Local Energy Planning

- a new supporting framework

January, 2011

Seven steps towards sustainable local energy systems

At present there is an increasing interest and intensified activities on local level where communities around the world set up their own sustainable targets, often linked to corresponding international targets. In Europe, there has been an overwhelming interest in the Covenant of Mayors, with more than 2,000 communities signing this agreement by which they commit themselves to go beyond the 20% targets in the EU Energy and Climate Package.

A new supporting methodology for energy planning

Actions undertaken at the local or regional level are crucial for meeting the global and EU goals for sustainable development. Path-to-RES has developed a seven-step methodology that can be used to evaluate and define pathways to renewable and efficient energy systems in the local setting, i.e., a supporting tool for energy planning.

Linking short-term actions to long-term visions

- Six case studies confirm the usefulness of the methodology

The seven-step methodology was tested in six case study regions within the EU. These case studies show considerable variability in terms of population size, land area, and characteristics of the existing energy systems. Nevertheless, the results indicate that the seven-step assessment tool is applicable to each of the six case studies, despite their considerable differences and unique features. This confirms the usefulness of the methodology.

A guide to practitioners

The purpose with this brochure is to provide a guide to practitioners and a first introduction to the checklist. Each of the seven steps are described, together with practical advice related to each step. The description of the steps is followed by some spotlights from the local case study project. More detailed information on the seven step approach can be found on the projects website, **www.path2res.eu**, where several reports and studies carried out during the project are available.

The methodology has been developed within the Path-to-RES project supported by the Intelligent Energy Europe programme.

THE 7 STEPS:

1. Project initiation
2. A detailed description of the present system
3. Assess goals in sustainable development
4. Identify key technologies and measures
5. Identify key actors
6. Analyse sustainable pathways
7. Etablish a roadmap

Towards sustainable energy systems

There is growing global concern and increasing consensus that the emissions of CO_2 and other greenhouse gases caused by human activities are affecting the climate in a harmful way. This has resulted in a number of political agreements, goals and targets, e.g. the Kyoto protocol, the EU goals for decreased emissions of greenhouse gases, increased use of renewable energy and more efficient use of energy (20-20-20). In order to succeed with the transformation of society necessary to achieve such goals a significant part of the requisite actions have to take place at the local level. To facilitate local requisite actions and measures it is necessary to prepare a local roadmap towards sustainability.

Currently, many municipalities within Europe are developing plans and strategies in order to transform their local energy system towards sustainability. There are also several municipalities, mainly within the EU, that have signed up to the Covenant of Mayors and thereby committed their municipalities and cities to go further than the EU 20-20-20 targets.

"EU 20-20-20"

The EU Heads of State and Government have set a series of climate and energy targets to be met by 2020, collectively known as the 20-20-20 targets. These are:

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels
- 20% of EU energy consumption to come from renewable resources
- A 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency

Even if the 20-20-20 targets may seem obvious at a first glance, experiences indicate that the implementation is far from trivial in plans and strategies on the local level, i.e. in municipalities and regions.

Related to this, the EU Commission have called for relevant supporting tools for municipalities that need guidance with developing plans and strategies for fulfilling commitments such as the Covenant of Mayors. Thus, there are ongoing energy planning methodologies being developed within different EU programmes and initiatives (such as Intelligent Energy Europe, ManagEnergy, etc.)

In addition to methodologies developed in the EU programmes there are several guidebooks available for practitioners, which describe structured working processes for local energy planning as well as practical examples of the implementation of different case studies. There have also been several papers written about local energy planning in the scientific community. Thus there are several different methodologies to choose from. It may even be difficult for practitioners to choose from the large number of methodologies available.

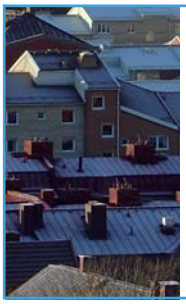
Many existing methodologies are not really adapted for considering the long-term perspective (i.e. 20-50 years from today) and furthermore it has been recognised that plans and strategies in the local setting often do not include any long term strategies that are related to the activities of today. Municipal energy systems generally consist of infrastructures with long life lengths (i.e. buildings, transport system, energy conversion and distribution) which are not adapted for rapid changes. Thus, there is a great risk that short term actions may result in costly long term lock-in effects if the long term perspective is overlooked.

The Path-to-RES project aims to fill this gap. It presents a step by step methodology that can evaluate and define pathways to renewable and efficient energy systems. It emphasises the importance of both short term and long term planning in order to identify a cost efficient bridge from the present system to a sustainable system. When the Path-to-RES project was initiated it was not envisaged to be possible to find one "standardized" methodology that can be applied to any municipality, since all local energy systems are quite unique. Furthermore the idea was not to replace existing methodologies. Instead a step by step checklist at a more general level has been developed, which can be of use to any municipality and in some cases can also complement other methodologies. The methodology has been tested in six local case studies in different EU countries.

In this brochure the checklist which consists of seven steps are presented, This includs critical aspects for each of the seven steps as well as some practical examples from the case studies.

The seven step methodology

With experiences from case studies in six communities and regions of the EU and from project partner's earlier experiences, a step-by-step methodology has been developed for defining and evaluating Pathways to renewable and efficient local energy systems. A Pathway is, as mentioned above, a cost efficient way to bridge from the present energy system to a future sustainable system. Based on these Pathways a Roadmap is then prepared. The Roadmap is a description of the preferred Pathway and includes a technology portfolio together with a description of the likely consequences and implications for the energy situation and emissions from the local system.



THE LOCAL CASE STUDIES HAS BEEN:

- The municipality of Göteborg (SE)
- Greater Dunkirk Urban District Council (FR)
- The home owner association of De Stoere Houtman in Arnhem (NL)
- The municipality of Lochem (NL)
- The municipality of Gdansk (PL)
- The Valencian Region (ES)

The aim of the methodology, which is called "The seven step checklist", is to be a general support tool for local energy and climate planning efforts (such as the Covenant of Mayors). The case studies have therefore included both large and small local systems as well as systems with high and low energy intensity.

The checklist consists of seven steps:

1. Project initiation
2. Establishment of a detailed description of the present system
3. Assessment of local, EU and global in sustainable development goals
4. Identification and assessment of key technologies which can bridge to a future sustainable system
5. Identification of key actors in the region
6. Formulation and analysis of pathways towards a more sustainable energy system
7. Establishment of a roadmap

The methodology has been developed within the Path-to-RES project supported by the Intelligent Energy Europe programme.

