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Municipal Energy Planning
– Scope and Method Development

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Sammanfattning

Enligt lagen om kommunal energiplanering ska alla svenska kommuner ha en energiplan för tillförsel och användning av energi. Men huruvida energiplanering är ett bra sätt att styra utvecklingen av lokala energisystem är omdebatterat. Denna avhandling studerar kommunal energiplanering: energiplaners innehåll analyseras och mål i energiplaner följs upp. Avhandlingen presenterar också ett pilotprojekt där en energiplaneringsprocess baserad på fyra olika beslutsverktyg testades i Finspångs kommun. De fyra verktygen var: en medborgarpanel, scenariometoder, samt kvantitativa och kvalitativa miljöbedömningar. Resultaten från kartläggningen av energiplaner och erfarenheterna från pilotprojektet utgör därefter grunden för en diskussion om energiplanerings effektivitet.

Forskningen har resulterat i fem vetenskapliga artiklar och ett resultatappendix. Två artiklar och appendix bidrar till kartläggningen av innehållet i energiplaner: planers innehåll, målformuleringar och miljöbedömningar. Appendix bidrar också till information om huruvida utvecklingen i de studerade kommunerna överensstämmer med de avsikter som beskrevs i energiplanen. Det tre sista artiklarna presenterar processen som testades i Finspång och erfarenheter från projektet.

Resultaten i avhandlingen visar att innehållet i energiplaner har varierat över tid. Innehållet följer till stor del innehållet i svensk energipolitik men också internationella trender avspeglas. Beskrivningar av miljöpåverkan och miljöpåverkansbedömningar är i allmänhet rudimentära. Resultaten visar också att miljöbedömningar var mer vanligt förekommande i de energiplaner som var antagna 2006-2008 än de 1995-1998, däremot visade sig de nyare energiplanernas miljöbedömningar vara mindre omfattande än sina föregångare. Bäst måluppfyllelse var bland mål som kommunerna själva har rådighet över, exempelvis fjärrvärmeexpansion och energieffektivisering i det kommunala fastighetsbeståndet.

Erfarenheter från energiplanprocessen i Finspång visar att beslutsverktyg kan bidra till ett bredare angreppssätt med mer omfattande miljöbedömningar och legitimitet, såväl internt i den kommunala organisationen, som gentemot externa aktörer. Den öppna dialogen mellan tjänstemän och medborgare uppskattades av kommunens arbetsgrupp och de flesta av medborgarpanelens förslag kom med i energiplanen. Scenarioverktygen bidrog till lärande bland deltagarna men hade kunnat bidra mer till ett bredare angreppssätt. Tillämpningen av beslutsverktygen var tidskrävande och ibland komplicerad. Dock verkar kvalitativa miljöbedömningar vara ett passande sätt att miljöbedöma energiplaner: miljöbedömningarna i Finspångs plan är, trots sin relativa enkelhet, unika i sitt slag.

Baserat på resultaten från artiklarna förs en diskussion om möjligheter för mer effektiv energiplanering. Effektivitet diskuteras utifrån vad energiplaneringen tar upp och dess legitimitet och hur detta kan påverkas med hjälp av beslutsverktyg. Avhandlingen visar att kommunal energiplanering har potential att vara ett effektivt verktyg för att hantera energifrågor på lokal nivå. Beslutsverktyg kan bidra till att göra energiplanering legitim och bidra till lärande.

Abstract

Swedish municipalities are required to produce a municipal energy plan for their energy supply and use. Whether energy planning is suitable to manage local energy systems, however, is subject to debate. This thesis maps municipal energy planning: the scopes of energy plans and whether goals stated in energy plans are fulfilled. It also presents a pilot project with the implementation of an energy planning process where four different decision-making tools were applied: a Citizen's panel, scenario techniques and quantitative and qualitative environmental assessments. The results from the mapping of energy planning and the experiences from the pilot project are then the bases for a discussion about the effectiveness of energy planning.

The thesis is based on six papers; five scientific papers and one working paper. The first three papers contribute to mapping municipal energy planning in terms of expressed volition (goals, measures and strategies in the energy plans), whether goals are fulfilled and the extent of environmental analyses and assessments in the plans. The three subsequent papers present the implementation and evaluations of the energy planning process in the pilot project.

The results show that the scopes of the studied energy plans have varied over time and have been adaptive to external factors such as contemporary energy policies and international trends. Environmental analyses and assessments were more commonly occurring in the energy plans adopted between 2006 and 2008 compared to those adopted between 1995 and 1998. The environmental analyses and assessments were however less comprehensive in the newer energy plans. Most positive development, in terms of fulfilled goals, took place for issues within the power of the local authority, for example district heating expansion and energy efficiency measures in public buildings.

Experiences from the pilot project showed that decision-making tools can contribute to a broader scope of energy planning, more comprehensive environmental assessments and legitimacy. The dialogue with the Citizen's panel was appreciated by the municipal workgroup and most of the suggestions from the panel were included in the energy plan. The scenario tools contributed to learning among the participants but could have supported an even broader scope. Environmental assessments in the pilot projects were unique and a qualitative approach seems to be suitable for the purpose. The application of the tools was however also sometimes complicated and proved to be time and resource intensive.

Based on the research findings possibilities for more effective energy planning are discussed. Effectiveness is discussed in terms of scope and legitimacy and how a broad scope and legitimacy are affected by the use of decision-making tools. It is concluded that energy planning has potential for being an effective tool for strategic energy work at the local level. The use of decision-making tools can also contribute to learning as well as legitimacy to energy planning.

Acknowledgements

Without guidance and support from a number of people, this thesis would never have been finished – I owe you all great gratitude. First of all, I am very grateful to my supervisor, Olof Hjelm. All support and intelligent comments have been invaluable! I also want to acknowledge my first supervisor Anders Mårtensson who guided me through my first years as PhD a student. Anders' extensive knowledge about energy systems and their environmental aspects has been fundamental to my work. Of course, I am also thankful to all my colleagues at Environmental Technology and Management for all support, ideas, advice and friendship on my personal journey to become a PhD and a mother.

I also would like to thank Owe Andersson and my colleagues Mats Eklund, Joakim Krook and Sara Emilsson for a fruitful discussion at my end-seminar in November. Niclas Svensson, Andreas Lamppa, Staffan Hedberg, and Mats Gustafsson are also thanked for their valuable feedback on earlier versions of this thesis. Michael Martin also deserves acknowledgement for his heroic efforts as proof-reader.

I am very thankful for financial support from the Swedish Energy Agency and the Swedish Environmental Protection Agency, as well as the opportunities to participate in the research programmes "Utsläpp och Luftkvalitet" (Emissions and Air Quality) and "Miljöstrategiska verktyg," MiSt (Tools for Environmental Assessment and Decision Making), respectively. Seminars, discussions and research cooperation in these programmes have been very enlightening and valuable.

I would like to thank my family and friends for their support. I want to especially thank my parents-in-law for taking care of Alvar during my most intensive work period. Special thanks also to JennyJ and MatsG for being the fun, intelligent and supportive friends everybody wishes to have. I look forward to having more time to spend with you at Sol & Ris and Friskis.

Last, but not least, I thank Anders for being the best of the best. Every day with you is a great day.

List of papers[1]

This thesis is based on the following papers and appendices

Papers

Paper I — Stenlund Nilsson, J. and Mårtensson, A. (2003). Municipal Energy-Planning and Development of Local Energy Systems, *Applied Energy* **76**, 1-3, 179-187.

Paper II — Ivner, J. and Hjelm, O. (manuscript). Volition and Environmental Assessments in Municipal Energy Plans. *Intended for publication in Energy Policy.*

Paper III — Ivner, J., Björklund, A., Dreborg, K.H., Johansson, J., Viklund, P., Wiklund, H. (submitted). New Tools in Local Energy Planning: Experimenting with Scenarios, Public Participation and Environmental Assessment. *Submitted to Local Environment.*

Paper IV — Ivner, J. (Submitted). Energy Planning with Novel Planning Tools - Experiences from an Energy Planning Project. *Submitted to Local Environment.*

Paper V — Ivner, J. (Submitted). Do Decision-Making Tools Lead to Better Energy Planning? *Submitted to Environmental Planning and Management.*

Appendices

Appendix — Study on Energy Plans and Energy System's Development.

[1] The author changed names in 2003, 2005 and 2007, which means that Ivner (2007-), Stenlund (2005-), Stenlund Nilsson (2003-2005) and Nilsson (-2003) refer to the same author.

Related Publications[2]

Listed below are other publications originating in the research projects that this thesis is based on.

Björklund, A. and Finnveden G., Dreborg K-H. and Johansson, J., Mårtensson, A. and Stenlund, J., Viklund, P. and Wiklund, H. (2007) Energiplanering med strategisk miljöbedömning i Finspång. Forskningsrapport Nr: 2007:05, Blekinge Tekniska Högskola.

Stenlund, J. (2006) Plan and Reality - Municipal Energy Plans and Development of Local Energy Systems, Licentiate thesis, Linköping University.

Mårtensson, A, Björklund, A., Johansson, J., Stenlund, J. (2006) Strategic Environmental Assessment in Energy Planning – Exploring new Tools in a Swedish Municipality, in: L. Emmelin (Ed.) Effective Environmental Assessment Tools - Critical Reflections on Concepts and Practice Blekinge Institute of Technology.

Mårtensson, A., Björklund, A., Johansson, J., Stenlund Nilsson, J. (2005) Energy Planning Using Strategic Environmental Assessment - Exploring new Tools in a Swedish Municipality ECEEE Summer study 2005.

Stenlund Nilsson, J, Tyskeng, S., Mårtensson, A., Eklund, M. (2004) Strategisk miljöbedömning av lokala energisystem. Projekt nr P12615-1. Slutrapport 2004-03-31 från ett projekt i Energimyndighetens program Utsläpp och luftkvalitet.

Stenlund Nilsson, J and Tyskeng, S (2003) The Scope of Municipal Energy Plans in a Swedish Region. A Review of Energy and Environmental Issues in the Plans. Linköping, Linköping University: LiTH-IKP-R-1274.

Nilsson, J. and Mårtensson, A. (2002) Municipal energy planning and energy efficiency, ACEEE, 8-18 August 2002 Pacific Grove, CA, USA.

Nilsson, J. and Mårtensson, A. (2002) Municipal energy planning and development of local energy systems. Energex ‘2002, Krakow, Poland.

Nilsson, J. and Mårtensson, A. (2002) Municipal Energy Planning and Renewable Energy, in Sayigh, A. A. M. (ed.) (2002) Proceedings of the World Renewable Energy Congress VII, 29 June - 5 July 2002, Cologne, Germany.

[2] The author changed names in 2003, 2005 and 2007, which means that Ivner (2007-), Stenlund (2005-), Stenlund Nilsson (2003-2005) and Nilsson (-2003) refer to the same author.

Word List

Below is a list of terms and concepts used in this thesis that may need further explanation. The list is not intended to give a comprehensive explanation of each term, but presents how the words are used in this thesis.

Term	**Explanation**	**Swedish**
Alternative vehicle fuels	For example biogas, ethanol, biodiesel	Alternativa fordonsbränslen: biogas, etanol, RME (rapsmetylester)
Ash	Solid combustion residue	Aska
Biogas	Gas for energy purposes. Methane (CH_4) from fermentation of biological waste products or sludge	Biogas
Boiler	General term for combustion devices	Panna
Building permission	An act of exercise of authority when the local authority gives permission for new or changed buildings	Bygglov
CHP, combined heat and power	Combined heat and power plant where combustion, often biomass based, is used for both power generation and district heating	Kraftvärme
Comprehensive plan	Municipal over-all plan	Översiktsplan
Surveillance	Exercise of authority, for example environmental controlling functions	Tillsyn, exempelvis miljötillsyn
District heating and local district heating	Centralised heating systems for buildings, based on a hot water distributions system	Fjärrvärme, närvärme
Environmental effects	Effects caused by resources extraction or emissions from energy conversion. Energy related environmental effects are for example resource depletion, acidification and health effects.	Miljöeffekter. Effekter på miljön orsakade av uttag av energiresurser och energiomvandling. Energirelaterade miljöeffekter är exempelvis uttömmande av ändliga resurser, försurning och hälsoeffekter.

