Energy planning using strategic environmental assessment – exploring new tools in a Swedish municipality

Anders Mårtensson
Environmental Technology and Management
Linköping University
SE-581 83 LINKÖPING
Anders.Martensson@ikp.liu.se

Anna Björklund
Centre for Environmental Strategies Research – fms
Royal Institute of Technology (KTH)
SE-100 44 STOCKHOLM
anna.bjorklund@infra.kth.se

Jessica Johansson
Environmental Strategic Studies
Swedish Defence Research Agency (FOI)
SE- 172 90 STOCKHOLM
jessica.johansson@foi.se

Jenny Stenlund Nilsson
Environmental Technology and Management
Linköping University
SE-581 83 LINKÖPING
jenst@ikp.liu.se

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Abstract

Development of local energy systems, i.e. supply, distribution and use of energy in a municipality, is crucial for overall environmental performance of national energy systems. It follows that availability and effectiveness of instruments to control this development are of great interest. For local authorities, energy planning may be such an instrument. Swedish legislation mandates each local authority to issue a plan for all supply and use of energy. In accordance with the EU directive 2001/42/EC, legislation now also requires that such plans include environmental assessment. This is often referred to as strategic environmental assessment (SEA). An ongoing research project is reported where tools for SEA are implemented and evaluated in municipal energy planning. The hypothesis is that such tools will improve the planning process, compared with current practice, and subsequently the energy plan in terms of its ability to direct the development of local energy systems towards less environmental impact. This development includes both increased energy efficiency and use of renewable energy sources. A planning process based on earlier studies of energy planning, on the EU-directive, and on earlier SEA processes is proposed and implemented in a Swedish municipality. Several tools are provided, such as, scenario analysis, environmental life cycle analysis, and public participation in the form of citizen panels. The main research question that will eventually be analysed by evaluating the process and its outcome is: "Does the use of SEA tools lead to improved energy planning from an environmental point of view?"

Introduction

Efficiency and environmental performance of a national energy system is to a large extent determined by the features of local energy systems, i.e. supply, distribution, conversion, and use of energy in a municipality. The direction of development on the local level is thus important for the performance of the national energy system. It follows that the availability and effectiveness of instruments to control this development are of great interest. For local authorities, energy planning may be such an instrument. Swedish legislation mandates each local authority to issue a plan for all supply and use of energy within the municipality borders.

In accordance with the EU directive 2001/42/EC, legislation now also requires that such plans include environmental assessments. This is often referred to as strategic environmental assessment (SEA). Such assessments have been applied in particular in the area of spatial planning. Application of SEA in energy planning has not been frequent internationally and even less so in Sweden. Hence, there is a lack of experience and methodology for application of SEA in this field. In this paper a research project is reported where tools for SEA are implemented and evaluated in municipal energy planning. The project aims to test an SEA process and different analytical and procedural tools and to analyse whether such tools will improve the planning process, compared with current practice, and subsequently the energy plan in terms of its ability to direct the development of local energy systems towards less environmental impact.

This development includes both increased energy efficiency and use of renewable energy sources. Furthermore, it is expected that the project will result in development of energy planning tools generally applicable by local authorities.

This paper aims to present the scope and objective of the project, the proposed SEA process and its tools and provide some results regarding the methodology development and implementation of the process. The project started in 2003 and is planned to be finished in 2006 when final results will be available.

CURRENT PRACTICES AND DEVELOPMENT IN SWEDISH ENERGY PLANNING

Swedish legislation on municipal energy planning was first established in 1977. This law mandates each local authority to issue an up-to-date energy plan. However, not all local authorities conform strictly and in practice there are no penalties available. Thus, the law has been criticized for not being effective. However, there appears to be a large variety in quality and effectiveness of energy plans. In an earlier research project, features and practices in energy planning in 13 Swedish municipalities have been assessed (Stenlund Nilsson and Tyskeng 2003). The investigated municipalities are all situated in the county of Östergötland and show a variety in size, type of business and industry, and natural resources. Also, the results show that energy plans have considerable differences in terms of age, comprehensiveness regarding analysis of the energy system and its environmental impact, definition of goals, and specification of implementation measures. The conclusions by Stenlund Nilsson and Tyskeng were that energy planning in several of the municipalities could be improved with regard to extent of environmental assessment, goal definitions, implementation, and follow up issues. Also, it was suggested that the planning process would be more effective if it allows for involvement by actors such as industry, energy companies, the public, and representatives of different sectors of the local government.