Important features

Before going into details about the different steps, we would like to highlight and summarize the most important features of the seven step checklist:

- The preparation of different pathways should be based on a detailed description of the present energy system.
- The methodology combines short and long term views and identifies bridging solutions.
- Key technologies are identified and evaluated in order to find pathways towards a more sustainable energy system.
- The importance of key actors participation in the planning process is emphasized.
- The methodology is general in its approach. This facilitates adaption to different local conditions.
- Identification and analysis of goals at different levels (international, national, regional) is an important feature of the planning process.
- No specific computer programs or software tools are required.
- The use of a structured energy balance, the Reference Energy System, highlights systems related issues.
- A short term action plan is an important part of the Roadmap. It specifies who is responsible for what, when actions should be taken and how the actions should be evaluated.

The seven steps are not necessarily to be taken in chronological order. However, in some cases the process has to be iterative so that the steps could run parallel activities if needed. This is further described in the description of the different steps.

Step 1:

Project initiation

For a successful planning project it is already from day one to attract create in the project, to find a common understanding of the goals and to build a commitment among key actors.

This first step is designed to:

- involve key actors and get a commitment at an early stage
- include the opinions from key actors in the pathway process
- connect to ongoing related activities
- be a natural starting point for collection of data
- discuss what the project should be used for

Since the project initiation is focused on interaction with key actors it is necessary to identify the most important key actors from the start. This means that a first part of step 5, "Identify key actors in the region", is already made at this stage. It is of course also necessary to have a rough idea of how the present energy system looks and how it could be developed towards greater use of renewable energy and a more efficient use of energy. It is however important to find the proper balance between having enough information to present the ideas behind the project and making a too extensive analyses that perhaps will not be used later on. Initial discussion can sometimes lead to a somewhat altered direction of the project.

In order to get support from all key actors it is often wise to focus on **short term development and actions**. If one initially focuses on long term, e.g. past 2030, people may experience that this is too many years away and that too little is known about the situation at that stage. It is also difficult to connect such a long perspective to ongoing activities. Most people tend to be more interested in the near future where actions more clearly can make an impact in the near future. The longer time perspective is however very important to introduce already early in the project.

One potential problem related to this step is that, in spite of best efforts, there may still remain a lack of commitment from key actors to the visions and actions. If this commitment is not possible to create, it is recommended that the whole pathway planning effort be reconsidered.

THINK ABOUT THIS:

- Clarify purpose and main direction of the work to be performed.
- Involve key actors in the process at an early stage in order to get their commitment.
- Connect to ongoing activities.
- Let opinions from key actors influence the direction of the pathway process.

Step 2:

Establish a detailed description of the present system

Due to the slow turnover of the energy system the description of the present situation is of great importance. The present situation is also important for the formulation of goals and for identification of cost effective measures for the action plan.

Local energy systems must be assigned a sustainability roadmap, which has as its point of departure, a detailed description of the present system and includes a definition of bridging systems and which is linked to EU and global sustainable development goals.

This formulation highlights the importance of the analysis being based on a **detailed description of the present system**. In order to be able to identify pathways towards sustainability it is essential to have a good picture of the starting point of these pathways, i.e. a detailed description of the present system. The reason for the importance of the present system is the **slow renewal of the energy system infrastructure**, such as buildings, district heating network and energy conversion equipment. This implies that development over long periods will be highly influenced by the present system. For example the majority of the buildings that will be heated in the year 2050 already exist.

One part of this second step is to analyse and formulate initial conditions. This requires an effort to find information about the local/regional energy system of today. This includes collecting data about the use of different energy carriers in different sectors, the related emissions and important background data, e.g. fuel prices, electricity prices and policy instruments. Another important part of this step is to identify existing plans and ongoing activities in related areas. When the local planning project is started it is a great advantage to make use of such plans and to refer to ongoing activities in related fields. This makes the process effective and attracts attention from those who are engaged in other ongoing activities.

One way of describing the present situation in the energy system, which has been found to be particularly useful, is by using the Reference Energy System (RES) method. It is a **structured and graphical method to present and analyse the energy system**. A schematic example of a RES is shown below.

There are often problems with finding data for a system description of local communities. Thus, some specific tips to overcome general obstacles of data collection are:

- Look for official (local, regional and national) data and prognoses.
- Make an effort to find data of key statistics such as most important primary energy sources and overall consumption in different sectors. This gives a first idea of the main characteristics of the energy system and it will simplify the process of finding further data and making assumptions.
- Establish contacts with companies/ organisations/people that might have access to data.
- Make your own assumptions. RES is also a valuable tool for identifying mismatches and doing approximations.

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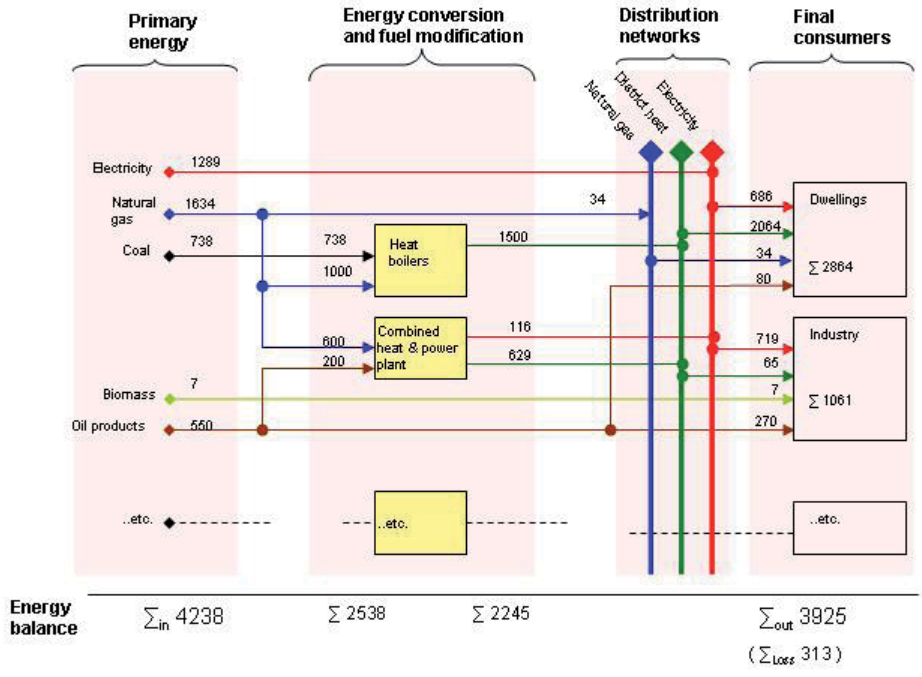


Basic design of a RES-diagram

Step 3:

Assess local, EU and global goals in sustainable development

To formulate local goals first thing to do is to identify and assess global goals, EU directives and goals together with goals and policy instruments applied on the national and local level. Such goals define pathways towards an energy system with an increasing share of renewables and efficient use of energy.

