 3.2 provides an overview, which is believed to be representative for most membership countries within the EU.
Table 3.2. Overview of different types of policy measures.

<table>
<thead>
<tr>
<th>Legislative</th>
<th>Financial/Fiscal</th>
<th>Information</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>Examples</td>
<td>Examples</td>
<td>Examples</td>
</tr>
<tr>
<td>• Regulations.</td>
<td>• Taxes.</td>
<td>• Information.</td>
<td>• Research.</td>
</tr>
<tr>
<td>• Limitations of emissions.</td>
<td>• Subsidies.</td>
<td>• Counselling.</td>
<td>• Development.</td>
</tr>
<tr>
<td>• Requirements on fuels and energy efficiency.</td>
<td>• Greenhouse gas emission allowance trading.</td>
<td>• influencing of public opinion.</td>
<td>• Demonstration</td>
</tr>
<tr>
<td>• Long-term conventions.</td>
<td>• Tariffs</td>
<td></td>
<td>• (Purchasing).</td>
</tr>
<tr>
<td>• Environment classification.</td>
<td>• Other certificate trading systems.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The policy measures in Table 3.2 can refer to one or several sectors of the energy system. The categorisation of the different sectors can vary slightly between different countries, but is in general quite similar. Thus a common categorisation could be:

- Residential buildings (households)
- Buildings and services (tertiary sector in some literature sources)
- Industry (energy production is often included here as well)
- Transport
- General and cross-cutting

A useful source in order to get a good overview of policy measures is the MURE database\textsuperscript{1}, which has been developed within the IEE programme. The MURE database categorises the policy measures and consumer sectors in a similar way as described in Table 3.2. The database contains all policy measures in the EU27 member states (and Norway and Cyprus). There are several search options in the MURE database in order to search for a policy applying more detailed categorisations than what is given in Table 3.2. Furthermore there is also a qualitative evaluation of the impact of most measures (an example from the database over policy measures relevant for the house hold sector in France can be seen in Appendix B).

Another useful source for information of policy measures is the National Energy Efficiency Action Plans (EC Directive 2006/32/EC). These plans are available at \texttt{http://ec.europa.eu/energy/efficiency/end-use_en.htm} for all member states, including the five countries of the case studies within PATH-TO-RES, and describe several important policy measures (present and future ones) that are relevant in order to reach the efficiency target in the EU202020 goal. The websites of national (regional) Energy agencies are also recommended, since these pages usually contain easy achievable and useful information.

Regarding the EU202020 goal it should be considered if there are any reallocations of the specific targets of the EU202020 goal done between regions/municipalities within the nation. If so, the goals for the municipality might differ from EU202020. Furthermore there are municipalities that have committed to agreements which require more ambitious goals than EU202020, for example "The Covenant of Mayors" which is signed by 400 cities\textsuperscript{2} (Göteborg, Dunkerque and Valencia are examples of those that have signed to comply with targets stated by the Covenant of Mayors).

\textsuperscript{1} MURE website, \texttt{http://www.mure2.com/}
\textsuperscript{2} European Commission -Covenant of Mayors. \texttt{http://www.eumayors.eu/}
Depending on the working processes and organisation of the work in each case study, the following questions could be helpful for the process of improvement of energy efficiency in a local setting:

- Is there a clear overview over present policy measures?
- On what level are the measures to be implemented (EU, national, regional, etc.)?
- Are there new policies to expect within the time frame of the planning process?
- What level of improvements can be reached with existing (or planned) policy measures?
- Are there risks that any important national policy measures will be discontinued or interrupted?
- Is there anything that could be done to increase the impact of present policy measures?
- Is there any new policy measures required? If the answer is yes;
  - Which ones?
  - Can they be decided on the local level, or must it be decided on a higher level (country, EU, etc.)?

As mentioned earlier, it is assumed to be a sensitive act of balance when new policy measures are established. Thus, it should be considered as a risk for any municipality to invest in new policy measures. Even a “simple” measure such as an information campaign is obviously wasted money if it does not help to improve the energy efficiency. Besides waste of money there is also a risk for a negative public opinion if a measure fails. Another important aspect that was seen in the example from the climate plan of London is the feedback to national decision makers of what impact of national policy measures will have on the local setting as well as what room for decisions is given to the municipality. It is also assumed to much easier to maintain a good dialogue and get response from the national decision makers if the suggestions from the local level are well-founded.