Exhaust gas cleaning	For example catalytic converters or electrical filters	Rökgasrening
Flue ash	Solid combustion residues that are filtered from exhaust gas	Flygaska
Flue gas	Exhaust gas from combustion	Förbränningsavgaser, ”rök”
HVAC	Heating, Ventilating, and Air-Conditioning	Värme, ventilation och komfortkyla – som VVS utan sanitet
Local authority	The administrative body within the municipality	Kommunen som myndighet
Municipality	Geographical area as well as decisive and administrative body	Kommun
Municipal administration	The administrative part of the local authority	Kommunala administrationen
Municipal council	The political decisive body within the municipality	Kommunfullmäktige
Municipal government	The political managing body within the municipality	Kommunstyrelse
NOx	Nitrogen oxides. Compounds that are formed during combustion at high temperatures as nitrogen gas from the air oxidises, and when fuels containing nitrogen are combusted	Kväveoxider. Bildas vid förbränning vid hög temperatur då luftens kväve oxideras (s.k. termisk NOx), samt vid förbränning av kvävehaltiga bränslen
Private estates	Small houses: villas, terrace houses	Småhus
Private residences	Buildings used for housing: small houses as well as apartment blocks	Bostäder
Purchasing	Swedish local authorities must follow a special procedure when purchasing. This provides possibilities to select the most favourable alternative according to specified requirements	(Offentlig) upphandling
Renewable energy resources	Energy resources that are naturally replenished, for example biomass, solar energy, wind energy and hydropower	Förnybara energikällor, exempelvis biomassa, solenergi, vindenergi och vattenkraft

Self sufficiency in energy supply	Energy policy goal for more domestic energy sources	Självförsörjning
Sewage sludge	Rest product from sewage treatment	Avloppsslam
Small scale solid fuel combustion	Combustion for heating purposes in small private houses, usually wood or wood pellet based	Uppvärmning med villapanna, baserat på fasta bränslen, oftast ved eller pellets
Sulphur emissions	Sulphur emissions are formed during combustion of fuels containing sulphurous compounds. Such emissions lead to acidification.	Svavelutsläpp. Bildas vid förbränning av svavelhaltiga bränslen, exempelvis torv.
Transition	Shift, change (of the energy system)	Omställning
Waterborne heating systems	Heating systems based on hot water circulating in radiators	Vattenburet värmesystem

Table of Contents

1 Municipal energy planning as a means to manage local energy systems

This introductory chapter aims to introduce and support the relevance of this thesis. It describes a brief background to the Swedish energy policy and energy management tools at the local level in Sweden as well as internationally. It also introduces the Act on Municipal Energy Planning and how this act has been debated. This chapter ends with aim, research questions, contribution and a presentation of the appended papers.

Energy has traditionally been associated with economical growth and the establishment of electricity was the spring-board for social and economic development in the Nordic countries (Kaijser and Hedin, 1995). Therefore securing a sufficient amount of energy was the primary aim of the Swedish energy policy until the 1970s (Bergman, 2001). Increased environmental awareness and the worldwide oil crises have however made the focus shift towards pollution control, reduction of oil dependence and energy conservation in the 1970s. Since the 1970s the focus of Swedish energy policy has developed further to address the efficient use of energy resources and to reduce the impact on the climate.

Today's Swedish energy policy is based on a Government bill from 2002 (Government bill 2001/02:143), which in turn is based on the 1997-year Energy Agreement where the main objectives were to secure cost-efficient energy supply as well as efficient and sustainable energy use with minimal impact on the environment (Government bill 1996/97:84). In addition to this, the Swedish Climate Strategy states that the Swedish emissions of greenhouse gases should be reduced 25% from the levels of 1990 for 2020 (Government bill 2005/2006:172).

Both the energy policy and the climate strategy point to local authorities as important actors in the transition towards an environmentally adapted energy system. One means to manage the development of local energy systems in Sweden is municipal[1] energy planning, which has been required by Swedish law since 1977 (SFS 1977:439). The law states that all Swedish municipalities should plan for energy supply and use of energy, include stakeholders and analyse the effects on the environment. The act however neither specifies instructions for the planning nor includes sanctions for those who do not follow the law. This has led to a situation, where at the time, as many as 30% of all Swedish local authorities have chose not to prepare an energy plan (Swedish Energy Agency, 2002, 2006). Energy planning has also been called toothless (Swedish National Audit Office, 1991) and studies have concluded that other factors influence the

[1] The Swedish word "kommun" refers to a geographical area as well as the local authority and local administration of that area. In this thesis, the word "municipality" is used for the whole local entity, territorial as well as administrative. "Municipal council" is used for the decisive body, "municipal government is used for the political management, and "local authority" for the administrative leadership, of the municipality. Palm and Wihlborg (2006) provide further descriptions of the management of Swedish municipalities.

local energy system more than municipal energy planning (Lindquist, 2000; Olerup, 2000; Palm, 2004; Stridsman, 2000).

Local energy planning is undertaken outside Sweden as well. Two other examples of approaches to manage local energy systems are: Integrated Resources Planning (IRP) and Community Energy Management (CEM). IRP has been used in the United states, for example, for the evaluation of choices concerning buildings and equipment from both the utility (supply) and customer (use) perspectives (Vince et al., 1993) . The aim is to supply energy services at the lowest cost to society (Bakken, 1996). CEM is an approach to include energy issues in urban and infrastructure design from the perspective of the local community that has been used in Canada (Jaccard et al., 1997).

Also internationally have benefits from local energy planning been questioned. Guy and Marvin (1996) for example mean that energy planning "is likely to remain an irrelevant technical exercise" distanced from the real driving forces that are shaping local energy systems. Nonetheless the potential of using energy planning has been stressed as well (Anderson and Doig, 2000; Butera, 1998; Jaccard et al., 1997; Jank, 2000).

There is a growing interest in energy management at the local level. In Sweden there are two large projects aimed at forming local strategies for the energy system; Sustainable Municipalities initialised by the Swedish Energy Agency and the Climate Municipalities funded by the Swedish Environmental Protection Agency. In the EU a large number of cities and communities work with energy strategies within the ManagEnergy programme (European Commission Directorate-General for Energy and Transport, 2008).

1.2 Aim and Contribution of the Thesis

The growing interest in strategic energy work at the local level together with the previous debate whether energy planning is a suitable tool for managing change of local energy systems or not, makes it of great interest to explore the potentials and shortcomings of municipal energy planning in a practical context. The aim of this thesis is therefore to investigate whether municipal energy planning can be an effective tool for managing local energy systems. Effective in this thesis is defined as "having the desired effect," effects that lead to the desired changes in the local energy system. Two aspects of effectiveness are analysed: scope and legitimacy.

The scope of energy planning, i.e. *what* the energy planning is about, or in other words what is desired to change in the energy system, is important. This aspect is of interest since energy planning needs to be relevant. Another important aspect is that appropriate targets are set for appropriate parts of the local energy system. The scope of energy planning is explored from two points of view: environmental assessments and systems approach.

Energy plans should include environmental assessments. The main reason for this is that energy affects the environment and changes in the energy system should therefore be assessed in terms of environmental impacts. There is also a requirement for environmental assessments in the act on municipal energy planning (SFS 1977:439).

Environmental assessments have been used in, for example, water management (Partidário and Clark, 2000), as well as spatial and transport planning (Dalal-Clayton and Sadler, 2005; Fischer, 2002) contexts. But environmental assessments at a strategic level in the energy sector in Sweden have been rare (Tyskeng, 2006). The theoretical relevance of environmental assessments for the energy sector has been highlighted in several studies (Finnveden et al., 2003; Russo, 1999; Tyskeng, 2006), but there are no standards of practice for the environmental assessments in energy planning. Therefore it is of great interest to map and develop practices for environmental assessments in municipal energy planning.

Effective energy planning also needs a systems approach. This could facilitate focussing on relevant issues. It is argued in, for example, the environmental systems analysis field that a systems approach is important to avoid side-effects and subsequent problem shifting (Raadschelders et al., 2003; Wrisberg and de Haes, 2002). Also within energy planning literature the importance of broad analyses have been stressed (Gebremedhin, 2003; Jank, 2000; Rydén, 2001, 2006). Here, the advantages pointed out are to avoid sub-optimization and to understand technical and organisational interactions and interdependence in the complex local energy system. Practical implementation of a systems approach is in this thesis explored with the aid of a number of tools that may facilitate environmental decision-making: a Citizen's panel, scenario techniques and qualitative and quantitative environmental assessments. Such tools have been judged as valuable for dealing with complex environmental decision-making in different studies (Dale and English, 1999; Sexton et al., 1999; Wrisberg and de Haes, 2002).

The second aspect of effectiveness is that it is of interest that the energy planning actually *leads to change* and not becomes yet another report on the bookshelf. It can be argued that there is a greater chance for successful implementation of the energy plan if it is accepted among those responsible for the implementation. The energy plan therefore needs to be legitimate in order to lead to change. Since energy planning has been criticised for being ineffective, there is a need to develop methods and procedures that can make the energy plan legitimate both internally in the local authority and externally towards other stakeholders. In this thesis internal, or organisational, legitimacy is related to Scott's (1998; 2008) theories about basis for legitimacy in institutions and organisations. External, or strategic, legitimacy is related to communication with stakeholders and public participation.

To sum up, there is a legal requirement for Swedish municipalities to produce an energy plan that includes environmental assessments. Energy issues are complex, and there are also questions about legitimacy of energy planning. Based on this it can be concluded that there is a need to develop energy planning. This thesis contributes to the knowledge about the scope of energy planning and whether goals in energy plans are fulfilled. It also contributes to development of energy planning when it comes to a broad scope, including environmental assessments and systems approaches as well as how energy planning may become more legitimate. It also contributes to the knowledge concerning the application and combination of decision-making tools in energy planning and how these may contribute to more effective energy planning.

1.3 Research Questions and Outline of the Thesis

The research in this thesis consists of two phases; mapping and method development. Three major research questions, RQ, were used in this work:

- RQA: What is the scope of municipal energy plans?
- RQB: Are goals in the energy plans fulfilled?
- RQC: Can the use of decision-making tools make municipal energy planning more effective?

RQA and RQB are used for mapping Swedish municipal energy planning; RQA generally regards the scope of energy plans as well as including aspects concerning the environmental assessment and systems approach. RQB regards how the real development of local energy systems in the studied municipalities correspond to the goals stated in their energy plans. RQB elucidates both the scope and legitimacy of municipal energy planning. RQC regards method development. The use of decision-making tools is analysed in terms of contribution to the scope and legitimacy of energy planning.

Outline of the Thesis

Before answering and discussing the research questions in Chapters 5 and 6, the background research leading to this thesis is presented. Chapter 2 presents the background and today's context for municipal energy planning in Sweden. Chapter 3 presents the scientific approach used for the thesis and Chapter 4 presents the methodology in the empirical work towards the thesis. Empirical findings from the mapping phase are presented and discussed in Chapter 5. The method development phase is presented and discussed in Chapter 6. Chapter 7 presents conclusions, implications of the research results and areas for future research.

1.4 Research Journey

The empirical work for this thesis consists of two phases: mapping and method development. Each phase consisted of three studies leading to five papers and a results appendix, Figure 1. Emphasis in the discussions and conclusions is focused upon the method development phase.

The mapping phase consisted of three studies. The study that formed the basis for Paper I was performed to gather the empirical basis for answering the first two research questions RQA and RQB, but as the energy plans were collected and analysed it became obvious that the plans varied widely in age. As some energy plans were twenty years old, it seemed unlikely that they would have any influence on today's energy system. However, the first study provided interesting information about how energy planning has developed over time, giving more depth to RQA.

Paper II was based on the most recent study. When gathering the reference set of energy plans adopted from 2006-2008 to be used in Paper V, the material proved to be very different from the energy plans in the first two studies. Therefore the energy plans were analysed further and compared to the earlier results, contributing to answer RQA.

The study that served as a basis for the Appendix was designed to be able to answer RQB, but it also contributed to RQA as some of the empirical material could be used in Paper II as well. Energy plans adopted from 1995-1998 in municipalities from different parts of the country were selected. It was of great importance that energy plans were of appropriate age; old enough for changes to occur, but not out-of-date. The energy plans were analysed in terms of expressed volitions, desires and ambitions, and then the energy systems were analysed on whether their developments were in line with these desires. However, finding information about everything that was intended in the energy plans was very difficult, and it became evident that it would not be realistic to follow up development thoroughly for all studied municipalities. Therefore, a decision was made to produce a more thorough analysis of the municipality that had the most information available, Kungälv.