The focus of this step is to redefine existing goals and directives in order to make them applicable at the local level. If there, for example, is a national goal of 20 % reductions of CO_2-emissions it is far from obvious that a certain municipality should reduce their emissions by exactly 20 %. Appropriate local goals depend on several conditions. Existing local goals in other local plans and projects are also important to consider in goal formulation. One important aspect is to identify possible conflicts between goals. An example of this could be conflicts between goals for economic growth and protection of the environment. Since there may be a large number or existing goals and directives in fields related to sustainable development there are consequently a large number of potential conflicts. When conflicts have been identified it is up to the project and the participants to discuss and conclude how to prioritize between different goals.

In the goal formulation it is important to include the total effect of actions within the local energy system. Local actions could lead to implications outside the system. If, for example, electricity is supplied by the national, or international, electricity system local actions may result in an increased production outside of the system. It is valuable to discuss how the electricity use could/should be made in relation to the fulfilment of goals.

Some sectors, such as the transport sector, tend to have problems meeting general goals, e.g. on CO_2 reduction. To handle this situation it may be necessary to differentiate the goals between different local sectors. A cost efficient response to targets should be favoured, i.e. when a general target is split into sub targets one could for example apply stricter emission reduction targets in sectors where measures are cheap and vice versa.

THINK ABOUT THIS:

- Goals on higher levels (global, EU, national) must be adapted to the local level
- Existing local goals in other local plans and projects are also important to take into consideration. The goals are sometimes very general. Such goals need to be defined in more operational terms.

>>> Continued Step 2

THINK ABOUT THIS:

- Due to the slow renewal of energy system infrastructure it is important to establish a detailed description of the present system.
- It is important to understand how the different parts of the energy system are connected and interact
- The system boundary defines what should be analysed. Properties for energy carriers flowing across the boundary are important to establish.
- The RES diagram (a structured way of presenting an energy balance) is a useful tool for a detailed presentation of the energy system.
- Problems with finding data for a system description (such as the RES) often occur. Most often data can be found even if some effort is necessary.

Step 4:

Identify and assess key technologies which can bridge to a future sustainable system

When investigating if the local action plan contributes to sustainable development it is important to identify and assess technologies/measures that contribute to a more efficient energy system with a larger share of renewable energy.

With a large number of possible measures with different effects both locally and outside the local system it is necessary to systematically identify and assess if measures contribute to a development towards a more sustainable energy system. The following categorisation of technologies / areas can be applied in order to provide a structured analysis of potential measures in the energy system:

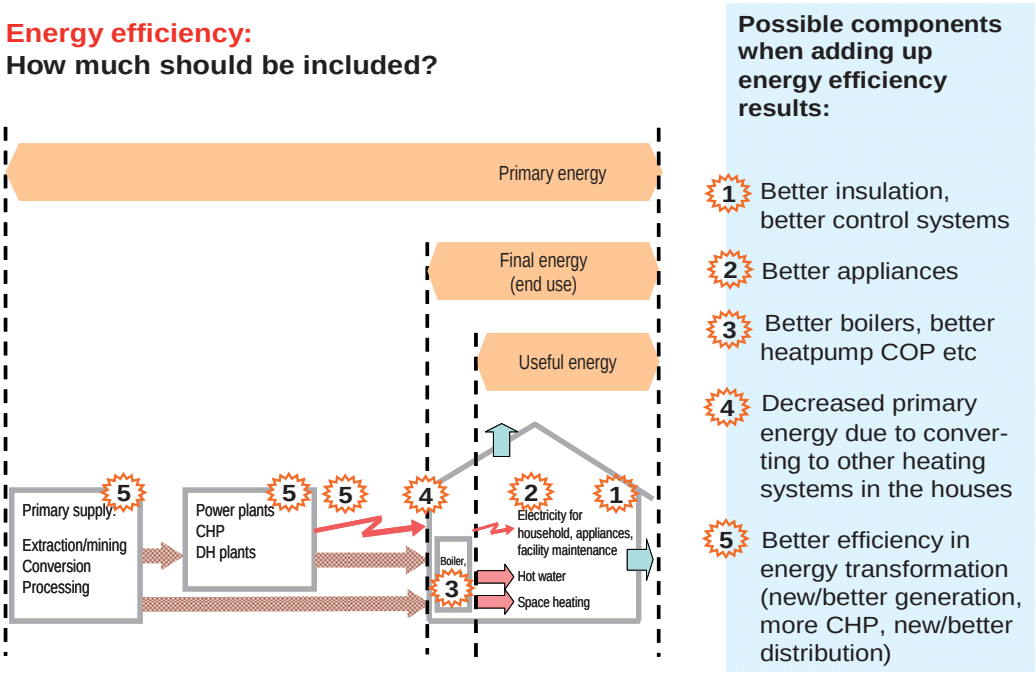
1. Energy conversion and distribution technologies
2. Efficiency measures
3. Transportation

Conversion and distributions technologies could be qualitatively evaluated with respect to the following aspects:

- Suitability in the local system
- Technology maturity and development potential
- Local and global risks
- Political climate/public opinion
- Time perspectives
- Local influence on the decision
- Environmental consequences (emissions, exploitation of land areas, etc.)
- Fuel markets and security of supply

The conversion and distribution technologies obviously also have to be evaluated for more technical and economical aspects such as:

- Demand and capacity (which the technology should provide)
- Basic technical data (such as thermal efficiency, CO_2 intensity)
- Emission levels (NO_x, SO_x, CO_2, etc)
- Economics (investment, variable cost)
- Life time
- Requirements on distribution system/grids