The Directive 2001/42/EC "on the assessment of effects of certain plans and programmes on the environment" (hereafter called the Directive) was issued in June 2001 with the requirement that member states shall bring into force the necessary laws before 21 July 2004. On this date, the Swedish parliament adopted new legislation which brings the Directive into force. In principle, the earlier law on environmental impact assessment has been amended to include environmental assessment of plans and programmes. However, there are still no detailed governmental regulations on how the requirements of the legislation should be implemented in practice. The law states that environmental assessment is mandatory for a few types of plans and programmes. Municipal energy plans are included which means that SEA must be included in the planning process resulting in the document required in the Directive. Thus, the project described here, where energy planning based on SEA is tested in a municipality, connects closely to the Swedish legislative development.

Methodology development and implementation

In the municipality of Finspång in southern Sweden local authorities have decided to issue a new energy plan and it was determined that the plan should be part of the development of the General Municipal Plan (Swedish "Översiktsplan"). This municipality was chosen as suitable for the research project described here. Several factors facilitated this choice: the timeliness of the planning start; the relatively small size of municipality, which means that developed methods may be useful for many other municipalities; the interesting energy system with interconnected waste incineration and several energy-intensive industries; and also the open attitude from the local authority.

A methodology is proposed where SEA is an integrated and integrating component of the energy planning process. A research team works together with civil servants in the municipality to develop, apply, and evaluate the methodology. The methodology, i.e., the SEA process is based on an earlier proposed framework for SEA in practice (Finnveden et al. 2003). Furthermore, input has been gained from methods for SEA proposed by the Swedish EPA (Naturvårdsverket 2000), manuals for municipal energy planning (Joanneum Research 2000; Energimyndigheten 2001) and a manual for SEA (Tyldesley 2003). Also, results from an earlier research project "Strategic environmental assessment of local energy systems" (Stenlund Nilsson and Tyskeng 2003). The process is designed to conform to the Directive.

Different kinds of analytical tools as well as tools for public participation are part of the process. The objective of the environmental assessment is to identify the likely significant effects on the environment of implementing the plan. It should also present a similar assessment of reasonable alternatives, the current state of the environment, and of the likely evolution thereof without implementing the plan (SFS 1998:808). The law gives little guidance as to how this should be done in practice, and there are no specific requirements regarding methodology and level of detail of the assessment. Public participation is seen as an essential component which is assumed to provide a better decision-making (compared to current practice) regarding the energy plan and its influence on the local energy system. Public participation is also part of the legislation based on the Directive but in this project a more far-reaching approach is applied compared to the requirements of the Directive. In particular, tools including deliberative processes are included.

The process includes a number of steps, Table 1, which will result in the energy plan. However, the research process goes even further (see last row in Table 1) as the intention is to evaluate the effectiveness of the tested process and tools in terms of their ability to provide a plan which would be efficient in controlling the development of the local energy systems in a direction towards improved environmental performance.

The process has been started and steps 0 through 4 have been executed. The first step included initial meetings where a working group consisting of civil servants from several departments in the municipality was formed. This group is the leading actor in the subsequent process. Objec-

Table 1. The process for the energy planning being implemented in Finspång. Emphasis here is on steps which are important for SEA. Also indicated are the responsible actor and other participants in each step.

Step no.	Task	Responsible and participants
0	Start of process including definition of objectives	Researchers, civil servants, politicians
1	Situation assessment (Assessment of the current energy system)	Researchers, civil servants
2	Workshop "Development of a visionary image of the future"	Researchers, citizens, civil servants
3	Choice: Decision on vision by politicians or information only	Civil servants (politicians)
4	Workshop "Development of external scenarios"	Researchers, citizens, civil servants
5	Workshop "Suggestions of actions and strategies"	Researchers, citizens, civil servants
6	Choice of robust alternative strategies	Civil servants, researchers
7	Environmental assessment	Researchers, civil servants
8	Evaluation of future alternative energy systems	Civil servants
9	Feedback to the panel	Civil servants, citizens
10	Development of implementation part in energy plan	Civil servants (researchers advisory)
11	Compilation of energy plan	Civil servants
12	Remittance of energy plan	Civil servants
13	Decision on acceptance of energy by the local government	Politicians
14	Follow-up and evaluation of the plan	Civil servants, researchers
	Evaluation of the process and its outcome	Researchers

tives of the process were discussed and defined at this step. Furthermore, the process was presented for acceptance by the local political government. Several actors are involved in the following steps. In particular, public participation has been ensured through a citizen panel consisting of citizens in the municipality and also representatives for industry. The panel was selected during step 0. Together with the group of civil servants and a group of researchers this panel is active in the three Workshops (Table 1) where scenario methods are used as tools in the SEA process. These tools as well as the environmental assessment tools will be described in the following. However, it should be noticed that the process was not fully developed before the application in this municipality. It is inherently flexible as there are a number of choices along the road where decisions for the continuation are taken by the actors involved. In several steps in the process new methods and tools are introduced. These are described explicitly below.