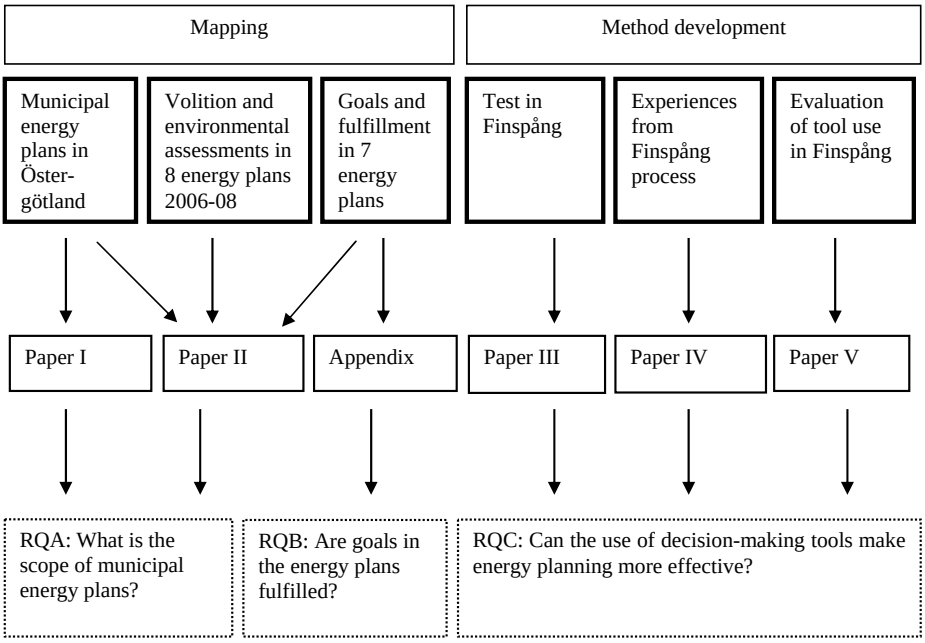


Figure 1. The two phases in the research process and relations between studies, papers and research questions

The results from the two first studies were important input to the method development phase (Papers III-V). The results indicated that energy plans had narrow scopes, rudimentary environmental assessments and that several goals stated in energy plans were not fulfilled, especially when it came to issues beyond the power of the local authority, for example with regards to new electricity generation. It was also found that tools to aid the planning process were seldom used.

Paper III presents a pilot project where an energy planning process was developed and implemented in the municipality of Finspång. The aim was to create a process where tools to aid decision-making were used to support a broader scope, more

comprehensive environmental assessments and better legitimacy, issues that were identified as weaknesses in Paper I and in the Appendix. A process template was also designed where three other research groups were invited to participate in order to develop the process further. The other researchers applied and combined a selection of decision-making tools from their areas of expertise in a proposed energy planning process. The process was implemented in Finspång municipality by a municipal workgroup and the three research groups. This study contributes to some extent to RQC.

The last two studies, Papers IV and V, aimed at evaluating the process that was implemented in Finspång (Paper III) and are the main basis for answering RQC. Paper IV is based on two focus group discussions with the participants from the pilot project, one with the municipal workgroup and one with the researchers responsible for application of the tools. Paper V presents the evaluation of whether the decision-making tools had the intended effects on the energy planning process and the energy plan. This evaluation was based both upon an analysis of the contents of the Finspång energy plan and a comparison to other contemporary energy plans.

1.5 Co-Author Statements

The appended papers presented below all contribute to this thesis. They are organised according to their contribution to the research questions as visualised in Figure 1.

Paper I

Jenny Stenlund Nilsson and Anders Mårtensson. **Municipal Energy-Planning and Development of Local Energy Systems.** Applied Energy 76, 1-3, 179-187.

The paper was written by the thesis' author with help in form of ideas and advise from Dr Anders Mårtensson (former supervisor).

Paper II

Jenny Ivner and Olof Hjelm. **Volition and Environmental Assessments in Swedish Municipal Energy Plans.** Manuscript intended for publication in Energy Policy.

The paper was written in cooperation with Dr. Olof Hjelm, supervisor. The author of the thesis was responsible for method development and result presentation. Other parts were written in cooperation.

Appendix

Study on Energy Plans and Energy System's Development

The results Appendix was written by the author alone.

Paper III

Jenny Ivner, Anna Björklund, Karl Henrik Dreborg, Jessica Johansson, Per Viklund, Hans Wiklund. **New Tools in Local Energy Planning: Experimenting with Scenarios, Public Participation and Environmental Assessment.** Submitted to Local Environment.

This paper was edited by the author of this thesis. The other authors contributed with texts about the choice of tools and the application of the tools that were shortened and modified by the editor.

Paper IV

Jenny Ivner. **Energy Planning with Novel Planning Tools - Experiences from an Energy Planning Project.** Submitted to Local Environment.

This paper was written by the author of the thesis with some input from the supervisor.

Paper V

Jenny Ivner. **Do Decision-Making Tools lead to Better Energy Planning?** Submitted to Environmental Planning and Management.

This paper was written by the author of the thesis with some input from the supervisor.

2 Historical Background and Today's Context for Municipal Energy Planning

This chapter presents a brief background to the Swedish energy sector. It also summarises some policies and trends shaping the prerequisites for municipal planning since the adoption of the Act on Municipal Energy Planning in 1977.

2.1 Oil Crises and Decentralisation

After the Second World War and until the 1970s Sweden was dominated by rapid economic growth and a corresponding increase in energy demands. There was little thought about alternatives and precaution because of economical hardship or lack of resources, (Svensson, 1984). Emissions from fossil fuels had been restricted in the new legislation: The Environmental Protection Act (SFS 1969:387), so pollution was not considered a problem (Svensson, 1984). When the first oil crisis arrose in late 1960s, Sweden faced several challenges; energy demands increased rapidly, oil dependence was heavy and hydropower expansion was heavily debated (Anselm, 1992). In 1973 energy issues were the prominent political agenda before a Swedish election for the first time (Moberg, 1987); this was also about the time the term "energy policy" entered into common usage (Vedung, 2001).

In 1975 an energy policy aimed at reducing vulnerability and environmental effects from oil use, and to preserve resources for future generations was adopted (Radetzki, 2004). Among the political measures in the 1975 Energy Policy was the Act on Municipal Energy Planning that was established in 1977 (SFS 1977:439). The requirements in the act were vague, and therefore led to uncertainty about the obligations the municipalities were to have and how the planning should be performed. It was interpreted that the municipalities were encouraged, rather than required, to develop energy plans (Swedish National Audit Office, 1991). Energy plans were tools for the municipalities, not a means for state control (Statens Energiverk et al., 1988). This decentralisation of responsibility to the local authorities was in line with the general development towards decentralisation in Sweden, where the adoption of the Municipal Act (SFS 1977:179) in 1977 played an important role. According to this act, Swedish local authorities now had the competence to "mind their own affairs" (the author's translation). This act allowed wide ranging self governance for Swedish local authorities embracing social services, education, elderly care, authority assignments such as surveillance and planning, civil defence and also communications (Gustavsson, 1999). Energy supply, especially heating, was also an issue regarded as a municipal responsibility, even though it was not a specified part of the municipal competence (Linquist, 1993).

2.2 Oil Reduction and Nuclear Power Expansion

In 1980, an advisory referendum on nuclear power was held. The political decision after the referendum was that all reactors in use were to be kept, and those under construction were to be started but phased out again in 2012. This decision meant that the installed capacity of nuclear power would double within five years (Government Bill

1979/80:170). The abundance of electrical energy led to low prices and that electricity was used for heating buildings. Among the houses built in the 1970s and 1980s, about 40% were heated with electricity; in the 1970s electrical radiators were most common, in the 1980s more flexible waterborne heating systems were used (Nygren, 2003).

There was a massive expansion of district heating during the 1980s. Heat supply increased from 15 to 40 TWh between 1975 and 1985; this rapid expansion was made possible with the aid of different kinds of subsidies (Swedish National Energy Administration, 2001). In 1980, 90% of the installed district heating was based on oil. Due to the remaining oil dependence it was decided the local authorities also should produce an oil reduction plan in 1981 (Statens Energiverk, 1986). In 1984, an amendment was added to the Act on Municipal Energy Planning that stated that energy planning should be pursued in cooperation with large energy users if it was not too cumbersome them (Government Bill 1984/85:5).

2.3 Integration of Energy and Environmental Issues

The 1985 Energy Policy included strategies for oil replacement and a phase-out of nuclear energy (Government Bill 1984/85:120). Goals in this strategy were to secure energy supply to industry and to base the Swedish energy system on reliable, preferably domestic, energy sources. Nuclear power was supposed to be phased-out as planned in 2012. This agreement was however abandoned in 1991 and the date for the phase-out was removed (Vedung, 2001).

After the 1985 Energy Policy the act on municipal energy planning was revised and the role of energy users as an important part of the energy system was acknowledged. Municipalities were now encouraged to plan for the use of energy as well as supply and distribution (Swedish National Audit Office, 1991). Another goal following the 1985 policy was that municipal energy planning should be comprehensive, a part of the municipality's overall planning (Lindquist, 2000). This integration of spatial planning and energy planning however proved difficult to implement because of different planning paradigms and procedures;, i.e. technical and economical considerations in energy planning and social considerations in spatial planning (Engström, 1988).

In the 1991 Energy Policy, the importance of "securing the supply of electricity and other energy" and maintaining "competitive prices" to promote economic growth were highlighted (Government bill 1990/91:88). The same year was also a new environmental policy launched (Government bill 1990/91:90). It was now stated that many different areas in the society should take part in the responsibility for the environment and for the management of resources. The ambition was to implement the policy in a broad integrated and decentralised manner. This bill also introduced Environmental Impact Assessments, EIAs, for certain planning activities. One example was municipal energy plans.

The relation between the energy and waste sectors has also changed since the early 1990s. Waste management is a municipal responsibility. After a governmental proposal in 1993 it has been the intention to minimise waste disposal and increase

recycling (Government bill 1992/93:180). In this case waste recycling also includes energy recovery (waste incineration for producing heat). Since the adoption of the Swedish Waste Decree (SFS 2001:1063) that prohibits disposal of combustible waste, the number of waste incineration plants in the district heating grids have increased substantially. This has lead to an integration of the Swedish energy and waste sectors where 20% of the heat delivered in the district heating grids originates from waste incineration (Swedish Waste Management, 2008).

During the 1990s and early 2000s, first the Swedish Agency for Economic and Regional Growth (NUTEK), and thereafter the National Energy Administration made several initiatives to encourage energy planning and clarify what energy planning could encompass. In addition, a series of handbooks on the subject, the MILEN series, were published (NUTEK, 1991; NUTEK and Swedish Environmental Protection Agency, 1994; Swedish Energy Agency, 1998a, 1998b, 2001a, 2001b; Swedish Energy Agency and Swedish Environmental Protection Agency, 1998). The compliance with the law on municipal energy planning within Swedish municipalities was however low. In 2002, 39% had an up-to-date energy plan, 35% had a plan older than five years and 26% had no energy plan at all (Swedish Energy Agency, 2002)

On the international arena the World Commission on Environment and Development presented a report on sustainable development that considered how to integrate economic development, environmental quality and a sustainable use of the world's resources, known as the Brundtland report (WCED, 1987). Following the Brundtland report the United Nation's Conference on environment and development was held in Rio de Janeiro 1992. One of the results from the conference was the acceptance of the action program Local Agenda 21 (LA21). The program included goals and guidance on sustainable development by eliminating poverty and environmental risks under the declaration, "Think globally–act locally." LA21 activities have been widespread in Swedish municipalities and many activities have regarded energy issues (Edström and Eckerberg, 2002)

2.4 Towards a Sustainable Energy System

Energy discourse during the 1990s was turning towards a transition of the whole energy system (Lindquist, 2000). In June 1997, the Swedish government delivered a new energy policy (Government bill 1996/97:84) that resulted in the 1997 Energy Agreement. The policy was based on three main goals: "secure energy supply," "competitive energy prices," and "low negative impact on health and the environment." Furthermore, the bill stated that this energy policy was part of a goal to make Sweden a forerunner when it comes to ecological sustainability. Local authorities were identified as important actors as many investments in new electricity production and energy efficiency are initiated at the local level (Government bill 1996/97:84). Local Agenda 21 activities were also pointed out as important in the transition of the energy system.