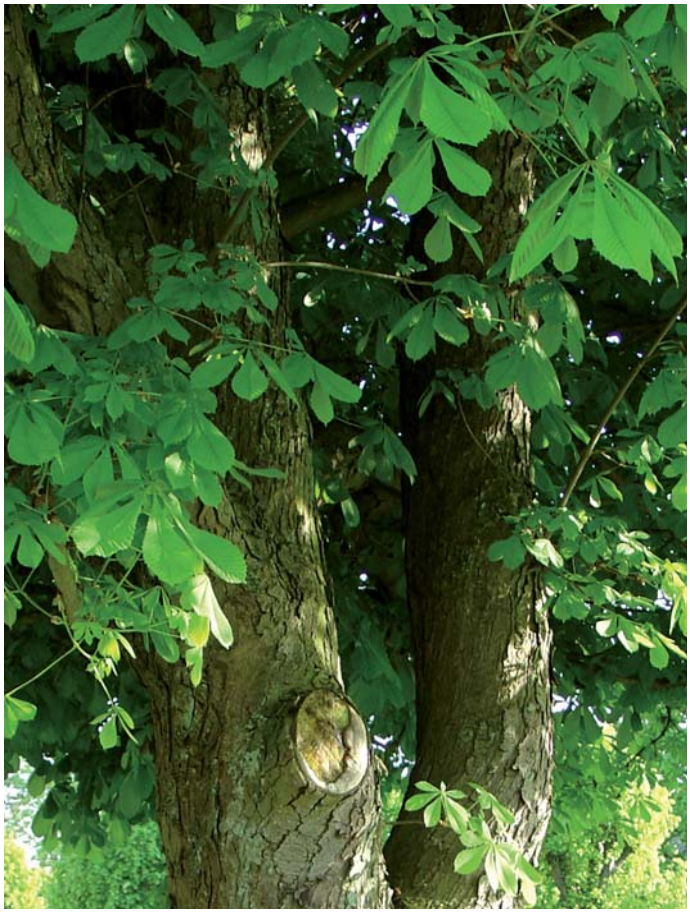
Some examples of energy efficiency measures in a system perspective

For measures used for improving energy efficiency the questions as to what can be classified as energy efficiency in a system perspective is important to discuss. As indicated in the figure below, both primary energy and final energy use must be considered. Energy efficiency is not only associated with the final energy use. Different systems boundaries also raise the question, as to who is responsible for increasing the efficiency of the local system; the final energy user, the distributer, the electricity and district heating producer or the owners of mines and refineries - or all in the supply chain? The local planning project has to identify what is effective to do locally and what should be done outside of the local system. Two ways for analysing local efficiency are to analyse the use of Primary energy and/or to include emissions from outside the local system (e.g. for electricity).

The transport sector differs from the stationary energy sector in many respects, in particular due to its mobility and in many cases due to its weak connections to the local system. The transport sector is therefore a local political challenge since

i) national policy instruments will be necessary and

ii) it has to be integrated in all parts of the physical planning.



THINK ABOUT THIS:

- A broad range of alternatives should be considered. Otherwise there is a risk that valuable alternatives are overlooked.
- Connect to ongoing activities and associated specific technologies, in order to attract interest and create commitment.
- Cost-efficiency should be considered when technologies are chosen.
- When technologies or sub-systems are assessed from a sustainability perspective it is important to include all effects from a systems point of view, and also resulting effects outside the system boundary.

Step 5:

Identify key actors in the region

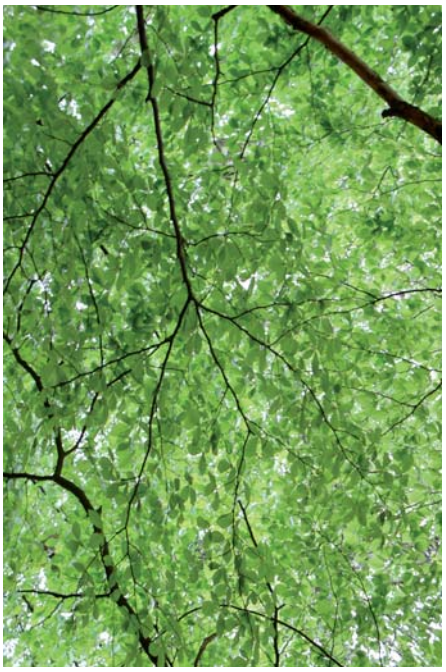
Involvement of the key actors is one of the most important factors for a successful planning process. Examples of such key actors are local politicians, representatives of strategic departments in municipalities, energy companies and utilities, transport companies, universities, institutes, consultancies, NGOs and the general public.

A planning situation includes actions to assure that key actors are identified and become involved in the process. The first step "Project initiation", emphasize the importance of this. As mentioned above, the aim of that step is to, already from day one, create interest in the project, find a common understanding of what the project should aim for, and to reach a commitment among key actors that the road map planning effort is an important task to perform.

Step 5 focuses on a more thorough mapping of key actors with the ambition to get their involvement and commitment to the planning process. One way for this is local workshops where the Pathways towards a renewable and energy efficient energy system are presented and discussed. Another important part of the work to get involvement is the action plan, which is a part of step seven "Establish a roadmap". In order to make the action plan effective it is important to link responsible key actors to each of these actions. To distribute responsibilities it is important to have a good knowledge about key actors and what they have a possibility to influence (and how they interact).

Important questions to reflect upon in relation to the identification of key actors are:

- How to "sell" ideas for sustainability and efficiency to decision makers?
- How does interaction between political/municipal key actors and stakeholders on the markets look like?
- Are there any key actors with responsibility to fulfil specific actions, for example according to an energy or environmental plan?
- How to inform other key actors and the general public about ideas of sustainability?
- How to win acceptance for long term visions on sustainability?
- How to deal with conflicting interests?



THINK ABOUT THIS:

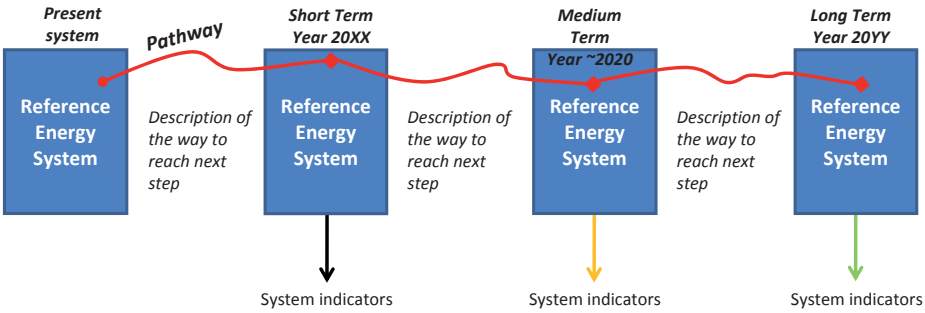
- It is important that key actors get involved and committed at an early stage. One reason for lack of interest and commitment from key actors might be that they get involved too late in the process, and therefore feel that they cannot influence the work to sufficient level.
- To present arguments promoting the project that are specifically chosen for each key actor. In order to attract interest it is important to present trends and actions that answers the question "what's in it for me".