**Example from the case studies, LFF in Göteborg**

*Here, the so called LFF in Göteborg is used as an example of a working process for improved energy efficiency. The example is chosen since it is quite representative for several of the above mentioned common obstacles and problems with energy efficiency measures and how some of them can be mastered. LFF translates to Local Energy Supply Administration)*

**Background:** LFF (Lokal Försörjnings Förvaltningen) in Göteborg\(^1\) is a municipal utility with operational responsibility for municipally owned buildings such as schools and kindergartens. During 2006, the total energy consumption in these buildings was 162 GWh (~10% of the public sector in Göteborg). The organisation of LFF contains a specific department for energy and environment which runs a comprehensive work in order to improve the overall energy efficiency for their buildings. The EU2020 goal is considered as one of the main targets.

**Results from the environmental plan 2007:** Within LFF there have been large progress made in order to reach the EU2020 goals. However this is a demanding process and the goals for 2007 of 2% reduction of electricity and 3% reduction of heat compared to the levels of 2005 could not be fulfilled.

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\(^1\) References: LFF webpage [http://www.goteborg.se/wps/portal/lff](http://www.goteborg.se/wps/portal/lff), Environmental plan of 2007 from LFF and correspondence with Mr. Frank Kärä, manager for the department of energy and environment.
Most important reasons why these goals were not completed according to LFF:

- The building stock is generally old and often not very well insulated. The coastal climate in Göteborg is rainy and windy and the weather conditions during 2007 were worse than for the average year. Thus, the precision of temperature regulations were difficult under these conditions and could not be done with high enough accuracy.

- It is difficult for LFF to control and influence the energy behaviour of those who utilize the buildings. For example, in some buildings the users installed heating fans on their own initiative without informing LFF.

Some actions taken from LFF

- An energy and environment department within the LFF organization was established during 2007 in order to work more focused and strategic with these issues.

- Measures are separated on different time horizons.

- To continue work with several important actions that was already planned but not yet accomplished.

Some general experiences from LFF

- The single most difficult obstacle for LFF is the behaviour of the electricity consumers in the buildings. Experiences point to that in order to influence the behaviour it is beneficial to establish cross functional co-operations with other municipal organizations.

- The problems with the temperature regulations in the building stock are difficult to avoid. Comprehensive actions in order to reach the standards of more modern buildings would solve these problems to a large extent, but investments would not be seen as affordable by the owners of the buildings (i.e. the municipality).

- It is important with a correct level of data on the energy consumption, but equally important to follow up and evaluate measures which were implemented.

- Several important energy efficiency and energy saving measures that were implemented by LFF have been possible due to different subsidies. Thus, as discussed above, policy measures have a large impact on the possibilities to improve the energy efficiency.

- Most of the important policy measures which influence the work carried out by LFF are instituted by national decision makers, especially those of legislative or financial character.

- Lack of labour force, engineers in order to evaluate and suggest efficiency measures and craftsmen to implement such measures can be a problem depending on the national/global financial situation. During the current global financial crisis this is not a problem since there is excess of labour force.
4 How to improve energy efficiency in the local setting

The purpose with this chapter is to discuss what can be done in order to identify the gross potential and reduce the energy efficiency gap as far as possible in the end-use sector. The 7-step checklist of PATH-TO-RES has been adapted as a framework for the discussion. The 7 steps are:

1. analyse and formulate initial conditions
2. establish a detailed description of the present system
3. assess local, EU and global goals on sustainable development
4. identify and assess key technologies which can bridge to a future sustainable system
5. identify key actors in the region
6. formulate and analyse pathways towards a more sustainable energy system
7. establish pathway (with respect to technologies, markets, institutions)

From the previous chapters it can be concluded that improvement of energy efficiency in the local community is a complex process which cannot be considered solely as a technical issue. Thus, a set of well organised working processes in order to gradually improve the overall efficiency seems to be necessary. It is neither intended nor considered as possible to provide general recommendations for such processes on a detailed level. However, several of the identified key issues from the previous chapters appear to be of a rather general character and therefore they seem to be helpful as checkpoints for most working processes of energy efficiency improvement. These checkpoints seem to fit within the structure of the 7-step check list, at least as an initial approach.