A financial programme was launched with the 1997 Energy Policy. Support was given for connecting buildings to district heating systems, and new electricity production from renewable energy sources was subsidised. The 1997 Energy Policy also called for energy advisory services (SFS 1997:1322). Local authorities could apply for

funding for an energy adviser with the task to inform the public and small enterprises about energy issues. Furthermore, the financial programme included possibilities for local authorities to apply for funding for projects that would lead to a more sustainable energy system in so called Local Investment Programmes, LIP (SFS 1998:23). In all, 161 municipalities initialised more than 1,800 environmental projects, many directed at energy related issues (Eckerberg, 2005).

Today's (2009) Swedish energy policy is based on a Government bill from 2002 (Government bill 2001/02:143), which is based on the 1997 Energy Agreement, and a bill stating the Swedish climate policy (Government bill 2001/02:55). The LIP was followed-up by new investment programmes, now called Climate Investment Programmes, also known as the Klimp-programmes (SFS 2003:262). The Klimp-programmes ran between 2003 and 2008 and included 126 different programmes with nearly 900 measures at the local and regional levels (Swedish Environmental Protection Agency, 2008a).

Another important recent development in the national energy policy is a wish for a changed role of the regional level. In 2002 it was decided that regional transport planning and regional development plans were subjects for regional development councils (SFS 2002:34). In 2008, all Swedish County Administrative Boards were mandated to produce regional energy strategies (Swedish Government, 2007). The county administrative boards are encouraged to take an active role in coordinating local efforts in the transition of the energy system.

Also the environmental policy changed during the late 1990s. In 1998 fifteen environmental objectives were adopted (Government bill 1997/98:145), these were expanded to sixteen goals in 2005 (Government bill 2004/05:150), Table 1. Six objectives were pointed out to be especially relevant to the energy sector: "clean air," "natural acidification only," "a good built environment," "non-toxic environment," "no eutrophication" and "limited influence on climate." (Swedish Energy Agency, 2007) Also other objectives are relevant for the energy sector. For example "Sustainable lakes and watercourses," "Thriving wetlands" and "Sustainable forests," relevant for hydropower, peat extraction and biomass extraction respectively (Swedish Energy Agency, 2007)

Another recent change in the prerequisites for municipal energy planning was the implementation of the EU directive on Strategic Environmental Assessment, SEA (2001/42/EC) into the Swedish Environmental Code (SFS 1998:808) in 2004. Strategic plans that are likely to have a significant impact on the environment, such as municipal energy plans, should then be subject to environmental impact assessments (which refers to SEA, but Swedish legislation uses the same terminology for both EIA and SEA).

Table 1. The sixteen environmental objectives (Swedish Environmental Protection Agency, 2008b). Goals identified by Swedish Energy Agency (2007) as relevant for the energy sector are underlined.

1	Reduced Climate Impact
2	Clean Air
3	Natural Acidification Only
4	A Non-Toxic Environment
5	A Protective Ozone Layer
6	A Safe Radiation Environment
7	Zero Eutrophication
8	Flourishing Lakes and Streams
9	Good-Quality Groundwater
10	A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos
11	Thriving Wetlands
12	Sustainable Forests
13	A Varied Agricultural Landscape
14	A Magnificent Mountain Landscape
15	A Good Built Environment
16	A Rich Diversity of Plant and Animal Life

In short, the prerequisites for energy management at the local level have changed since the adoption of the Act on Municipal Energy Planning in 1977. Objectives for energy and environmental policies have changed over time as well as the development of international attention to energy issues. Also other factors have influenced the arena for local energy planning, for example the deregulation of the electricity market and large investment programmes. A selection of factors that may have affected municipal energy planning since the adoption of the act in 1997 is presented in Table 2.

Table 2. Important factors that may have affected municipal energy planning since the adoption of the Act on Municipal Energy Planning in 1977.

	1977-1984	1985-1996	1997➔
Energy policy	Expansion of nuclear power Reduce oil dependency	Phase-out of nuclear energy Reduce oil dependency Reliable energy resources Energy efficiency	Transition of the energy system Deregulation of electricity market Competitive prices Investment programmes Energy advisory services
Environmental policy	Reduced pollution	Environmental Impact Assessment	15 (16) environmental objectives
Other	Rapid expansion of district heating (oil based) Electricity for heating Self governance	Local Agenda 21 Integration of energy and waste sectors	Local Agenda 21 Kyoto Protocol

2.5 Context for Municipal Energy Planning 2009

As indicated in Section 2.1, Swedish local authorities have diverse roles that may affect the local energy systems. The municipal Councils have the exclusive decision-making power of defining comprehensive policies and plans (Palm and Wihlborg, 2006). There are also several other roles that offer possibilities to influence the energy use within the municipal territory, for example, energy advisory services or business development, Figure 2. There is also an evident wish from the national authorities to support the local authorities in these roles. One example is the Sustainable Municipalities (Uthållig kommun) initiative launched by the Swedish Energy Agency.

This programme aims at supporting municipalities in their work in the transition of the local energy systems. In June 2008, more than 60 municipalities were offered to participate (Swedish Energy Agency, 2008b). Participating local authorities should produce an energy strategy. This requirement does however not refer to the act on municipal energy planning. Local authorities were encouraged to produce a less ambitious document, since results from participating in the programme are considered more important than producing documentation (Swedish Energy Agency, 2008a).

Also the Swedish Environmental Protection Agency supports the energy transition at the local level. The Klimp-programmes have been expanded to include informational

efforts in 2006 Climate Strategy (Government bill 2005/2006:172) and funding has been granted for a number of projects to support local authorities in their strategic work to reduce climate impact. One example is the "The Climate Municipalities" (Klimatkommunerna) which and aims to support local authorities in the work to form a climate strategy. The local authorities are offered support in workshops, seminars, direct support with process leading and data collection (Lamppa, 2008).

The author estimates that more than 100 (almost 50%) Swedish municipalities are being, or have been, part of the different initiatives funded by the Environmental Protection Agency and Energy Agency in 2009.

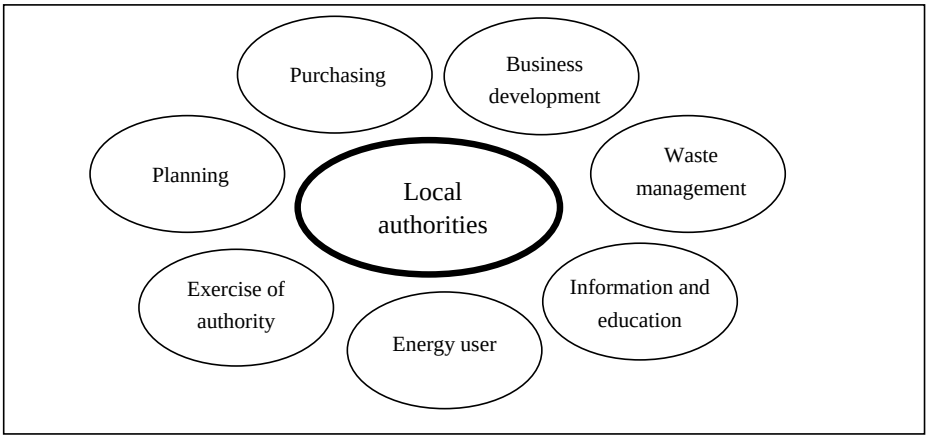


Figure 2. Some examples of the diverse roles of Swedish local authorities that offer possibilities to influence the development of local energy systems.

3 Theoretical Framework and Scientific Approach

This chapter presents theoretical points of departure that have been fundamental in the work with the thesis. Thereafter the scientific approach in the empirical work and analyses are presented.

3.1 Theoretical Points of Departure

Research on energy planning is inter-disciplinary and may have several different approaches. It is therefore of importance to clarify for the reader which theoretical points of departure the author has taken. Some fields have directly influenced the methods and results in this thesis as they form basis for the approach to collect empirical data and analysis. These are presented in Sections 3.2 and 3.3. There are also other views and concepts that have influenced the view on municipal energy planning. These are presented below as some important theoretical points of departure.

Efficient Use of Energy and Renewable Energy Resources are the important means to Reduce Environmental Pressure

As mentioned in the introduction chapter, energy usage affects the environment. Environmental pressure is caused during the entire energy lifecycle, from the fuel extraction to conversion into heat and electricity and also including waste product treatment and disposal. There are primarily three ways to reduce these environmental impacts, i.e. using less energy (energy conservation), using renewable energy resources instead of fossil fuels and employing new energy technologies (World Energy Assessment et al., 2000). The Swedish energy policy today is directed at two of these areas; energy conservation and increasing the share of renewable energy resources in the energy system (Government bill 1996/97:84; Government bill 2001/02:143). It is therefore the view in this thesis that energy conservation, the efficient use of energy and the use of renewable energy resources are the most important means to reduce environmental impact from energy systems.

Efficient energy use in this thesis means that if energy is used, it should be of the *lowest quality possible*. This reasoning is based on the concept of exergy (Wall, 1977, 1997, 2002). Exergy is a measure of the value of energy, or its usefulness (Wall, 2002). Simplified this means that high quality energy, such as electricity, can be used to diverse purposes but low quality energy, such as hot water at 80°C, can practically only be used for space heating. It is the fundamental view in this thesis that electrical energy should not be used for purposes where energy of lower quality can be used.

There are a number of different kinds of renewable energy resources, for example biomass for combustion, solar heat and power, wind power and hydropower. Even though it is not based on finite resources, renewable energy also affects the environment (World Energy Assessment et al., 2000). Biomass can replace fossil fuels in incineration power plants, be processed as vehicle fuels and can also be used for small scale combustion for heating buildings. Biomass fuels lead to environmental impacts during upgrade and combustion, but only marginally contribute anthropogenic carbon to the

atmosphere (Uppenberg et al., 2001a, 2001b). The residual waste products are to some extent suited to recycle as fertiliser (Jacobson, 2003). Sun collectors for heating purposes or electricity do contain scarce metals, however, these are possible to recycle. Both hydro and wind power plants mean impact on the local environment, although the effects disappear moderately as the plants are taken out of use and removed. It is the view in this thesis that renewable energy is preferable to fossil fuels and nuclear power. It is also of great interest to use renewable energy resources with care to avoid new environmental problems arising from so called *problem shifting*. The concept of problem shifting is further discussed in Section 3.3.

Energy Planning as a Proactive Approach to Environmental Issues

Energy planning is here viewed as a suitable tool for a proactive approach to environmental issues. A proactive approach to energy issues in regards to this thesis means that decisions are made with the intention to shape the energy system towards efficient energy use based on the careful use of renewable energy resources. González-Benito and González-Benito (2006) define three aspects of environmental proactivity in organisations; planning and organisational practices, operational practices and communicational practices. Swedish local authorities may act within all these aspects. Organisational and planning practices can take energy resource issues into account in comprehensive planning or planning for energy efficient transports. Operational practices may embrace exercise of authority, such as efficiency requirements in building permission procedures or purchasing. Communicational practices may include energy advisory services and education.

Rational Energy Planning

Municipal energy planning has its roots in a traditional rational planning philosophy where the planning is seen as a straight forward way to predict the future, finding optimal solutions and achieving them (Khakee, 2000). The energy planning process was seen as a linear process, a funnel to collect and treat information for the decision-makers (politicians); see for example Rydén (1991) or NUTEK (1991). Rational planning was however accused for not taking peoples views into account and being unable to foresee societal changes (Khakee, 1999, 2000). Today it is the view in planning theory that community planning should be an interactive and communicative process (Khakee, 2000). Strategic planning should not only focus on technical development but also to identify conflicts and give a voice to stakeholders (Healy, 2006). The research in this thesis is however mainly based on a rational view of planning, that is, it is assumed that the quality of the planning process affects the energy plan and that the quality of the energy plan in turn affects the outcome of energy planning. Interactive and communicative aspects of planning are parts of the analytical approach described in Section 3.3.