Step 6:

Formulate and analyse pathways

A Pathway can be described as a way to reach a certain goal (or a set of goals) over a certain period for a given scenario. It is also a pedagogical instrument in the process of creating consistent scenarios over time.

In this step, pathways are formulated on the basis of the Path-to-RES guidelines. In the figure (right) a flow diagram overview of the proposed concept is presented.



Flow diagram overview of a suggestion of how to describe a pathway towards sustainability

A Pathway can be described as a way to reach a certain goal (or a set of goals) over a certain period for a given scenario. The following items are considered necessary in order to be able to describe a pathway towards sustainability for a local energy system:

1. An appropriate technical description of the energy system with all its components (Such as the previously described RES, as described by a corresponding system model).
2. The time frame. The time frame should be divided into a certain number of time steps.
3. Relevant indicators must be chosen for energy supply, energy consumption, emissions etc.. The indicators are used to evaluate whether the goals have been fulfilled.
4. Pathway parameters which define and express the pathway should be described. These parameters are i) "hard" parameters (such as the components of the Reference Energy System), ii) "soft" parameters such as goals and visions, present plans and projects and roles of key actors and iii) "Overall reflections" i.e. discussions about how all parameters interact in terms of risks, possibilities and obstacles. One example of question could be large scale use of biomass; how will this interact with district heating, the public opinion and the demand for transportation?

Parameters

- System components (RES diagram);
  - **Energy end users**
  - **Distribution networks**
  - **Primary energy sources**
  - **Energy conversion**
  - **Fuel modification**

-What to be changed?
-Which are the key technologies?

- Important goals and visions.
- Interacting plans, projects and strategies. (Including actions planned).
- Role of stake holders and key actors.
- Institutional and financial framework.
- etc..

Overall reflections

- Foreseen obstacles *(reflections on how to overcome them if possible)*
- Possibilities foreseen *(could for example any "win-win" relations be identified?)*
- Interactions between short term actions and long term strategies.
- Potential risks (could have connections to development scenarios). *Note, the term risk should not be considered as the same thing as obstacles.*
- etc...
- *Problems/obstacles for which solutions cannot be proposed for, or information considered necessary but cannot be found, can also be important input for discussion in a Pathway.*

Examples of overall reflections on the important parameters of a local energy system

On the basis of this flow diagram overview, the methodology provides guidance for the development of pathway scenarios. It is also important to stress that the pathway methodology should be seen as an ongoing process that should be revised regularly. The result is not one definitive energy plan for the period from today to the year 2050. It is certain that over time political goals, policy instruments, fuel prices, costs and performance of different technologies, etc. will change and therefore the pathways must change accordingly. The evaluation of the action plan will also show which

>>> Continued Step 6

areas that have developed according to plans and which areas need "stronger actions". Energy and climate strategies are also a learning process – don't hurry but be active!

THINK ABOUT THIS:

- It could be difficult to make detailed technical descriptions for a very long term perspective (e.g. 2050). Due to uncertainty about long term technology development it is difficult to make meaningful detailed projections. Therefore place less emphasis on detailed technical description. More emphasis should then be put on visions, goals and principal directions.
- Too tight system boundary may lead a situation where important issues are overlooked, e.g. within the transport system. Consider the total energy system. It is important to make a comprehensive analysis of the total energy system.
- Make sure that the Pathways lead to the increased sustainability of the energy system.
- Energy and climate strategies are also a learning process – don't hurry but be active!

Step 7:

Establish a roadmap

When different pathways have been identified and analysed there is one important step left; establish a roadmap. The roadmap is the preferred pathway, together with a process of how to transform it into real actions. Action should be the result of the project!

It is important to see the Roadmap as an instrument for change in the direction of sustainability. It is not the Roadmap report as such that is the goal of planning efforts; rather it is the resulting development of the energy system in a desired direction that is the important outcome. The planning process is merely a means for achieving this desired development.

The establishment of a roadmap can be described in the following points:

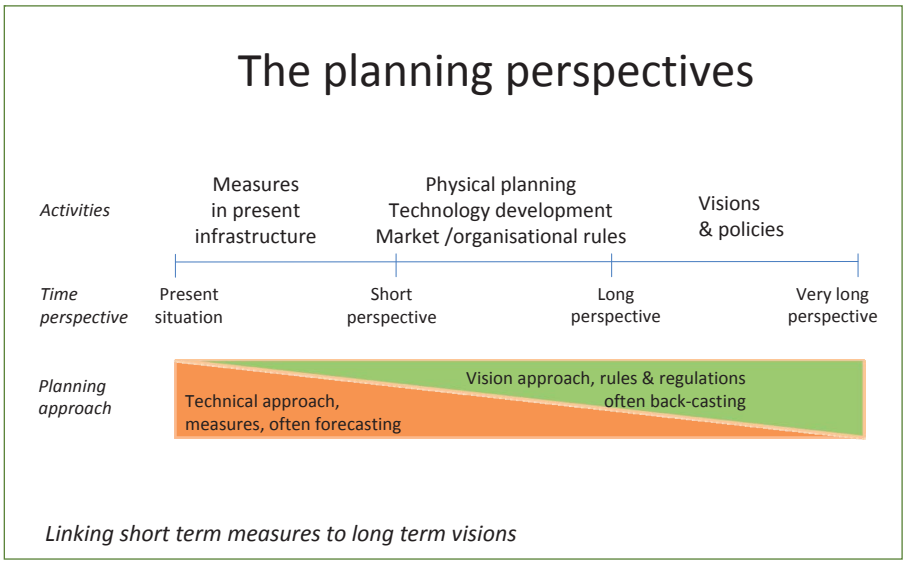
- Involvement of key actors / stakeholders is crucial. If their involvement and commitment is missing it is impossible to evolve the planning process into real change of the energy system.
- The Roadmap could be developed in an iterative way in order to get acceptance from key actors. In order to get the involvement of key actors it is important to make them to be part of the process and that they have the possibility to influence the work, e.g. to formulate goals and to suggest actions.
- It is important to be aware of the possibility to influence the development in different sectors. The municipality has direct control over their own buildings and their own vehicles. In other areas the possibilities to influence are less direct, e.g. by means of physical planning. In some areas the municipality may act such as through specifying certain qualities when equipment or services are bought. In other areas the municipality's only way of influencing the development is through information. This means that different strategies must be chosen accordingly (control, act, and inform).
- The Roadmap should include an action plan in order to be effective (short and mid term perspective). In the action plan responsibilities for each action should be specified. It should be specified when each action should be finalized and how it should be evaluated. This is important in order to make sure that the plan is implemented through concrete actions.
- For the long term there should be more focus on visions and strategies. For the long term development, e.g. 40 years from now, it is not meaningful to specify a typical action plan. Much can change and what we could specify today may become irrelevant

over this long period. Development desired for the long and very long time perspective could preferably be expressed through visions and general strategies. These could later be transformed into more "action like" plans. See the illustration to the right.