“Initial conditions and description of the present system” (Steps 1 and 2)

Even if only selected parts of the system are subject for analyses of efficiency measures, to establish a clear description of the total energy system of the region is important in order to conclude how changes in a part of the system influence other parts of the energy system as well as the total energy system. From a sustainable perspective the overall goal is to reduce the total consumption of primary energy. Key activities in steps 1 and 2 are:

- Definition of system boundaries, i.e. geographical area, population and other boundary considerations. It can also be useful to study current trends of population development, consumption patterns etc.
- Establishment of a model over the energy system, in order to get a structural and quantitative overview. The PATH-TO-RES project applies the RES-diagram, as shown in Appendix A.

“Assess local, EU and global goals” (including plans and policy measures) (Step 3)

This is believed to be a foundation in order to perform any evaluation of efficiency measures. The following items are considered to be particularly important:

- Make sure to invent and follow-up previous plans and actions for improved energy efficiency.
  - Have plans been completed as planned?
  - If yes, have the goals of the plans been achieved?
  - If not, determine what went wrong and how it could be adjusted.
- Make an inventory over goals. The EU202020 goal and the national energy efficiency action plan are two important sources to consider on the comprehensive level. It should also be clear if there are other relevant goals (local, global).
• **Establish specific goals.** Most often it is necessary to break down comprehensive goals to corresponding goals for various parts of the system.

• **Make an inventory over Policy measures.** See last section in Chapter 3 including the “help questions”. The initial activity should be to get a good overview over present policy measures of relevance.

It can also be useful to study other plans or projects in the municipality which could have a direct or indirect relevance for some measures of energy efficiency, for example water supply, waste management, etc.

**“Identify and assess key technologies” (Step 4)**

In this context the most obvious activity is to identify potential measures that can improve the energy efficiency. Some specific aspects to consider are:

• **Structure and data available over present use of energy for the consuming sectors.** A more detailed description over the energy consuming sector generally makes it possible to quantify measures with higher precision than if there is only an aggregated description. However, in order to get the working process started and advancing, it must be some act of balance for each specific context of how detailed the system can/must be described. There should at least be a clear view over the total consumption of fuels and energy carriers in the sector to be analysed (see example page 1 in Appendix A). Sometimes it can also be useful to divide the sectors further, such as to separate industries into large scale and small scale or to separate buildings into municipality owned and private owned. For several analyses this level of detail is enough, but in some analyses it can be necessary to specify end use technologies as well (see page 2 in Appendix A). However, this is usually a comprehensive work and compromise with estimations of data may have to be done. If data on end use technologies is scarce or lacking, a first approximation of the present system may be based on the use of statistical sources (for example as available from national statistics).

• **Obstacles to implement potential efficiency measures.** As seen in the previous chapter, even if the end-use sector (or specific parts of it) can be described on a relatively detailed level and that the measures that are required in order to improve energy efficiency can be identified, there are likely to be several obstacles which prevent some of the measures to be applied, despite the fact that they are profitable. Thus, identification of obstacles is at least as important as to identify and quantify the measures themselves.

• **Available technologies.** As indicated in the previous chapters, there is a large potential for improvements in energy efficiency by application of commercially available technologies. Thus, the obstacles are not technical, but rather related to lack of driving force (economic incentives) or lack of information. However, possibilities with new technologies should of course always be considered.

**“Identify key actors in the region” (Step 5)**

As indicated Chapter 2, this is a difficult part of the end-use sector, since the decision process includes many individual decisions. In addition to choices of individuals, there are local actors of importance when it comes to influence individuals (e.g. city mayor, energy companies, municipal government, etc.). Thus, identification of key actors is not straightforward when it comes to the end use sector. Some aspects which should be considered are:
• **Organisation of work.** Most important is to identify and apply working methodologies that are suitable for the conditions and organization of the municipality in question.

• **Identification of possibilities for influencing energy efficiency in different parts of the end-use sector.** From a governmental perspective the possibilities to influence different parts of the energy system can be divided into:

  - Direct decisions
  - Political influence
  - Information
  - Cross functional co-operations (*between different organisations/companies, etc.*).

Thus, the decision structure and possibilities to act and influence must be clear in order to organise the work efficiently.