SITUATION ASSESSMENT (STEP 1)

At this stage the status of the current energy system is documented in terms of energy sources, conversion plants, energy use for different purposes, and annual energy use in the different sectors of the municipality. Also, the environmental pressure from this system is analysed. Furthermore, general information about the municipality is gathered at this stage. This concerns, e. g., demographic data, industry structure, and development plans in various sectors of the municipality. This information will be used later when alternatives are designed for the future development of the energy system.

SCENARIO ANALYSIS AND FORMULATION OF ALTERNATIVES

As a basis for the formulation of alternatives a scenario approach is used. The approach is inspired by back-casting (as described by Robinson 1982, 1990, and 2003, Dreborg 1994, and 2004) and scenario planning (as described e.g. by van der Heijden 1996, Dreborg 2004), and combines features from these two methods.

In back-casting, as opposed to forecasting, one, rather than making projections from the present into the future, starts with designing a desirable image of the future showing a solution to a major societal problem. Then one tries to come up with ways to realize that future state. The time horizon is typically long, often several decades, in order to allow for real change to take place. This is a visionary way of thinking and it presents a means to free the mind from the burden of prevailing trends and makes it easier to find new and interesting options (Dreborg 2004). This may be useful when faced with a problem that requires action to be taken and a new and radically different solution. In our case we wanted to test if elements of back-casting could be an effective means to incorporate the vision of sustainable development into the planning process. With an awareness of long-term goals it is possible to avoid lock-in situations although the planning horizon is short.

In scenario planning, as developed by Royal Dutch/Shell, external scenarios are developed and used. These scenarios describe the development of factors that greatly affect but are outside the control of the relevant actor, e.g., a company or a public decision-maker. The aim is to make a strategic analysis of the options open to the actor. The different options are assessed against the external scenarios in order to find a combination of measures that gives a fair outcome in all or most of the scenarios. The idea is to obtain a flexible planning. External scenarios may make it easier to realize emerging patterns in the organizations environment (van der Heijden 1996) and often strategies and measures are continuously evaluated and adapted according to experiences gained. This allows for adaptive planning.

A prominent feature of scenario planning is the use of panels in the scenario development process. The panels typically consists of representatives of the actor organization, often from different management levels, and often some external experts or 'remarkable people'.

The approach we designed, based on these two methodologies, can be divided into three main steps:

- The development of a visionary image of the future,

- the development of external scenarios, and
- the generation of suggestions for actions and strategies to be included in the energy plan.

In the following description of these steps, reference is made to the numbering of process steps in Table 1.

Development of a visionary image of the future (Step 2)

The first step is to develop a visionary image of the future. We wanted to create a process where opportunity was given to discuss and agree on common long-term goals. For this purpose we adopted the workshop methodology from scenario planning, where a panel is invited to participate in a structured brainstorming. The panel consisted of municipal civil servants, representatives from local companies, including the local energy company, citizens and researchers from our research group. The topic for the brainstorming was: How do we live and work in Finspång in the year 2040 so that the energy use is sustainable in the long term ecologically, economically, and socially? After the brainstorming the participants were allowed to vote on the ideas they found most attractive. In this stage the researchers, who are not actually living or working in Finspång, were inactive. After the workshop the ideas were compiled into a draft of consistent image of the future. The draft was then sent out to the panel for comments and based on the comments the draft was revised.

Development of external scenarios (Step 4)

The second step is to develop external scenarios. Ideas for these scenarios were collected in a second workshop with structured brainstorming. The same panel as in the first workshop was invited to participate, plus three additional experts – one expert on energy markets, one official from the national energy authority, and one expert on the regional development. The topic for this brainstorming was: What outside factors influence the possibilities for Finspång to achieve a sustainable energy system? The time horizon was set to 15 to 20 years from now. After the brainstorming the participants were encouraged to vote, first on which factors they found most important and then, in a second round, on which of these important factors they thought were most uncertain. After the workshop four external scenarios were developed based on the result from the brainstorming and the voting. Two prominent factors that were deemed by the panel to be both important and uncertain were chosen as dimensions in a scenario cross, and for each of the quadrants in the cross a scenario was formed.