- The Roadmap work should be considered as an evolving process which is updated regularly in cooperation with key actors. Since prerequisites will change it is important to revise the roadmap regularly. Otherwise it will gradually become disconnected from reality.

The **action plan** is an important part of the roadmap. Important items related to the action plan are:

- Specify how specific measures should be implemented, who is responsible, when it should be completed and how it should be evaluated.
- There are different possibilities to influence the development in different sectors – control, act or inform.
- The key actors that are assigned responsibilities in the action plan should be included in the planning process in order to ensure their involvement and commitment.
- All parts of the action plan should regularly be followed up and evaluated.
- The plan should be transferred into decisions on actions / goals / directions / ambitions.



Linking short term measures to long term visions

THINK ABOUT THIS:

- The Roadmap is an instrument for change in the direction of sustainability. It is not the Roadmap report as such that is the goal of planning efforts; it is the resulting development of the energy system in the desired direction that is the important outcome.
- Involvement of key actors / stakeholders is crucial.
- Different strategies must be chosen according to possibilities of influencing development in different sectors (control, act and inform).
- The action plan is important in order to make the plan operative. Here responsibilities for each action should be distributed. When each action should be finalized and how it should be evaluated should also be defined.

- Measures from the action plan should be included in the budget process of the municipality.

Spotlights:

Experiences from our case studies

The 7 step checklist has been developed from experiences from local case studies in six communities and regions. Here follows a brief overview of each case study and some results from the local projects in order to illustrate how the methodology has been applied by the case studies.

Key technologies of the community of Dunkerque

The Urban Community of Dunkerque (CUD) includes 18 municipalities with a population of 200,000 inhabitants and a total area of 255 sq. km. Located on the shore of the North Sea in France, near the Belgian border, the CUD is characterized by the presence of an industrial port zone of both national and European importance in the energy sector. The energy system of Dunkerque is characterized by a large amount of national installations, for example refineries, the nuclear power plant (one of the biggest in the world) and the large thermal power plant. Dunkerque is heavily industrialized and the industries are by far the biggest energy demand group. Furthermore, as a consequence of the industrials both waste heat for the district heating network and blast furnace gases used for electricity production are recovered. Several measures to conserve energy, manage demand and develop renewable energy have been put in place in the community with targets linked to national and international policies (Local Climate and Energy Actions Plan, Covenant of Mayors, Kyoto Protocol). Key technologies include commercial available technologies, which are already being implemented (energy efficiency, district heat, wind and solar), and medium to long-term available technologies under development in the territory (marine energy, and Hythane hydrogen, PHEVs).

With a focus on energy efficiency and use of local resources the technologies listed in the table have been identified as key technologies that could bridge to the future sustainable energy system. The table includes technologies for the full time perspective; from the short perspective to the long term perspective.

One of the important technologies is the district heating system in Dunkerque. This system received a Global District Energy Climate Award in 2009 motivated with "the heating network is an essential component of the regions environmental policy, and enables the community to maintain and enhance the regions reputation as a leading industrial area".

	Short term - 2014	Mid term - 2020	Long term - 2050
Energy efficiency	Building insulation, Condensing gas boiler, Double flux ventilation		
District heating	Extension of the network	Connection of RE sources	Connection of RE sources
Solar and wind energy	Solar water heating, Solar space heating, Solar PV	Onshore wind / Offshore wind	Onshore wind / Offshore wind
Marine energy		Thermal energy (sea water heat pump), Osmotic energy	Wave and current
Hydrogen energy	Hythane for transportation	Hythane for stationary	Hydrogen for transportation
V2G (Vehicle to Grid)		Electrical cars and Plug-in hybrids	Smart grid

The detailed description of the present energy system of Valencia

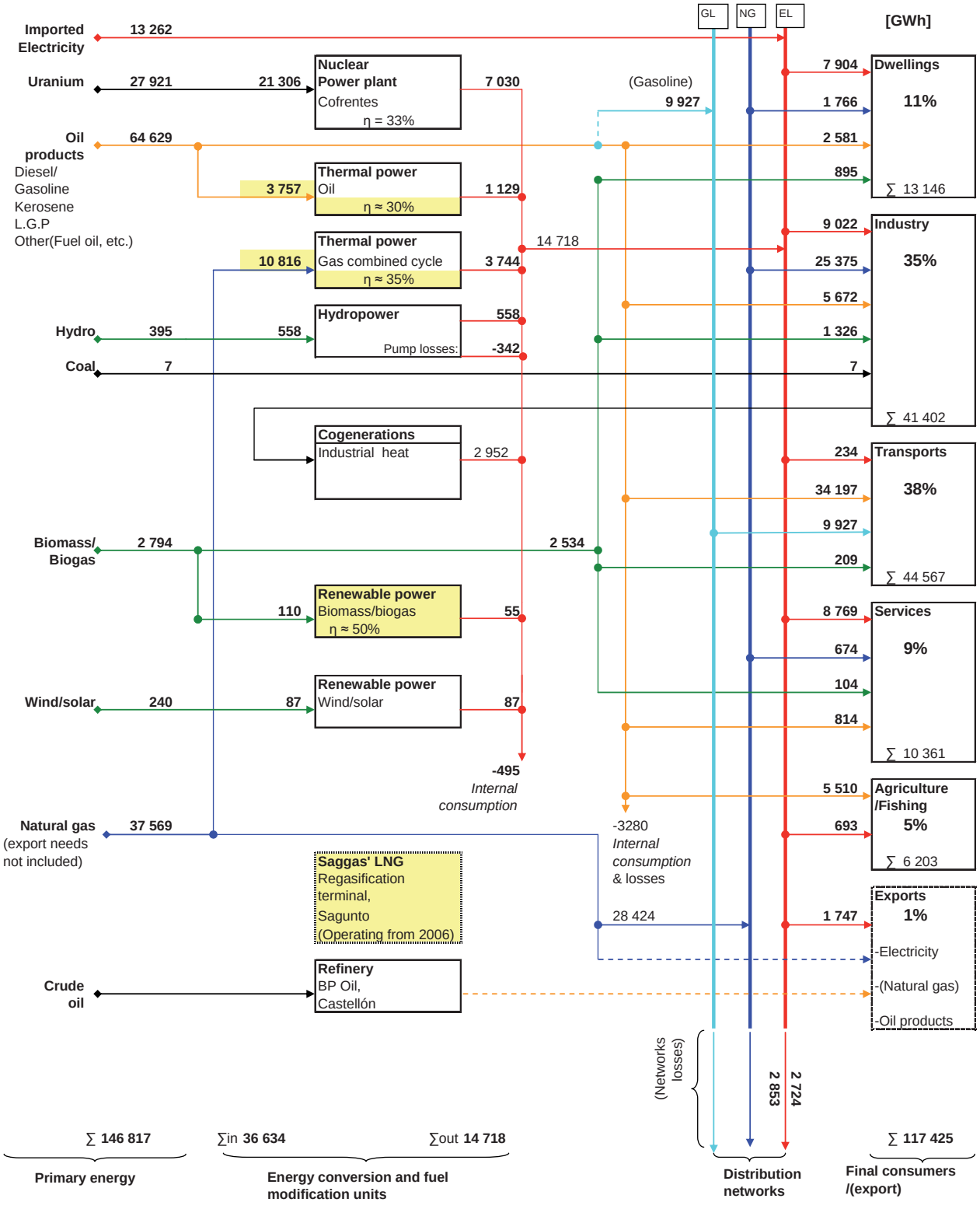
The energy system of the region of Valencia with its 4 900 000 inhabitants is a large system which is strongly integrated with the national energy system through electricity production and refineries. The roadmap developed in Valencia is built upon a detailed forecast scenario where the current increase of population and the economic growth will continue throughout the pathway period, i.e. until 2050. Consequently, the overall energy consumption in the scenario is foreseen to increase as well. To increase the penetration of renewable energy sources several energy strategies at regional and national level, have been considered. Thus, the roadmap provides an indication of what effect these plans may have on the Valencia energy system. The pathway formulated indicates that in spite of a considerable increase in the use of renewable energy sources, overall- and per capita CO_2 emissions continue to increase due to the increased energy consumption. The most valuable conclusion that can be drawn from this result is that if the current trends of increased energy end use continue, overall CO_2 emissions cannot be sufficiently reduced in spite of a comprehensive shift towards renewable energy sources. Thus, more comprehensive measures for improved energy efficiency and energy savings are needed as well.