• **Cross functional co-operations.** Typical example where co-operation is necessary is the building and service sectors where the building owner and the energy consumers are different persons/organisations with conflicting interests. (“Principal agent problems” described in Chapter 3). Thus, a good strategy for energy efficiency should take an integrated approach, designed in a way that the building owner and the tenants/consumers have a common will to apply efficiency measures.

• **Dialogue with decision makers outside the municipality.** Since policies which are important for the municipalities are decided on national/international level it is highly valuable to maintain a good dialogue with decision makers on national/international level as well.

• **Exchange of experiences with other municipalities.** This is always useful and most likely there are further improvements of energy efficiency that can be implemented in the own municipality. Experiences from successful work in other municipalities and/or other EU programmes should be brought into the process of implementing energy efficiency. For example, ManagEnergy has examples of good practice projects on energy efficiency from several European municipalities on their website.

**“Formulate and analyse pathways” (Step 6)**

In this step the main activity is to analyse and prioritize the identified efficiency measures which can help to meet the specified targets related to energy efficiency. Some key points are:

• **Sub-categorization of available measures.** For example, a division into different cost levels and time perspectives can be useful, in order to prevent that only “lowest hanging fruits are picked” and the potential of more comprehensive measures which could lead to a considerable improvement of energy efficiency is lost.

• **Quantification of all measures.** If there is no room for a more comprehensive analysis, estimations of available measures (*in terms of MWh, GWh, etc.*) should be done. The quantification is important in order to later follow up and evaluate measures which were actually implemented.

• **Evaluation of identified obstacles which prevent implementation of efficiency measures.** A first step could be to identify which obstacles can be handled and which ones that cannot be handled. Obviously, a measure for which there is an obstacle that seems impossible to overcome within the specified timeframe is of little use in an action plan.

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1 Energy Efficiency on the ManagEnergy Website. [http://www.managenergy.net/indexes/l44.htm](http://www.managenergy.net/indexes/l44.htm)
• **Determination of what is required to overcome the main obstacles.** If the present policy measures are not believed to overcome the obstacles, new policies should be considered. In some cases it is possible that the decision makers in the municipality can implement appropriate policy measures, in other cases policies depends on national decisions (require dialogue with the national government).

The outcome of this step should be a package of measures, which are important inputs in order to establish the action plan.

**“Establish pathways” (Step 7)**

This step is important in order to assure that suggested measures will be implemented, but it is perhaps even more important in order to maintain a continuous working process for improved energy efficiency. Thus, following steps are recommended to be included:

• **Prioritise proposed activities and measures from criteria** which relate to how difficult it is to implement the activities and measures (easy to achieve, high reduction of CO₂, profitability, public awareness, etc.). It is of course important that the number of proposed activities and measures as well as the effort required for them to be implemented is realistic.

• **Establish a plan of action.** Make sure to distribute roles and responsibilities.

• **Make sure that there is a follow up procedure to check to what extent the plan has been fulfilled.** Thus, these three steps most likely have to be carried out in an iterative way.

**Some comments on the 7-step checklist**

Within the case studies no detailed analyses have so far been carried out on working processes for improved energy efficiency among final consumers. Thus, it is possible that some of the case studies already have several appropriate working processes for different parts of the system which may be in line with the proposed steps and checkpoints. The experiences from the case studies will hopefully be valuable for assessing the guidelines proposed in this report. Thus, the guidelines in this report must be seen as an initial proposal.

The basic idea with the 7-step check list proposed in this project is to analyse long term development (i.e. 30-50 years) towards sustainability in a local setting. However, the basic structure of the 7-step checklist is assumed to be relevant for energy efficiency plans on any level of aggregation and time frame. It is neither intended that these checkpoints must be performed in any exact order, nor that each of the steps must have the same relevance for every specific case. What is important is that the list provides a useful supporting tool for decision makers, project leaders, managers, etc. for projects or working processes in the work of local energy planning.

A conclusion from the previous discussion is that it is difficult to implement considerable improvement of energy efficiency in consuming sectors if this is done as a single project in isolation from other activities. For example, if a municipality would set the following goal “The overall energy consumption in the sector of single family dwellings should decrease with 35% per capita before year 2015, i.e. within six years”, several points make it difficult to implement measures which can fulfil this goal, such as:

• The measures have to be implemented by thousands of different house owners (i.e. many decision makers).
Each house owner has access to several different measures of varying comprehension and character.