3.2 Approaches for Data Collection

This section presents the different approaches for collection of the empirical material. These approaches are different for each of the respective research questions even though

the overall aim has been to evaluate different aspects of the outcome of energy planning processes. This is due to the different natures of the three research questions and the studies used to answer them. The methods used for the data collection are further described in Chapter 4.

Common to all approaches used in the data collection, is that all are based on systems thinking approaches and a black-box model. The features of the model and the points of observation however differ.

The approach to answer RQA is based on the rational view on planning, i.e. that the quality of the energy plan affects the outcome of planning. This approach can also be described as systems thinking according to Vedung (1998). Here, policy is viewed as a system where the parts are dependent of each other. In the simplest form this means an open loop system with an inflow, a process of change and an outflow as shown in Figure 3. Inflow could be political decisions, reforms or programmes. The process of change is, for example, implementation within authority administration. Finally outflow is what comes out from the authority, for example an action plan. These kinds of models are heuristic, explorative, and can be used for investigating processes and asking new questions (Vedung, 1998).

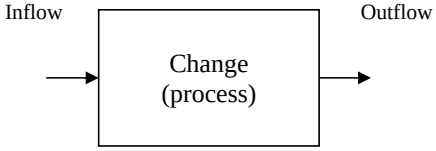


Figure 3. Evaluation of policy as a system in its simplest form as described in Vedung (1998).

When RQA is answered, the energy plan and its implementation are viewed in a similar way. A number of energy plans were studied (Papers I and II) and it was assumed that the quality of the studied energy plans can tell us how the energy planning will affect the local energy system, Figure 4. This means that the implementation process, in this case, is disregarded or viewed as a “black box” (the black box is discussed further below). Instead the observation point is the inflow, the energy plan and its qualities.

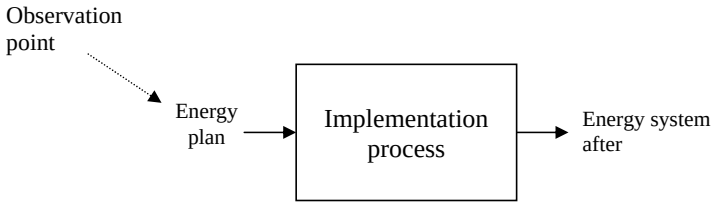


Figure 4. Research approach to answer RQA. Energy planning as a systems model where the implementation process is seen as a “Black box.” It is assumed that the contents of the energy plans mirror how they may affect the local energy system.

When answering RQB "Are goals in the energy plans fulfilled?," an analogous approach is used but here there are two information flows that are of interest. In the study of expressed volition and development in seven municipalities (Appendix), there are three points of observation: the municipal energy system before the energy plan was adopted, the energy plan itself (the document), and the energy system some years after adoption of the energy plans, Figure 5. This approach reveals whether the development in the municipality is in line with the ambitions stated in the energy plans.

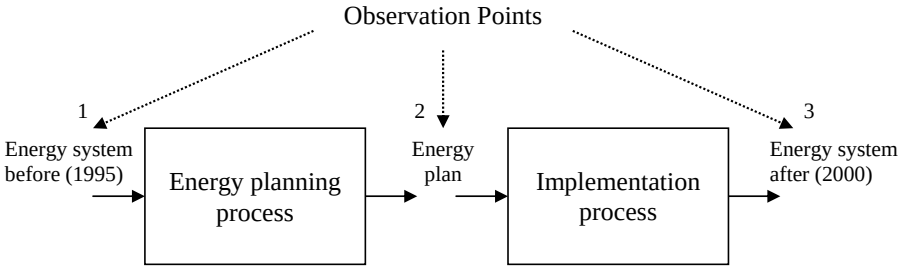


Figure 5. The first research approach to answer RQB. Energy planning and implementation processes seen as seen as black boxes. It is assumed that the contents of the energy plans have some effects on the local energy system between two points of observation.

In a deeper study of Kungälv municipality (Appendix), brief glimpses of the energy planning and implementation processes are also given. This means that some of the contents of the black boxes are revealed, Figure 6. According to a general systems theory, the black boxes are now "grey boxes" as there is a partial knowledge about the internal processes (Skyttner, 2001).

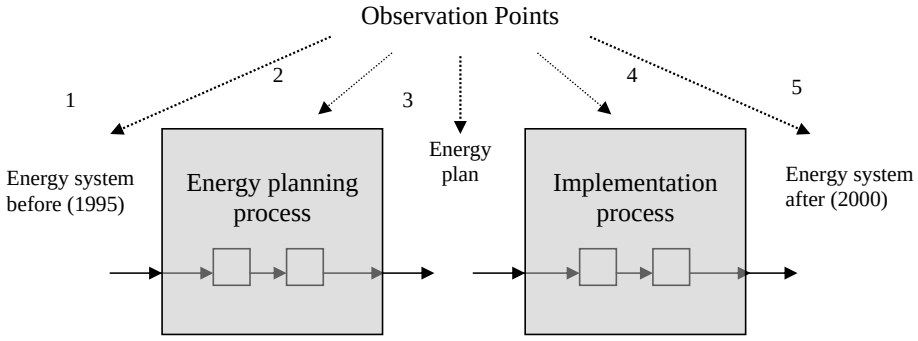


Figure 6. Research approach in the deeper study of Kungälv municipality that also contributes to answering RQB. The planning and implementation processes are grey boxes, where some of the contents are known.

When RQC, "Can the use of decision-making tools make municipal energy planning more effective?" is answered, the purpose is to get a comprehensive view of the energy planning process. The presentation of the pilot project (Paper III) and the evaluation of

the process (Paper IV) are used to illuminate the energy planning box and make the processes within it visible, Figure 7. When the black box is made transparent and there is good knowledge about the contents of the box, it can be called a “white box” (Skyttner, 2001). It is of course not possible, or desirable, to gain total command of the information in the box. However, the aim is here to answer RQC and therefore the intention has been to gather empirical material that is sufficient for that purpose.

Also whether the use of decision-making tools had the desired effect on the energy planning process and the energy plan is of interest for RQC. It is still assumed that the contents of the energy plan affect the local energy system, but the importance of the process leading to the plan is also highlighted. Thus, the observation points are the “white box” (Papers III and IV) and the outflow from it (Paper V).

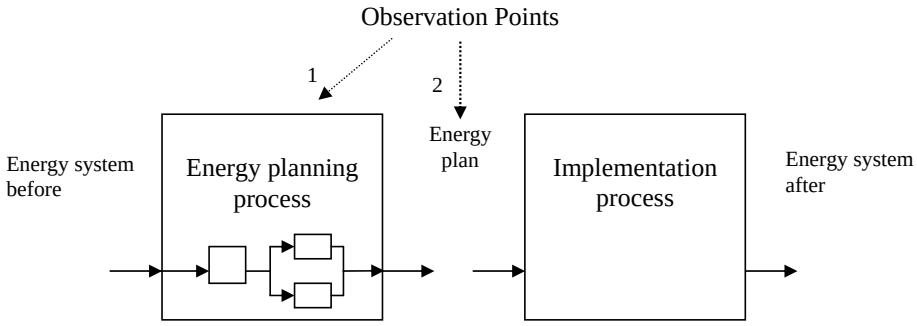


Figure 7. Research approach to answer RQC. The energy planning process is a transparent “white” box. The outflow of the process is the energy plan.

3.3 Scientific Approach for Analysis

This section presents the theoretical basis for the analytical approach towards the empirical material. As presented in the introduction chapter, the main approach to explore effectiveness of energy planning is shown as well as analysing two aspects of energy planning: scope and legitimacy. Scope and legitimacy are also clarified from different points of view, Figure 8.

Scope

As mentioned in the previous section, the quality of energy plans and the energy planning processes are considered very important for the outcome in terms of changes in the local energy systems. This implies that the scope of energy planning is of importance, i.e. *what the energy planning is about.* Energy planning needs to be relevant, in short this means that energy planning should address issues that are likely to lead to an energy system based on efficient energy use and renewable energy resources. Use of energy resources should also be monitored in order to avoid other problems arising. This relevance is approached from two points of view: environmental assessments and a systems approach.

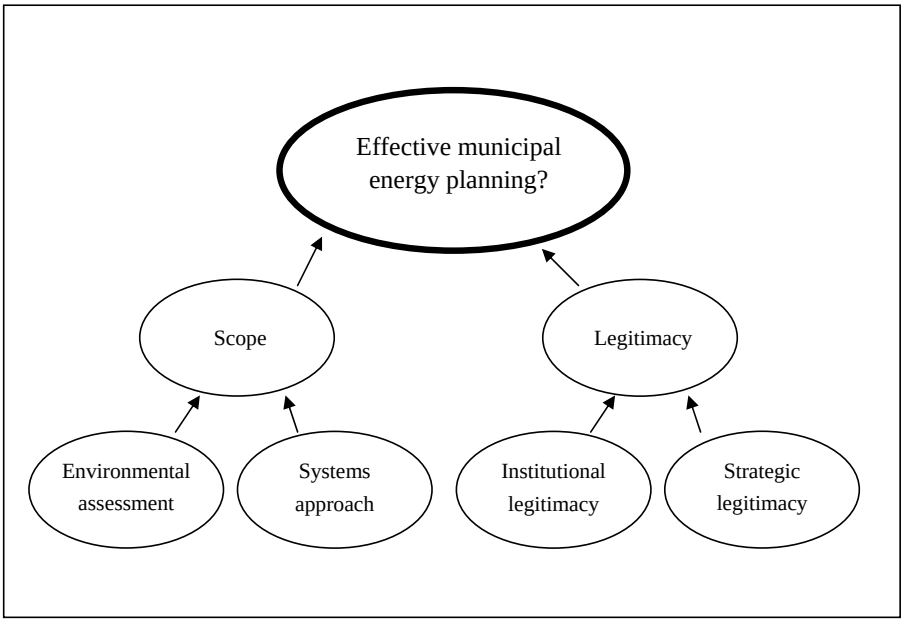


Figure 8. Analytical approach in this thesis. The figure presents the main theoretical fields that are important for the analyses and discussions in this thesis.

Environmental assessment means that current and future impacts on the environment are assessed. Environmental assessments at a strategic level, in planning for example, seek to analyse strategies to reach goals and to anticipate problems or need for change in the strategies and therefore reflects a proactive approach (Noble, 2000). They can also be seen as a tool for integrating the environment into decision-making since they allow a systematic approach to consideration of environmental issues in the decision-making process (Sheate et al., 2003)

There are a vast number of methods and tools that can be used in environmental assessment (Petts, 1999; Thérivel, 2004; Tyldesley, 2003) and environmental decision-making (Dale and English, 1999; Petts, 1999; Sexton et al., 1999). Each and every tool aspires to facilitate for decision-makers to get “the whole picture” and that they have a systems approach. A systems approach means considering the parts as well as the whole of the system (Senge, 2006) and is important when dealing with complex issues, such as energy planning. There are many possible interactions and interdependencies of components in local energy systems (Jank, 2000; Rydén, 2006). A systems approach towards municipal energy planning means that it is important not to focus solely on energy efficient equipment or expanded district heating. In a systems perspective single measures might lead to sub-optimization of the energy system instead of an overall improvement (Gebremedhin, 2003).

The complex nature of local energy systems makes a systems analysis approach appropriate when studying and analysing local energy systems (Ling et al., 2002; McIntyre and Padhan, 2003; Rydén, 2006). There are a number of tools for

environmental assessments (and subsequent decision-making) that have been identified as especially suitable for the energy sector (Finnveden et al., 2003). The choice of which tools to use depends on available resources, such as data or personnel, but also on the desired level of results. The results from environmental systems analysis tools are very dependent upon the context in which they are used, for example does the choice of system boundaries in space an time affect the outcome of the analyses to a great extent. Therefore, when it comes to analysing energy systems from an environmental point of view it is important to apply a life cycle perspective. This is important since energy affects the environment during the entire energy lifecycle, from fuel extraction to conversion into heat and electricity to waste product treatment and disposal. This means that it is important to include the whole life cycle when analysing changes in the energy system.