The result of the mapping is shown below in form of a Referens-Energy-System and includes :

- Primary energy sources: The diagram starts from the left hand side with input of energy from outside the system boundaries. Examples are oil products, natural gas, biomass and imported electricity.
- Fuel modification processes, e.g. oil refineries and gasification plants.
- Energy conversion technologies: Examples of these are electricity production plants, heating plants, and combined heat and power plants.
- Distribution systems: From conversion, and sometimes primary energy and fuel modifications as well, energy is connected to the distribution systems, mainly different through networks for example for electricity, natural gas and district heating.
- Final consumption and exports: On the right-hand side of the diagram, consumption is summarized in different user categories as well as the energy products that they consume. Examples of such user categories are dwellings, service buildings, industry and transport. It is also possible to illustrate how energy is used by final consumers via for example end use technologies like boilers, district heat exchangers and energy demands like electricity needs for cooking and lightning, etc.



The Reference-Energy-System of Valencia Region



Key actors of Lochem

Lochem is a rural municipality in the Netherlands, which covers a total land area of 216 km^2 and has about 33000 inhabitants. Currently the main sources of energy supply are fossil-based electricity and natural gas. Both are produced outside of the region and delivered to Lochem through national grids. A variety of industries are situated there. Two seed mills and a dairy company located on the canal can be classified as "heavy industries". Most of the industry is craft-related, such as metal, publishing and wood-related industries. In 2008 the Municipality formulated a Climate Policy with a strong focus on energy policy for future years. The document was the adaptation, at local level, of the National policy agreed by the Dutch government ('Regeerakkoord van Kabinet Balkenende IV – 2007). These national objectives are: 1) 30% less CO_2 emissions by 2020 (compared with 2009). 2) 2% energy efficiency improvement per year. 3) 20% share of renewable energy. In the case study of Lochem, the aim is to carry out an assessment on the availability of biomass and identify strategies to convert this biomass to an energy source in order to provide valuable information on the handling and use of local biomass in a regional, but also in a European context. Lochem has a high penetration of non-bio diversified vegetation on creeks, riverbanks and road-sides. The mowing of riverbanks, creeks and roadsides will create new excess biomass. Biomass could also be produced on local farms.

As a part of the process of involving key actors and to getting commitment to the Pathways works the project in Lochem has involved a large number of local and regional stakeholders. It has also been important to connect to on-going activities in the community. The key actors involved are listed below together with their role in the energy planning process.

Organisation	Role / Responsibility
Municipal board	Decision makers
Municipal departments	Executer of activities
Local politicians	Decision makers
Province of Gelderland	Regional authorithy, permissions
Municipal cooperation platforms	Cross border activities
External consultants	Support to the implementation process
Utilities (energy companies)	Energy distribution network
Industrial companies	Energy user
Housing corporations	Energy saving measures
Project developers	Energy saving measures, investments
Architects, construction companies and installers	Energy saving measures
SMEs	Green Business development
Interest groups	
General public	Energy saving measures

Formulation and analyses of long term Pathways in Göteborg

The present energy system in Göteborg is characterized by extensive networks for district heating and natural gas, as well as extensive use of recovered heat from refineries, combustion of household waste and sewage heat by means of heat pumps. The amount of locally produced electricity is around 30 % of local consumption. The City of Göteborg has been working with sustainability issues for a long time, and has thus accumulated substantial experience in the field. In order to succeed with strategic investments, it is necessary to have both a short and long-term perspective simultaneously. The Seven-Steps' method is a simple way of ensuring that long-term visions and shorter term actions support and complement each other. The Covenant of Mayors (CoM) action plan for Göteborg is implemented according to these principles. The Göteborg case study focuses on working with the local government to create an action plan that is required for Göteborg, to fulfil its obligation for the CoM, which the City of Göteborg signed in early 2009. By doing so, the Seven-Step Method is tested in a real situation, and will contribute to make the CoM Action plan as robust as possible. This means that the main focus of the planning is done in a 2020 perspective, but the methodology used ensures that the longer term perspective is maintained at all times. Hence the risk that efforts to fulfil the 2020 targets are not "future-compatible" is greatly reduced.