It is a difficult task to identify and quantify potential measures with any precision.

It is likely that there are a number of measures which are profitable for the house owners, but in spite of this they may not be implemented. Even cost efficient measures can in most cases not be made compulsory.

Thus, it follows that it is difficult to establish a single plan which will result in that efficiency measures will be implemented. A more appropriate way to organise the work could be to divide the master plan for the above goal into several plans of actions with shorter time frames where a key issue is to **always follow up and evaluate the results of previous plans**. In this way the efficiency improvement can be performed in an iterative way, where some level of “trial and error” can be included. Thus, energy efficiency improvement among consumers appears more appropriate to consider as a **continuous working process** rather than a single project. **For comparison; in the supply sector it is often a question of a few measures with large impact, such as replacement of a power plant which will have a direct impact which will last over a long time (See Chapter 2).** Another important issue is that there should be a connection between short term plans on energy efficiency (as well as plans for other parts of the energy system) and overall plans of the energy system in order to assure a development towards long term sustainability (most obvious the case study road maps within the PATH-TO-RES project). Such connection should of course be on a regular basis in time, e.g. in connection to the above mentioned following-up work of the efficiency plan.
5 Discussions and conclusions

Experiences from work with energy efficiency are summarized with the aim to provide a first guidance on how to plan and execute work with energy efficiency in a regional setting. The following points have been identified as important:

Sustainable development – Importance of improved energy efficiency
Most trends and analyses indicate that under present conditions both the total energy consumption and the energy consumption per capita will continue to increase. The global capacity of renewable energy sources (hydro, solar, wind, geothermal) is limited and will by far not be sufficient to fulfil the global climate goals until year 2050 (at least not with present technologies). Thus in order to reach the goals, the trends of increasing energy consumption must change. In order to achieve this change, the potential of energy efficiency improvements must be utilized to a larger extent and unnecessary use of energy must be minimized. The importance of initiatives and actions from the local level is of great importance since the decision on local and regional level are near the end-users of energy.

Time horizons, Short term, midterm (~2020) and long term (~2030-2050)
On longer terms, it is difficult to predict the development of policy measures. Thus, it is important to try to establish plans which are committed to a time period as long as possible. This calls for broad agreement with respect to politics (to avoid that plan is overthrown with change in local government). Also, long term development in population, technology consumption patterns are more or less difficult to predict. As concluded above, implementation of several measures of energy efficiency are dependent on policy measures in order to be realized (even if the measure is cost efficient). Compared to investments in the supply sectors which often have a high upfront investment cost, there are a number of energy efficiency measures which are cost efficient. Thus, such measures must be identified since it should be possible to implement them on short term and, thus, short term policy should be designed which make them to be implemented. Obviously, there must be considerations on long term as well. For example, it should be important to establish a strategy for future measures in the more “difficult” sectors (such as transports and industries) so that policies are prepared once the long term goals has been reached in the relatively “easier” sectors, such as in the building sector.

System considerations
Even if this report has its main focus on short term measures in the end use sectors it is important to connect this work on some regular basis to the overall system in the municipality, i.e. how will changes in energy consumption affect the total primary energy supply? Thus if there are several isolated projects and working processes they should be connected to a more comprehensive plan towards sustainability. Connections to the overall local system (i.e. all sectors) are also necessary for successful implementation of supply-side management. One example, which is relevant for some of the other case studies as well, is Göteborg where the major share of the district heat comes from a waste incineration plant and exchange of waste heat from a petroleum refinery, thus a result of rather comprehensive efficiency measures. However, if the conditions for the refinery or the amount of household waste for some reason would drastically change in the future, it would obviously have a large impact on the capacity of district heat as well and, thus, such connection must be considered in the planning of the future. It is also important to consider how the world outside the region of interest are likely to change in the future, i.e. how the system within the boundaries may be
influenced by the system outside the boundaries. It is of course equally important to consider what impact changes in the local system will have on the world outside the region.