This thesis primarily focuses on the municipal energy system and its components, Figure 9. The overall perspective is that local energy systems are viewed as large technical systems (LTS). The author also refers to parts of the LTS, sub-systems and technical parts of the system. Sub-systems are, for example, systems in buildings or district heating grids. Technical parts of the sub-systems include for example equipment for heating and cooling buildings and separate plants in the district heating grid.

Municipal energy systems are also socio-technical. The socio-technical characteristics of energy systems mean that the technical (electrical grids, district heating pipes and so forth) and social parts (users, decision-makers, legal structures et cetera) are inseparable (Kaijser et al., 1988; Summerton, 1998). As the technical historian Thomas P Hughes (1983) states, the energy system consists of a “seamless web.” This shows that technical and social parts are not only interrelated, they are spun together as a web. Socio-technical systems have specific characteristics, for example systems momentum (Ingelstam, 2002; Kaijser et al., 1988; Summerton, 1998). The momentum originates from, among other things, the large investments in knowledge and equipment and renders changes to the system difficult. Another characteristic identified for socio-technical systems is systems culture, which means that actors within the system share views and opinions about what developments are most preferable (Kaijser et al., 1988). The systems culture makes the actors “blind” for other ideas and technologies that do not fit into their perspective (ibid).

The author is aware that there are flows of energy carriers across the municipal borders. Such flows are of course of importance to take into consideration when analysing and assessing changes in the municipal energy system with a systems approach. Performing such calculations is however not within the scope of this thesis and will therefore not be discussed further.

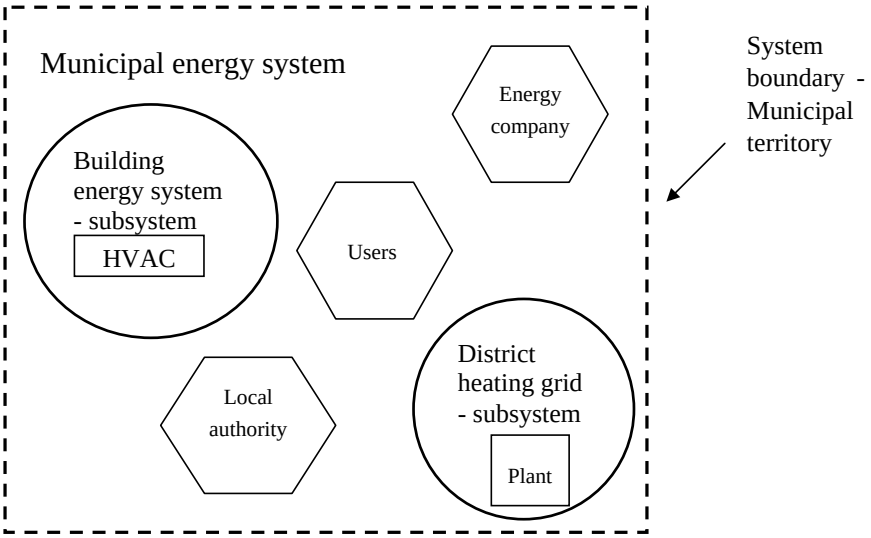


Figure 9. A municipal energy system with examples of sub-systems and actors as viewed in this thesis. Sub-systems are depicted as circles, technical parts as boxes and actors as hexagons. The system boundary is the municipal geographical territory. Analysing flows of energy carriers across the municipal border are not within the scope of this thesis.

Legitimacy

There are different theories that can be applied to explain what makes planning legitimate. Suchman (1995: p 574) provides a definition of the concept of legitimacy:

> *Legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, belief, and definition.*

This means that legitimacy has to do with how organisations are perceived and whether their actions are accepted. Suchman (1995) further refers to two kinds of legitimacy, i.e. the *strategic* and the *institutional*. Strategic legitimacy regards aspects of the organisation from outside and how organisations act for societal support. Institutional legitimacy deals with internal aspects of the organisation and how different pressures and cultures shape how organisations act. Since organisations face both strategic and internal operational challenges and pressures (Suchman, 1995), it is of interest to highlight both perspectives. Therefore, with the criticism towards ineffective energy planning in mind, this thesis discusses both legitimacy towards the surrounding society and legitimacy within the municipal organisation. This means that it is the view in this thesis that energy plans that are legitimate, accepted, within the local authority and among other stakeholders possess a better chance for successful implementation.

The discussion about institutional legitimacy is based on W. Richard Scott's theories about institutions (1998; 2001; 2008). Scott refers to institutions and

organisations as based on three pillars that are regulative, normative and cultural-cognitive. These three pillars represent three different (but related) types of legitimacy. The regulatory pillar refers to the conformity to rules. The normative pillar stresses a moral base for legitimacy and the cultural-cognitive view refers to the legitimacy that comes from conforming to a well-known way of acting (Scott, 2008). The three bases for legitimacy may conflict, but can also differ between organisations (ibid). The three pillars are summarised in Table 3.

Table 3. Basis for the legitimacy discussion. The first row presents bases for legitimacy within the three pillars of an organisation according to Scott (1998; 2001; 2008), the second row describes how organisations seek legitimacy within each pillar according to Scott (1998)

	Regulative	Normative	Cultural-cognitive
Basis for legitimacy	Legally sanctioned	Morally governed	Comprehensible Recognizable Culturally supported
How organisations seek legitimacy	Follows rules in order to get awards or avoid sanctions	Lives up to norms, guided by a sense of what is appropriate	It is guided by taken-for-granted common understandings

Strategic legitimacy is based of whether the organisation is *operating* in a desirable, proper and appropriate manner (Suchman, 1995). Strategic legitimacy rests heavily upon what and how the organisation communicates with the surroundings (Elsbach, 1994), therefore the communication with stakeholders during the energy planning process is of certain interest. The importance of communication during decision-making processes is also highlighted in ideas of ideal democracy originating with the German philosopher Jürgen Habermas. These ideas emphasise that a reflective dialogue between citizens lead to better decisions. It is believed that decisions become more legitimate if people are offered to share their views and know that their ideas are considered (Wiklund, 2005).

4 Methodology

This chapter presents the methods used in the cover essay and in the studies that form bases for the appended papers.

4.1 Method for the Cover Essay

In order to answer the research questions, the relevant results from the appended papers were summarised for the cover essay. Some new tables were added as the results were summarised and rearranged. The results were then analysed from the two points of view described in the previous chapter: scope and legitimacy. Results from the mapping phase (Paper I, II and appendix) are presented and analysed in relation to RQA and RQB in Chapter 5. Results from the method development phase (Papers III-V) are presented and analysed in Chapter 6. This arrangement was made because the pilot project that forms the empirical basis for the method development phase and RQC was partly based on the research from the mapping phase.

Results from the mapping phase are primarily analysed in terms of scope of energy plans, that is, environmental assessments and systems approach as described in the previous chapter. There is also a discussion about the results from the mapping phase in Chapter 5. This discussion regards what may affect the scope of energy plans and whether goals in energy plans are fulfilled.

Findings in the method development phase are analysed and discussed in terms of both scope and legitimacy. Scope is analysed in the same manner as in the mapping phase. The discussion about legitimacy is based on the theories about institutional and strategic legitimacy, which is described in the previous chapter. To summarise the discussions about the results, energy planning is discussed in terms of learning. Learning is briefly discussed as a prerequisite for change and for creating shared visions of the future energy system.

4.2 Methods Used in the Mapping Phase

The mapping phase of the empirical work for this thesis was based on three studies, see Figure 1 in Chapter 1. The first study (Paper I) regarded the scope of the energy plans in Östergötland County and contributes to answering RQA. The next study regarded expressed volition in energy plans adopted from 1995-1998 and analysed the development in the municipalities up to the year 2000 (Appendix). This study contributed to both RQA and RQB; analyses of expressed volition contribute to RQA and the information about whether the development of the local energy systems corresponds to this volition for RQB. The third study was about expressed volition and environmental analyses and assessments in eight energy plans adopted from 2006-2008 (Paper II). These aspects of the energy plans were also compared to parts of the results from the first two studies and give more depth to RQA.

Selection of Study Objects

Paper I

For the study presented in Paper I, Östergötland County in southern Sweden, with its thirteen municipalities of different types and sizes, was chosen as the study object. It was considered that this region represents the diversity of Sweden's municipalities fairly well since it possesses different kinds of industries, coastal and inland areas, agricultural areas as well as (by Swedish standards) large cities. The choice of municipalities was designed to obtain a fairly good overview of energy planning in general.

Appendix

Since the aim with the material presented in Appendix was to use the material to study whether goals stated in energy plans were fulfilled, the main requirement on this set was that the energy plans should be old enough to provide an opportunity for changes to occur in the municipalities, but not so old that they would be completely out of date. It was decided that the energy plans should be adopted between 1995 and 1998. The selection was designed to get a fairly good representation among the municipalities that actually had a recent energy plan, therefore it was another requirement to acquire geographical diversity (coast and inland, north and south). In this process two of the energy plans from the first study were chosen and five additional plans from other parts of the country.

One of the municipalities, Kungälv, was chosen for a deeper study. Kungälv was chosen since there was plenty of published material about the municipality. Kungälv is not an average Swedish municipality when it comes to energy issues; it should on the contrary be viewed as a good example.

Paper II

In this paper, the scope of energy plans adopted between 2006 and 2008 were compared to the scope of older energy plans; the energy plans from the Appendix and the newest energy plans from Paper I adopted between 1992 and 1999.

The set of energy plans for comparison in Paper II was chosen using the following procedure. The energy plan should be new, adopted 2006 or later, to make sure that they were produced during similar political conditions. The plans should also represent average Swedish municipalities in terms size (average in Sweden is 30,000) and classifications according to the Swedish Association of Local Authorities and Regions, SALAR (1997; 2006). Also a good representation of the Swedish regions was sought. This selection represents a broad representation of municipalities with energy plans adopted from 2006-2008, not Swedish municipalities in general.

Forming the Empirical Bases and Analyses

Paper I

This Paper was based on study with a black-box approach (as presented in Figure 4 in the previous chapter). This means that the quality of energy plans was of interest. For the empirical base, the most recently adopted energy plans from each of the Östergötland municipalities were used. Their contents were categorised and analysed with the aid of a set of questions based on the handbooks issued by the Swedish Energy Agency in the 1990s and early 2000s. Most of the contents in the energy plans were categorised and analysed, since the questionnaire was very detailed. However, since the age of the studied energy plans varied widely, so too did the contents. This also led to several of the questions in the questionnaire not meeting corresponding information in any energy plan. Even though it was interesting to find that very few energy plans discussed certain issues, it made the results more difficult to generalise. The complete questionnaire and all results from the first study can be found in Stenlund Nilsson and Tyskeng (2003).

For each question, every plan received a grade based on whether it contained no, little or a lot of information about the issue. All questions in each analysis category were summarised and presented in tables. These tables revealed trends for the issues covered by energy plans, and furthermore to what extent they were covered. The tables were thereafter analysed in relation to the age of the energy plan and (contemporary) national energy policy.

Appendix

The material in the Appendix is also based on a black box model, but here both the energy planning process and the implementation of the energy plan was of interest (see Figure 5 in the previous chapter). Here the volition expressed in the energy plans as well as the state of the local energy systems before and after the adoption of the energy plans was of interest.

All the selected energy plans were analysed in terms of expressed volition. This was done by collecting and analysing all stated goals, measures and strategies from the energy plans. This procedure included categorisation of the goals. This categorisation was based on the knowledge of common volition in the newer energy plans from Paper I. Every occurring goal, measure or strategy in the seven energy plans were placed and indicated in large matrices in the most appropriate category.

The method for analysing whether the development in the studied municipalities was in line with what was expressed in the energy plans or not was a compromise between accuracy and generality. Statistical data from Statistics Sweden (2003) was used and that meant that the material was similar for all municipalities and therefore possible to generalise. The quality of the statistical data varies (Statistics Sweden, 2008). Linking development according to statistics with goals stated in energy plans may lack accuracy, but for this purpose the general trends for district heating and shifts in the use of energy carriers were considered reliable. The possibilities to follow up

specific goals using this method was however limited. Therefore one municipality was subject for deeper analysis.

As mentioned above Kungälv was chosen for a deeper study due to extensive documentation and high priority of energy concerns in the municipality. All goals stated in the Kungälv Energy Plan were followed up with aid of different kinds of documentation issued by the municipality, for example reports and newspapers and personal communication. Specific information about sources and methods for data collection is provided in Appendix.