Suggestions of actions and strategies (Step 5)

The third step is to generate suggestions of actions and strategies that could be included in the energy plan. This is done in a third workshop where the same participants as in the first workshop are invited. This time the participants are divided into four groups. Each group is responsible for one of the external scenarios and is to come up with as many ideas as possible on actions and strategies suitable for their scenario. In this work the image of the future developed in the first step may serve as inspiration. When this is done the entire panel gather again to discuss and evaluate the usefulness of the generated ideas in the other scenarios. After the workshop the most viable ideas are taken to environmental analysis and based on the results from this, alternatives are subsequently formed.

ENVIRONMENTAL ANALYSIS

The environmental analysis should consider the environmental effects of alternative strategies, but also the current state of the environment, and of the likely evolution thereof without implementing the plan (the no-action, or baseline alternative). A range of qualitative and quantitative analytical tools are available for environmental analysis in SEA (Finnveden et al. 2003). The choice depends on availability of data and on required level of detail of the results. While experience has shown the difficulties of qualitative approaches to prioritise between alternatives (Hochschorner and Finnveden 2003b), there is also an advantage of including qualitative information as a complement to quantitative methods (Hochschorner and Finnveden 2003a).

In this project the environmental analysis is primarily based on quantitative Life Cycle Assessment (LCA), complemented with qualitative checklists and possibly some site-specific analysis. LCA is a tool to assess the environmental impacts and resources used throughout a product's use and disposal (ISO 1997, 1998, and 1999). A product in this sense is not necessarily a physical item, but may also be a service, such as energy supply or transportation.

Environmental indicators

According to Swedish legislation, the environmental analysis is to cover issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage, and landscape. Depending on the type of impact, the environmental analysis will be done with a local, national, or global perspective. We have chosen to use the Swedish environmental objectives and indicators as criteria for identification of impact categories and choice of indicators. Objectives and indicators with a regional focus have also been developed (Anonymous 2003a, 2003b), which will be used for assessment of local impacts. Many, but not all of these indicators can be derived using LCA. Some indicators may only be assessed qualitatively.

Description of the technical system

A significant challenge lies in linking the scenario analysis and formulation of alternatives to the LCA. This requires that the results from the workshops, which are mainly descriptive and non quantified, are 'interpreted' into a more specific and quantified description of the technical system, suitable for LCA modelling. Subjective influence when doing this 'interpretation' may be minimised by following a well-defined structure. We chose to use the Swedish Municipal Energy Balances (Kommunala Energibalanser, KOMENBAL) as a template (SCB, 2005). These are yearly updated matrixes that are based on best available statistical data, describing energy use in all Swedish municipalities in terms of different sectors and energy carriers. This data will be used to develop an LCA model, which calculates the life cycle emissions and resource use related to energy use in the municipality.

Scenarios

The *current state scenario* is taken as the KOMENBAL report of a certain year. This was done by Eriksson (2004).

The *no-action scenario* is to mirror energy use is the municipality in 15-20 years from now, in case no energy plan is implemented. It is to be used as a reference when evaluating whether a suggested strategy in the energy plan is likely to lead to environmental improvements. As far as possible, this scenario should be based on current trends and knowledge about decisions already taken. As a consequence of working with four external scenarios that were identified in Workshop 2, there will be four parallel no-action alternatives. Each one of them will be based on the same known decision, but placed in different future environments.

Alternative strategies scenarios describe strategies and measures suggested at Workshop 3, complemented with additional suggestions from the municipality. Each individual strategy or measure will be evaluated against the no-action scenarios. Robust strategies, which lead to environmental improvement for all or most external scenarios, will be considered in the final energy plan.

VALUATION

There may be at least two dimensions of valuation. One is to weigh different environmental impact categories against each other. This is done using some kind of valuation methods. Because different issues may be emphasised by different valuation methods, it is recommended to use two or more methods to compare. Valuation is also necessary to compare environmental impacts to other impacts, e.g. economic or social. It is also important to evaluate the energy plan against other municipal goals.