**Risks related to decision makers and public opinion**

In order to reach comprehensive goals on energy efficiency (as well as other goals) it is important to have support from the general public as well as from relevant stakeholders. A measure for improved energy efficiency has a strong advantage as long as it results in a decreased cost for the stakeholder assuming that the service provided by the process is maintained. Obviously, if an efficiency measure would impair the service for the stakeholder/user (for example reduced heat or ventilation in a public building) it will be difficult to gain acceptance for the measure (no or little willingness by user/stakeholder to implement measure). Thus it is important that goals on reduced energy consumption are realistic and that proposed actions have some level of social acceptance in case they will affect the performance or comfort for the end users. For efficiency measures with high upfront costs, municipalities may be dependent on policy measures on a national level, for example programs of subsidies. Thus, if national and international decision makers for some reason abolish such a subsidy program it can make it difficult or even impossible to implement certain measures of energy efficiency improvement in some local communities, depending on their economical situation.

**Challenge to initiate work on energy efficiency**

If there is little or no work in the area of energy efficiency in the municipality it must be realised that significant resources are required to initiate and maintain such work. As shown in this report, it is crucial to get a clear description of the energy system (such as can be done with a RES-diagram or similar) as well of the organisational structure of the municipality. The latter is important in order to identify who are involved and in control of various decisions required to transform the regional energy system. An initial task should be to identify in which parts of the system it is least difficult to initiate energy efficiency measures (The “best bets” in Appendix B is one good example). Successful implementation of energy efficiency measures (e.g. resulting in that money is saved) will obviously contribute to a positive attitude to energy efficiency work within the municipality which is good for the continued work.

As for statistics of the end use sectors it is often difficult to find data when it comes to the level of end use technologies. However, it is assumed that if a working process is initiated where proposed measures are quantified and results of previous plans are continuously evaluated, the statistical information of the end use sectors will be improved during the work. Thus, a key issue is to get the work started.

**Status for the case studies**

As seen in the previous chapter, there is for all case studies of this project a clear description of the energy system as well as that energy efficiency measures on the supply level have been identified (for example, recovery of waste heat from refineries or industries), whereas it is more difficult to draw any conclusions for the end-use sectors. Some information has been obtained and a typical example of an obvious measure is different types of building insulations (which is proposed by most case studies as being a short term action). Information of some policy measures and potential risks and obstacles (for example, support of national policy makers and willingness of stakeholders to initiate work on energy efficiency) has also been provided.
What can be expected to be achieved in the case studies during the PATH-TO-RES project?

It is not likely or expected that the methodology proposed in Chapter 4 can be applied to a full extent during the project period. **A key activity is to identify ongoing working processes and projects related to energy efficiency improvements as far as possible in each case study.** This ongoing work in this project will try to identify established working processes in order to improve the guidelines in Chapter 4 further. The aim is also that each case study will try to identify parts of the system where the work of energy efficiency has not been successful and, when this has been the case, analyse and propose what can be done to avoid future unsuccessful work. During the project period it is not expected that detailed data over specific end use technologies can be established. However, in some cases it could be useful to divide some of the consuming sectors in a way that the sectors correspond to the organizations which can decide on improved energy efficiency.

Interesting inputs to the project are experiences from those case studies that participate in the Covenant of Mayors and thereby have committed themselves to more ambitious goals on than the EU202020. Finally, for the road map work in each case study it would be valuable to investigate how the current working processes and projects of energy efficiency improvement contribute to the long term development towards sustainability. The advantage with performing road map work is that it should help to identify the likely results of various measures and policy required to reach the pathway defined in the roadmap work.

6 Summary of key aspects on energy efficiency

The work presented in this report can be summarized as follows:

- There are several reasons why the work with energy efficiency improvements is important in the local setting:
  - Energy efficiency measures are often cost efficient
  - Improved energy efficiency is typically associated with measures near the end-user and, thus, the municipal level is well suited to handle implementation of such measures (e.g. policies, information, requirements on new settlements).
  - There are considerable possibilities to reduce the overall energy consumption and thereby greenhouse gas emissions and to do this with commercially available technologies.
  - Work with energy efficiency measures gives smaller municipalities with no or few large scale conversion technologies (power plants) or industries the possibility to achieve considerable improvements.
  - Work with energy efficiency measures contributes to an increased level of understanding and acceptance for energy issues among the final consumers of energy.
  - The possibilities to act are often better on the local level than on national (or EU or global) when it comes to establishment of improvements of final energy use.

- It is important to understand the context of the term energy efficiency and keep it separated from terms such as energy savings or energy conversion measures (See Chapter 2 for examples).
Both primary energy and en-use energy consumption must be considered for measures of improved energy efficiency.