The deeper study also contributed to information about energy planning and implementation processes in the Kungälv case. This led to new observation points in the black box model and contributed to partial knowledge about the contents of the black boxes (See Figure 6, chapter 3).

Paper II

This paper is based on a study with a very similar approach to the empirical material as in Paper I. The method was however different. The same method was used as for mapping volition in Appendix. After the energy plans adopted from 2006-2008 were compared to the volition expressed in energy plans adopted between 1995 and 1998, the material was reorganised. This was done since the distribution of expressed volition had changed and many goals, measures and strategies therefore had to be placed in an "other"-category since they did not fit elsewhere.

For the comparison of environmental analyses and assessments parts of the same questionnaire as in Paper I were used on the new energy plans. In this way it was also possible to compare the development over time in terms of environmental analyses and assessments in the energy plans. The older group of energy plans was represented by five energy plans from the first study adopted between 1992 and 1999.

4.2 Methods in the Method Development Phase

The method development phase of the empirical work is based on a pilot project where an energy planning process was developed and implemented in Finspång municipality. The aim was to test decision-making tools that might improve certain aspects of energy planning in reality. This approach meant creating a white box of the energy planning process (see Figure 7, chapter 3). Experiences from the project contribute to RQC. The implementation of the process is presented in Paper III, evaluation of the process and the contribution of the tools are presented in Paper IV and V respectively.

The Pilot Project and the Evaluation

These studies were based on the implementation and evaluation of an energy planning process in the municipality of Finspång. The cooperation with Finspång was begun after a civil servant took contact for advice on how to proceed with an energy planning process that had been initialised in the local authority. The contact was very timely as a research project with the aim to test tools for strategic environmental assessment in municipal energy planning was about to start. The relatively small size of municipality, planned district heating expansion, several energy-intensive industries and large

transportation needs also contributed to a choice for continued cooperation in a pilot project.

Paper III

The proposed process was first designed by the author based on the experiences presented in Paper I and Appendix and energy planning handbooks (California Energy Commission, 1997; Jank, 2000; Joanneum Research, 2000; Johansson, 2001; Swedish Energy Agency, 1998b, 2001a, 2001b). The process was then modified in cooperation with researchers from three other research groups with the aim to involve the public in the energy planning process and to assure a broad scope and environmental assessments. The researchers from Jönköping International Business School contributed with their expertise on deliberation tools, those from the Swedish Defence Research Agency on scenario tools and those from the Royal Institute of Technology tools for environmental assessment, Figure 10. Each research group chose which tool would be suitable to meet the aim of the pilot project: A Citizen's panel was chosen as a tool for public participation, a combination of backcasting and external scenarios to assure a broad scope and life cycle assessments and qualitative assessment with indicators chosen for environmental assessments. Steps in the process were inspired by SEA-methodology and the steps described in the EU-directive (2001/42/EC) on strategic environmental assessment that was, at the time, soon to be implemented into Swedish law. These choices are further described in Paper III. The three research groups were also responsible for combining the tools within the proposed energy planning process. The author was not directly involved in the implementation of the energy planning process, but was the responsible editor for Paper III and the following evaluations of the process (Papers IV and V).

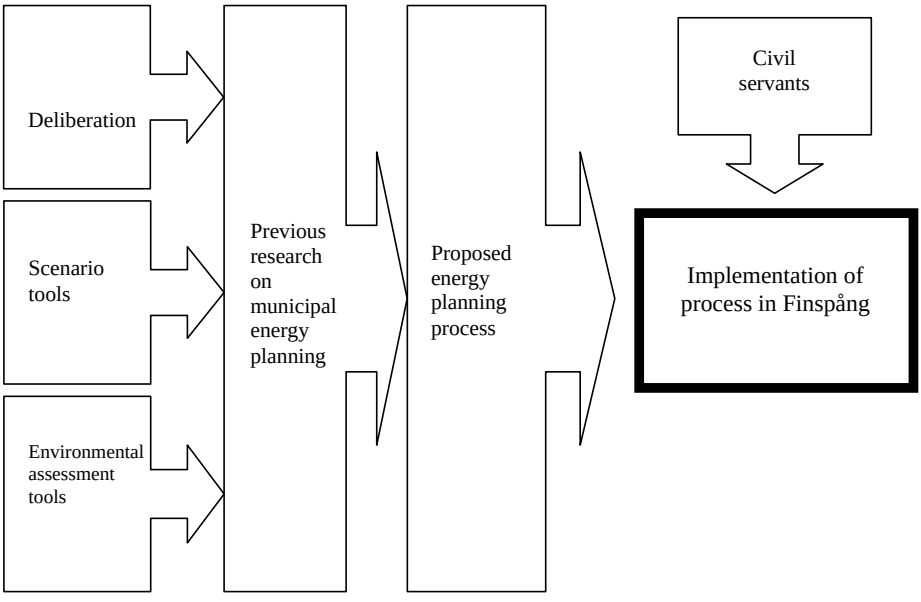


Figure 10. The process leading to the pilot project where a proposed energy planning process was implemented in the municipality of Finspång.

Paper IV

The first part of the evaluation of the pilot project was designed to find out how the participants experienced the implementation of the proposed energy planning process, what they have learned from it and to generate ideas about how to develop the methodologies used (Paper IV). The evaluation was therefore based on focus group discussions, since they offer the participants a chance to give their reflections under free forms. Focus group discussions have also been stressed as a good method for evaluation (Dahlin Ivanoff and Hultberg, 2006) and as a creative method for generating ideas (Breen, 2006).

Two separate discussions were held, one with the municipal workgroup and one with the researchers. The aim was primarily to facilitate for the people from the municipality to criticise the process. All people that had been involved in the implementation process were invited to the discussions; five persons from the municipal workgroup and five researchers. Three persons from the municipal workgroup (two civil servants and one representative for the local energy company) and four researchers attended. The attendance was still regarded as satisfactory since the parts of the municipal organisation that had been represented during the energy planning process were present and all research groups were represented.

Paper V

The second part of the evaluation focused on the contribution of the tools that were used. Different methods were used to analyse the contribution of the scenario tools, the Citizen's panel and environmental assessment tools. The scenario tools were aimed to facilitate learning among the participants and contribute to a broader scope in the process. The contribution of the scenario tools were therefore evaluated in terms of learning and the scope of the energy plan. Empirical material about whether the process facilitated learning was found in the transcribed focus group discussions. The scope of the plan was analysed by comparing the Finspång energy plan to other contemporary energy plans. The width of the analysis was limited to expressed volition in the energy plans. Volition was chosen since the contents of energy plans varied widely but all energy plans included some form of goals and ambitions, but also since volition gives a picture of the desired future energy system and the focus of the energy plan is given.

A similar method was used for the environmental assessment tools. In this case all statements in the energy plans that regarded environmental issues were collected and categorised using the same questionnaire as in the mapping phase (Paper II). A choice was thereafter made to collect all material that could be regarded as some kind of "environmental analysis" because of the experiences from the first study when it was apparent that energy plans included very few or rudimentary environmental assessments. The wider definition allowed a wider range of environmentally related topics to be included in the analysis.

Methods for the Analyses

Paper III

This paper is narrative in nature. The author edited the paper based on the contribution from the three research groups on the applications of the tools and notes from workshops and meetings.

Paper IV

The focus group sessions that formed the empirical bases for the paper were held by the author. Each discussion lasted two hours and were recorded, transcribed and summarised by the author. These summaries were sent to the participants for comments. Two clarifications were given, one from members of each group. The results were then critically reviewed with special attention to similarities and differences of the experiences pictured by the two groups. As mentioned above, the process was inspired by the steps in the SEA-directive (2001/42/EC). Therefore the experiences from this process were compared to good practice and success factors according to SEA-literature. However, since this was an energy planning process, the results were also compared to energy planning handbooks and their descriptions of good practice and success factors.

Paper V

As mentioned above, different approaches were used to evaluate the contribution of the tools. In a similar manner to Paper IV, the results were discussed in relation to literature. In this case literature about environmental decision-making was used.

5 What is Municipal Energy Planning?

This chapter presents the main findings and results from the mapping phase (Papers I, II and Appendix). The results are presented and analysed in terms of environmental assessments and systems approaches and used for answering RQA and RQB. The results are presented in relation to the two research questions in Sections 5.1 and 5.2. The results are then discussed in section 5.3 in terms of what may affect the scope of energy plans and whether goals in energy plans are fulfilled.

The first research question, RQA, was "What is the scope of municipal energy plans?" Papers I, II and Appendix all present different kinds of empirical evidence for answering this question.

5.1 The Scope of Municipal Energy Plans

The scope of Swedish energy plans has varied over time. It was found in Paper I that some municipalities had very old energy plans and that some were recently adopted. The differences between the energy plans to a large extent varied with the age. Similar differences could also be seen in Paper II where expressed volition and environmental assessments in energy plans adopted between 2006 and 2008 were compared to energy plans adopted in the 1990s. For example, the newer plans included more goals for transport, information and education with respect to the older ones.

It was also found in Paper I that the focus of the municipal energy plans seemed to have been to describe the energy systems. Almost all plans presented in Paper I contained information about the present types of fuels used for heating buildings (public and private) and for industry. In the newer plans, the fuels used for district-heating systems were also described. Even though it was not within the scope of Paper II and Appendix, the author noted that these kinds of thorough descriptions of the local energy systems were not as common in newer energy plans. Most plans included some kind of overview of the energy system, for example energy use and energy carriers, but similar detailed descriptions of the energy systems as in the older plans were not observed.

Paper II compared volition in energy plans from 1995-1998 to energy plans adopted between 2006 and 2008. The total number of different goals had increased (Figure 11), which indicates that the scope of volition is broader in energy plans adopted between 2006 and 2008 than those adopted between 1995 and 1998. There were also more goals that did not fit into any of the categories in the newer set of energy plans that therefore were placed in an "other" group. Goals, actions and strategies in the newer set of energy plans were also reorganised for Paper II because of this change of expressed volition, Figure 12. This redistribution facilitated the analyses of expressed volition in the newer plans.

The energy plans adopted from 2006 to 2008 included a large number of goals for the local authority, for example overall planning, energy advisory services and exercise of authority, Figure 12. The rest of the goals, actions or strategies regard for example reduced energy use, conversion from oil and electricity for heating buildings, district heating expansion and energy supply security. Also, all the analysed energy plans

include goals for reduced environmental impact from the energy system. Most commonly occurring are goals for reduced carbon dioxide emissions (in 88%).

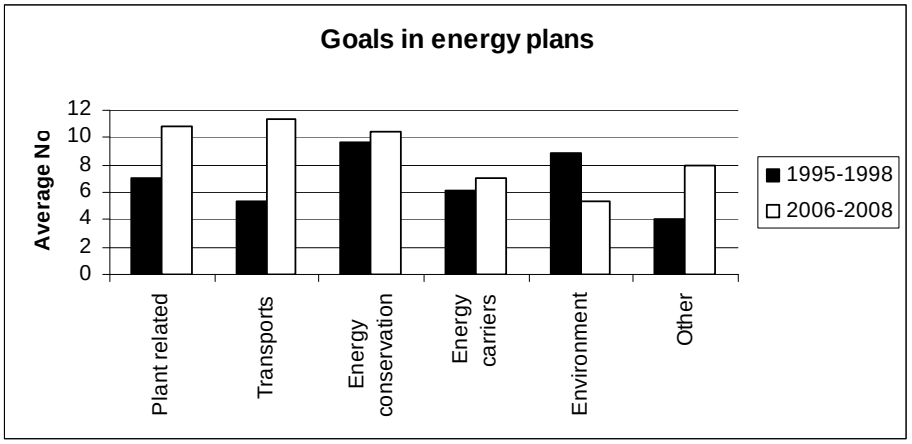


Figure 11. Average distribution of different goals in seven energy plans adopted 1995-1998 and eight energy plans adopted 2006-2008.