The municipal vision for 2050 includes a nearly fossil free community. The only CO_2-emissions left will be in the form of indirect emissions through import of goods. By this time, even without any technological breakthrough in electricity production technology, the production capacity of sustainable electricity (wind, photovoltaic, etc.) should have become so large that electricity is cheaper than fuels. This could mean that more biomass could be available for the chemical sector and possibly for bio transportation fuels if those are needed. Some indicators for the development of the energy system are presented below.

PRIMARY ENERGY (GWh/Year) (Estimated population: 500,000 600,000 800,000)			
	2012	**2020**	**2050**
Total primary energy [GWh]	22,600	16,400	8,000
Total primary energy/capita [GWh]	0.045	0.027	0.01
Electricity	5,000	4,000	4,000
Natural gas / Bio gas	(N) 1,700	(N) 3,000	(B) 1,500
Wind	13	200	200
Waste	1,184	1,184	500
Petrol	2,400	2,000	0
Diesel	3,600	3,000	0
Fuel oils	530	530	0

Goals in Gdansk

The approximate land area of Gdańsk in Poland is 262 km² and its approximate population is 460,000 inhabitants. Electricity is available to 100% of the region's population but the supply is intermittent because of problems caused by the unsatisfactory condition of medium and low-voltage distribution lines (including voltage transformation facilities) and unreliable cable lines. The operation of the regional heat supply system is satisfactory. Recent years have seen a significant drop in the demand for heat, despite new residential and industrial developments. This results form the fact that existing buildings have been modernized to improve their energy efficiency. Despite increased efforts to improve thermal insulation further, there are still a lot of efforts in progress. The percentage of the population using centralized district heating is high, more than 80%. A major drawback of the heat supply system however is that it uses a high proportion of coal. Also coal stoves are used relatively frequently as well. Natural gas and biomass are also used to produce heat.

The total production of renewable energy in the region represents about 5% of total regional energy production, significantly less than the EU average, suggesting the need to raise awareness of possibilities with renewables. An improvement and extension of the energy distribution network is needed to cope with distribution of renewables. The Pomorskie region of Poland has been mainly using energy from rivers and biomass. Biomass appears to offer the greatest potential for renewable energy production in the region. Because of its location (Baltic coastline), the region has seen a growing interest from investors in producing wind energy. Solar PV is another possibility.

The project has formulated local goals for a medium and long time perspective. The goals are focused on the energy utilities i.e. power/heat/natural gas production and/or distribution companies and local authorities e.g. City Hall.

GOAL
Modernization of district heating system
Gasification of oil refining by-products in LOTOS Refinery
New power unit in Wybrzeze CHP Plants; natural gas fuelled power unit to electricity production
Increasing the share of biomass co-combusted with coal in Wybrzeze CHP Plants
New natural gas fuelled CHP Plant for new housing estates in Southern part of the city
New power plant housed on area of Gdansk
- Construction of district heating for new housing estates - Development of natural gas distribution system for heat only boilers in new housing estates - Construction and renovation of power distribution network for new housing estates and industry districts
Development of electrical transport system
Percentage of gren electricity volume distributed by ENERGA - Power Distribution Company: 8,7% in 2009, 10,4% in 2010, 11,4% in 2014, 12,9% in 2017
Increase the share of yellow electricity (from natural gas fuelled combined heat and power units)
Percentage of red electricity (from CHP coal fuelled power units) in electricity volume distributed by ENERGA - Power Distribution Comapany: 20,6% in 2009, 23,2% in 2012

Short term Pathway of the home owner association "De Stoere Houtman"

Arnhem is located in the Gelderland province of the Netherlands and is mainly an administrative centre. One of the communities within the city is 'De Stoere Houtman', a home owner association with 138 dwellings and 262 inhabitants. For "De Stoere Houtman", the goal is to become an "energy neutral" house association. The houses are more than forty years old and in need of renovation, which provides an opportunity for investing in energy reduction. At present the main energy supply comes from fossil-based electricity and natural gas. Natural gas is used for heating and cooking and electricity for all other purposes. Each apartment has its own gas fired central heating boiler. Most of these boilers are obsolete, with a relative low average efficiency and need to be replaced by newer and more efficient ones or other more innovative heating systems. By using the 7-step methodology, 'De Stoere Houtman' has developed a roadmap for the community's energy use for the short-term, 2020 and the long term 2050. Besides the aforementioned plans for improving energy efficiency, there is an ambition that by the year 2020 the major part of imported electricity is from renewable resources and for 2050 all imported electricity. For the long term there are also plans to continuously increase local energy production (solar and/ or local wind).

Short term activities are:

- Starting point is a feasibility study for renewable energy in co-operation with some neighbourhood projects.
- An important activity is to further develop the contacts with local, regional and national authorities to make it possible to implement an innovative energy system in the dwellings of "De Stoere Houtman".
- In this respect the City of Arnhem Climate Programme 2008 – 2011, examine the possibilities of having 'hydrogen houses'.
- To stimulate creativity for renovation of existing houses towards energy neutrality "De Stoere Houtman" has started activities to organise an international architecture-energy-competition. The objectives of this competition are to get 3 to 5 good ideas for sustainable refurbishment of existing houses from a proposed consortium of architect/constructor/financer.
- In the period 2015-20 the winning plan will be a basis for all the new houses being build energy neutral and existing houses being renovated as close to energy neutral as possible.



Contacts

Project partners

Dunkerque Grand Littoral Communauté Urbaine
www.cud.fr

EED Espace Éolien Développement – Le bon sens du vent – Une société du groupe POWEO
www.espace-eolien.fr

Gdansk University of Technology
www.pg.gda.pl/eng.php

Göteborg Energi
www.goteborgenergi.se

NTDA Energía
www.ntdaenergia.com

Susebeek Technical Consultants
www.susebeektc.com

CHALMERS
(Leading partner)
www.chalmers.se

nepas New Energy Performance AS
www.nepas.no

Profu
www.profu.se

Fundación Comunidad Valenciana Región Europea
www.uegva.info

Useful Links

PATH2RES – Pathways to Renewable and Efficient Energy Systems
Path-to-RES
http://www.path2res.eu

Supported by Intelligent Energy Europe
Intelligent Energy Europe
http://ec.europa.eu/energy/intelligent

Covenant of Mayors – Committed to local sustainable energy
The Convenant of mayors
http://www.eumayors.eu

Intelligent Energy e-library
http://www.iee-library.eu

managenergy
Managenergy
http://www.managenergy.net

sec-bench
Sec-Bench
http://www.sec-bench.eu

Intelligent Energy Europe