The RES-diagram is a good way to structure the energy system of the region, including the energy use in each end-use sector.

Energy efficiency measures can be applied on the “Supply-side” as well as on the “end-use side”. As described in Chapter 2, differences in the decision processes are one important argument for this division. Furthermore, these two sides require different policy measures and it is therefore practical to separate these in the analysis of the energy system and of required policies to implement the measures identified.

It is important to be aware of the “Gross potential” (or “energy efficiency gap”) in order to understand why it is difficult to realize the entire potential of improvements in energy efficiency.

Different types of policy measures are important tools for the decision makers which can reduce the “energy efficiency gap”.

It is important to consider both the socio economic profitability and profitability from the decision maker’s perspective when energy efficiency measures are evaluated.

It is important not to give up energy efficiency work due to initial difficulties. Instead it must be understood that it is a comprehensive process and the work has to get started somewhere in order for experiences to be gained which can then be used to improve the continued work.

It is important to understand that the possibility to influence the development differs between different user groups and that the strategies therefore must be specifically designed for each group.

Large energy efficiency measures on the supply side are often advantageous to organise in project form, whereas in the consuming sectors it is often appropriate to organise the work with energy efficiency improvement as a continuous process.

There should be some long term strategies as well for energy efficiency improvement. An important question to investigate is whether current working processes in the municipality will lead to a sustainable development in the long term future or not.

The EU202020 goals can be helpful as a motivator for the municipalities. However it is important for each municipality to consider its individual conditions and not automatically to be “satisfied” with this goal. The Covenant of Mayors programme is a good example. It should also be some targets beyond year 2020 in order to have a direction for the long term development.

Any exact answers of the questions about how the gross potential can be determined with high precision and the “energy efficiency gap” could be minimized in the local community cannot be given in this report. However, some checkpoints are suggested which are considered as useful in order to establish a successful work of improved energy efficiency among final consumers:
- Establish a model over the energy system, in order to get a structural and quantitative overview (the RES diagram could be a good start).

- Always follow up and evaluate previous plans and activities.

- Make an inventory over global and local goals on energy efficiency.

- Determine what level of improvement each energy consuming sector must achieve in order to fulfil these goals.

- Important policy measures must be identified.

- It must be clear how the different parts of the system can be influenced (in terms of direct decisions, political activity, information, co-operation projects, etc.)

- Establish relevant structures and data for the energy consuming sectors in order to identify potential measures of improvement.

- Identify obstacles for the different measures.

- Find appropriate organisation forms for the different sectors.

- A good dialogue with those who can make direct decisions on any level (private persons, companies, national politicians, etc.) must be maintained.

- Cross-functional cooperation activities must often be established in order to deal with several common obstacles.

- Find appropriate criteria in order to prioritise suggested activities (such as time frames, investment level, technology, etc.)

- Suggested measures should be quantified. (A pure estimation is better than nothing if it is too comprehensive to find data, in this way the measure can be followed up and evaluated later on).

- Establish a plan of action. Make sure to distribute roles and responsibilities.

- It must be assured that the plan is followed up later on.
Appendix A - Description of the system on different levels

Example from case studies – RES diagram over the present energy system in Valencia

Figure A.1. RES-diagram over the region of Valencia. Data from 2006\(^1\).

Example from case studies – Diagram over end use technologies in the residential sectors (corresponding to the sector of dwellings in the diagram over Valencia above) of Göteborg

Figure A.2. RES-diagram over the end use of energy in residential buildings in Gothenburg. Data from 1993.¹

Appendix B – Examples: “Best bets” and MURE

“Best bets” From the NCS: Climate Protection Manual FOR CITIES

From the manual: “The 9 sub-sections in “Best Bets” describe initiatives that have lower initial costs, short payback, positive return on investment and can quickly reduce GHG emissions. In evaluating what programs cities should put in place, cities should consider first the greatest sources of emissions, as shown by the baseline inventory and then create the best package of programs to quickly control emissions.”

Best bets include:

- In municipal buildings cities can retrofit city buildings with energy efficient lighting and appliances, establish LEED/energy efficient standards for new municipal construction and major renovations, and perform energy audits for existing municipal buildings.

- For other infrastructure within the city, best practices include installing Light-Emitting Diode (LED) traffic signals and traffic flow management systems, updating to high efficiency street lighting, increasing efficiency of water and wastewater utilities and establishing landfill to gas energy projects.