IMPLEMENTATION OF PLAN AND MEASURES AND FOLLOW UP OF MEASURES

Implementation of the plan includes a number of measures and decisions to be taken by the local authority in order to direct the development of the local energy system as indicated in the plan. To be able to evaluate the real development and its compliance with the plan a number of checkpoints shall be introduced for the whole time span of the plan. Legislation also requires that the energy plan shall be up-to-date which means that revised plans must be issued regularly at relatively short intervals, for example, four to five years. At these instants parts of the process must be repeated, such as, the assessment of the actual energy system and its environmental impact. However, if monitoring of the energy system development and environmental effects is built into the normal activities in the municipality revision of the plan will be greatly facilitated.

EVALUATION OF THE PROCESS AND THE TOOLS

The aim of the research project as a whole is to evaluate the effectiveness of the applied SEA tools in terms of facilitating decisions which would improve environmental performance when compared to current practice. The effectiveness concept here includes both legitimacy and rationality of decisions. Legitimacy in this context means that the process and the decisions caused by the process are well founded in the local authority, among policy makers, and the public. This can be evaluated by analysing the process in terms of, for example, the degree of participation by citizens, industry representatives, political bodies etc.

Evaluation of the actual outcome of the energy plan in terms of environmental performance of the energy system can ultimately only be done after several years beyond the time span of the plan. However, there are ways to analyse the contents and quality of the plan in order to find indications of its ability to fulfil its goals. Based on earlier research by Stenlund Nilsson and Tyskeng (2003) the following aspects are proposed for the analysis:

- Extent of system boundaries used in the analysis of the energy system
- Scope of environmental impact assessment: included impact categories, time and space boundaries etc.
- Quality of environmental impact assessment: data and methods used etc.
- Quality of analysis regarding links between proposed system and environmental impact
- Extent of goal setting in terms of both short and long term goals
- Degree of detail and plainness in implementation issues
- Scope of follow-up and evaluation measures

Some preliminary results

The energy planning process is ongoing and steps 0 through 4 have been executed so far. This means that no results in terms of answers to the main research questions are available yet. Nevertheless, some results regarding the development of methodology and some experiences from the initial steps can be reported. One interesting result concerns the start of the process. Our experience is that the setting up of a working group in the municipality is crucial in the sense that this group shall be the driving force of the process and it is thus important that this group gets strong legitimacy in the local authority.

The situation assessment (step 1) was performed using a life cycle analysis approach for the environmental assessment of the current energy system (Eriksson 2004). Data was retrieved from official Swedish statistics on municipal energy use and from information already available in the municipality on district heating and other types of heating. The results show that industry is a large energy user in Finspång, larger than the average municipality. The share of electricity in the energy carrier mix is high and electricity is largely generated outside the municipality. Fossil fuels contribute more than one third of the energy input and is used mainly in the transport sector. About 10% of energy input to the municipality comes from biofuels. Environmental impact from the energy system was analysed primarily in the categories global warming, eutrophication, acidification, toxicity, and photochemical oxidants.

After having completed the first two steps of the scenario analysis and alternative generation we can say that the process so far has been quite successful. The workshops have been possible to carry out as planned, providing useful results. It has been easy to engage citizens and civil servants to participate in the panel, but it has however been hard to

get representatives from the local business community to volunteer. The participants in the panel seem happy with the way the work has been done, particularly during the workshops.

The environmental awareness in the panel is generally high and it was quite easy to design a visionary image of the future based on the common sense that was striking during the workshop.

Discussion

New tools for strategic environmental assessment have been proposed for municipal energy planning and a process including these tools has been initiated in a Swedish municipality. The outcome will be evaluated in terms of improvement in the energy planning in comparison with earlier planning practice. Evaluation will focus on the plans ability to direct the development of the local energy system towards decreased environmental impact and improved energy efficiency.

The initiated process involves a number of methodological challenges. The ambition is to involve citizens to a large extent and during a large part of the process. Scenario methods are included in a way that needs development in this particular application. Quantitative environmental assessment methods, such as LCA are mixed with qualitative methods to assess environmental impact of alternative development of an entire municipal energy system. Environmental aspects are to be weighed against other aspects in the municipality, such as, economic and social factors.

Experience from the first steps in this process indicates that the approach facilitates involvement by a wide range of actors, certainly a wider range than is normal in energy planning. This involvement appears so far to have contributed both to the method development and substantially to the process. Although the ambition to use far-reaching environmental assessment applied to several alternative strategies is demanding, it appears to be feasible and will most likely lead to proposals for simplified methods which can be useful in other municipalities as well. It is also encouraging that the first steps in the application of scenario methods have shown that our approach is feasible and, as far as can be judged now, also successful.

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