- Municipalities can modify city transportation in addition to the residential transportation options (see residential transportation below). Cities can reduce emissions from municipal vehicle fleets through the use of hybrids, alternative fuel vehicles and idle reduction policies and campaigns as well as establishing programs to reduce city employee driving. Municipalities can also modify school buses, waste haulers, ambulance services and other contracts to use alternative fuels.

- Municipal waste reduction and recycling programs can reduce emissions.

- The city can also establish purchasing programs to procure energy efficient appliances, purchase materials that require less energy, and reduce the amount of waste it produces. The best practice is to create efficiency standards for office equipment, adopt recycled/salvage product use policies, and develop local purchasing programs.

- Finally cities can work to encourage utility providers to offer energy efficiency services and to have a minimum commodity that is to be from renewable sources.

- Cities can work to support local businesses in their transition to energy efficient technology and practices. The best practices in doing this are: promoting the use of audits, provide incentive programs for private developers to provide higher energy efficiency standards, establishing energy efficiency standards in city building codes, work with power plants and other significant emitters, while helping small and local businesses to save money by undertaking energy savings measures.

- The best ways to support residents in increasing their energy efficiency at home is by supporting residential home efficiency upgrades, establishing local policies to

\[\text{NCS: Climate Protection Manual FOR CITIES } \text{http://www.climatemanual.org/Cities/index.htm}\]
promote renewable energy, providing lower-income weatherization assistance, addressing split-incentives in renter occupied homes, creating home size restrictions and taxing large residential energy consumers, and promoting energy and water efficiency by smart metering, price signals and price structuring.

- The residential transportation section discusses how after public transportation options are established, cities can offer residents and businesses incentives to modify their transportation uses. The best practices are to first make cities pedestrian and bicycle friendly, implement school and campus transportation management programs, encourage or require local businesses to implement commuter trip reduction programs, provide better access to public transportation, install park & ride facilities and provide car sharing programs, offer location efficient mortgages and provide incentives for hybrid or low emission vehicle use.

Example from the MURE database – Policy measures for the household sector of France

More specific information can be found for each measure on the MURE website

<table>
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<th>Code</th>
<th>Title</th>
<th>Status</th>
<th>Type</th>
<th>Start Year</th>
<th>End Year</th>
<th>Semi quantitative impact</th>
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<td>VAT Reduction on energy efficiency investments</td>
<td>Ongoing</td>
<td>Fiscal/Tariffs</td>
<td>1999</td>
<td></td>
<td>High</td>
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<tr>
<td>FRA9 (ex A1FRA9)</td>
<td>Building insulation standard of 1982</td>
<td>Completed</td>
<td>Legislative/Normative</td>
<td>1982</td>
<td>1989</td>
<td>High</td>
</tr>
<tr>
<td>FRA16 (ex F4FRA3)</td>
<td>Local energy information centres</td>
<td>Ongoing</td>
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<td>Information and advertising campaign “Faisons vite ça chauffe”</td>
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<td>FRA23</td>
<td>Tax credit for energy efficiency materials and renewable energies</td>
<td>Ongoing</td>
<td>Fiscal/Tariffs</td>
<td>2005</td>
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<td>FRA33</td>
<td>Building codes RT 2005</td>
<td>Ongoing</td>
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<td>FRA34</td>
<td>Energy performance audits</td>
<td>Ongoing</td>
<td>Legislative/Informative</td>
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<td>FRA1 (ex B1FRA2)</td>
<td>High environmental quality of buildings</td>
<td>Ongoing</td>
<td>Information/Education</td>
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<td>Minimum efficiency standards for hot water boilers</td>
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<td>FRA10 (ex)</td>
<td>Subsidies for wood equipment</td>
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### CHALMERS

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Note: The “Tertiary sector” in the MURE databases and simulation tool is very similar to the sectors often referred to as “Public buildings and services” etc. in PATH-TO-RES. It covers measures and data related to energy use in nonindustrial organisations, covering mainly the public sector and service industries. For the purposes of simulation, the energy use has been broken down into nine main subsectors:

- Commercial offices
- Distribution and warehousing
- Education
- Government offices
- Health
- Hotel and catering
- Public buildings
- Retail
- Sport and leisure

Appendix B – page 3