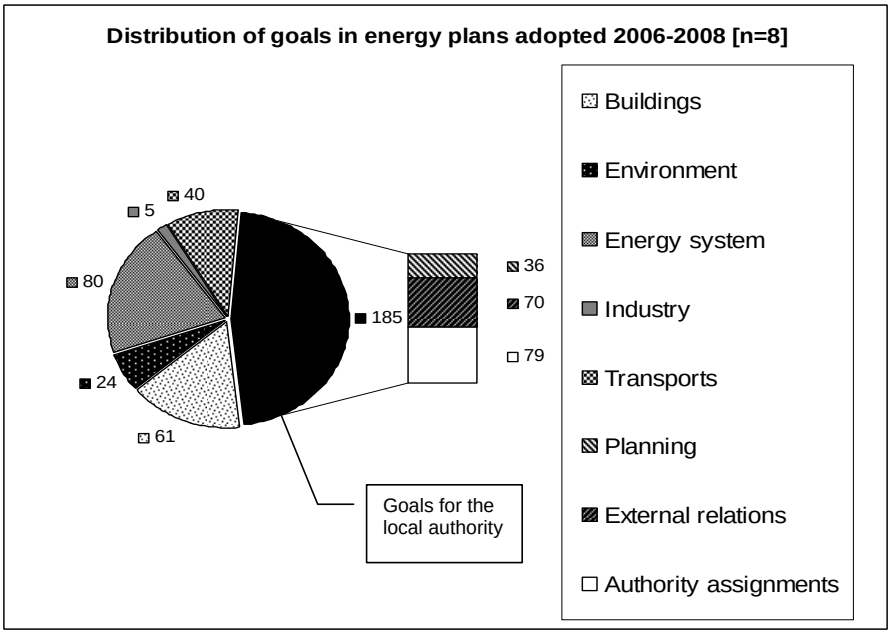


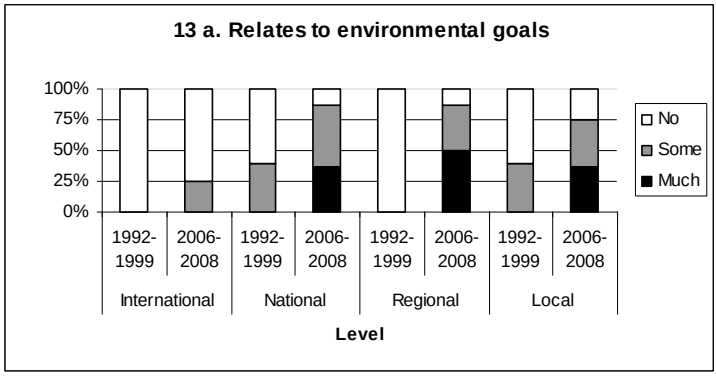
Figure 12. Distribution of goals, measures and strategies in the eight studied energy plans adopted 2006-2008.

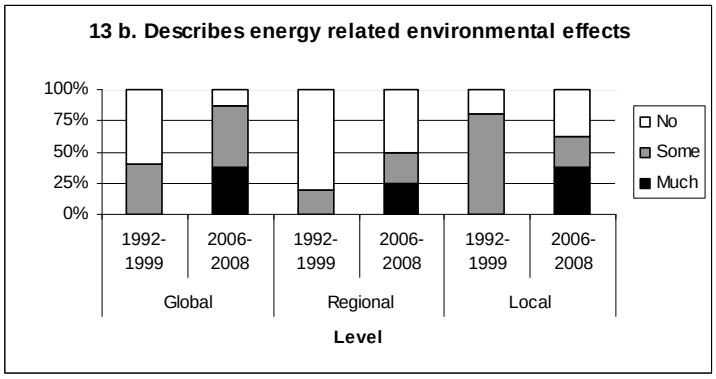
Environmental Analyses and Assessments

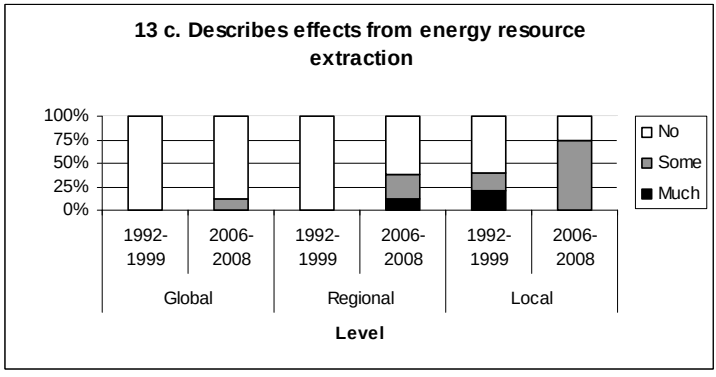
It was concluded in Paper II that the energy plans adopted 2006-2008 generally have a broader scope of environmental analyses and assessments. Most plans from 1995-1998 included brief descriptions of local effects, such as air quality. The plans adopted between 2006 and 2008, on the other hand, relate to global effects and energy related issues. Some of these also relate to local and regional effects. The newer energy plans also refer to environmental goals to greater extent, which can also be seen in Figures 13 a-c.

Even though all but one of the studied energy plans from 2006-2008 describe and relate to different kinds of environmental quality goals, such as “clean air” or “sustainable forests,” only a few state goals for emissions of other substances than carbon dioxide. There are significantly fewer goals for environmental issues in the newer plans. In fact 12.5% of the plans do not include goals for reduced emissions of other substances than carbon dioxide in comparison to 71% plans that include goals for reduced NOx and SO_2 among the previous plans. Furthermore, 86% of the older plans include goals to reduce impacts from resource extraction, while only 38% of the newer plans include such goals.

It was also found in Paper II that the newer energy plans had goals for increased use of renewable energy resources, but there were fewer analyses and assessments about what problems increased use of renewable energy resources might lead to compared to older plans.







Figures 13 a-c. Reference to environmental goals, environmental impacts and effects in five energy plans adopted 1992-1999 and eight adopted 2006-2008.

Systems Approach in the Studied Plans

It was found in Paper I that the contents of the plans varied. For example the system boundaries were broader in the newer plans. In the older plans, efficiency in buildings played a central role. In the newer plans, however, efficiency in the whole municipal energy-system is considered. The relationship between the energy plans and strategic planning in municipalities has also varied. Older energy plans included detailed suggestions on how to include energy issues in spatial planning. The energy plans adopted between 2006 and 2008 (Paper II) include goals for developing routines for including energy issues in spatial planning.

Most of the energy plans presented in Paper I include some kind of implementation part. Goals or expressed volition in the older plans primarily regarded the reduction of oil consumption and energy efficiency in buildings. Plans adopted between 1985 and 1997 included goals for reduced emissions and district heating. The newest plans also include goals for renewable energy resources.

The range of different types of goals expressed in energy plans was studied in the Appendix and Paper II as well. Figure 14 presents an overview of the distribution of goals at different systems levels in energy plans adopted between 1995 and 1998. Goals for reduced energy use and reduced environmental impacts were primarily on the large technical systems level, which means that the goals address changes on a societal level. Goals for energy supply issues, plants and energy carriers were on sub-systems or the technical level. A large number of goals addressed district heating expansion.

In regards to the results about environmental issues presented in Paper II, a change in the systems approach can be seen. Almost all energy plans adopted between 2006 and 2008 included goals for reduced climate impacts, i.e. environmental effects at the global scale. These plans also referred to environmental goals to a larger extent. This does not necessarily mean that the newer plans have a broader systems approach than the older. There were fewer plans that address other emissions than CO_2 in the energy plans adopted between 2006 and 2008 than in those adopted between 1995 and 1998. It was also concluded in Paper II that the newer plans were primarily project oriented rather than addressing major systems changes.

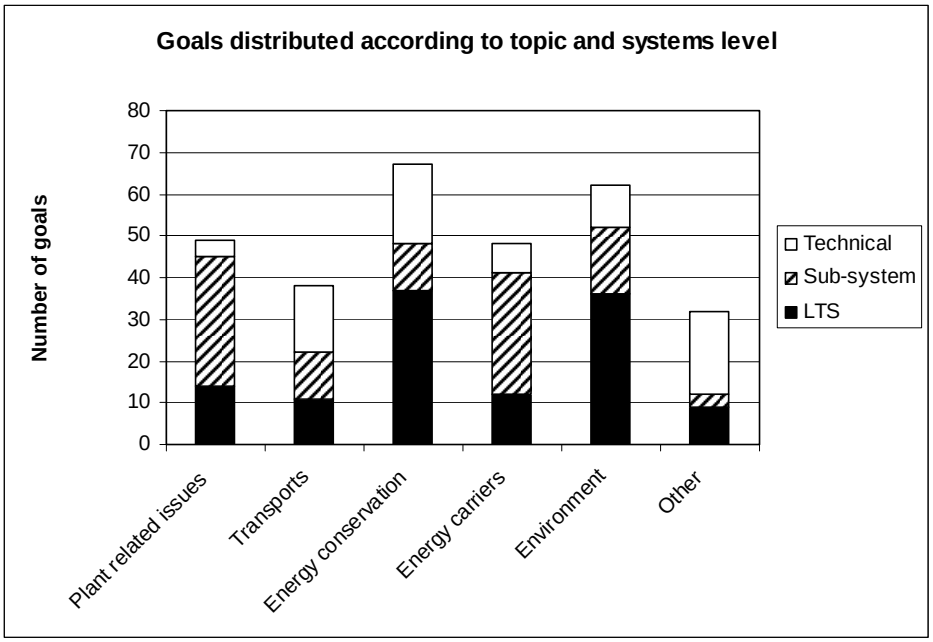


Figure 14. Distribution of goals in seven energy plans adopted 1995-1998. “Technical” means technical parts of the system or technical solutions. “Sub-system” means systems solutions that are primarily technical, for example district heating. “LTS” means a broad systems approach including both technical solutions and behavioural issues.

5.2 Are Goals in Energy Plans Fulfilled?

The second research question, RQB, was “Are goals in the energy plans fulfilled?” Empirical material to answer this question is presented in the Appendix.

The results in the Appendix indicate that there was a positive development in relation to stated goals for district heating, rail transports and reduction of the share of fossil fuels. The most positive trend is for the group of goals about energy carriers. There has been a general transition in the use of energy carriers in all municipalities. One reason that can be tracked with the method used is expansion of district heating systems. In general, environmental performance of the energy system improved. In particular, there are large reductions of CO_2 and SO_2 emissions, which can be explained by the reduction of fossil fuel use for heating purposes.

There was evidence for negative development for energy use for transportation, attempted biogas/ethanol production and total energy use. Despite the fact that energy consumption in households and in the public sector decreased in most municipalities, there is a net increase in energy use per capita in all studied municipalities but one. The large increase has been in the industrial and transport sectors. The most positive trends

in relation to stated goals can be found for issues that are within the power of the local authority. A general trend indicated that there was better development in relation to goals of technical character, for example new energy plants, than for goals on the LTS-level. This could be, for example, an overall reduction of energy use.

As all stated goals in the Kungälv energy plan were reviewed a general tendency could be seen. Among the goals that were not fulfilled (or goals with a negative development), a large part of the goals were more or less outside the power of the local authority. Among these goals were, for example, reduced electricity use and reduced transportation, Table 4. Among the goals that were fulfilled (or with a positive development) were goals relatively within the power of the local authority, Table 5.

Table 4. Goals in the Kungälv energy plan that showed negative development in 2003 and main responsible actors. Both means that both the local authority and private actors are responsible for fulfilment of the goal.

Goals with Negative Development (2003)	Local Authority	Both	External	Comment
Not increased transports within the municipality			X	
Reduced total electricity use		X		Mostly private
Reduced use of electricity for heating		X		Mostly private
Total reduction of energy use		X		Mostly private
New wind power			X	
Not increased retail of petrol and oil			X	
Start breeding energy crops			X	
Formalised procedures to consider energy issues in spatial planning	X			

Table 5. Goals in the Kungälv energy plan that showed positive development in 2003 and main responsible actors. LA means local authority. Both mean that both the LA and private actors are responsible for fulfilment of the goal.

Goals with positive development (2003)	Local authority	Both	External	Comment
Expansion of district heating (several projects)	X			Local energy company owned by municipality
New local district heating	X			Local energy company owned by municipality
Reduce small scale solid fuel combustion		X		Possible subsidies
Reduce transports within Kungälv city centre		X		Transport planning
Increased travelling with public transports			X	
Reduced use of oil for heating			X	
Investigate possibilities for biogas production	X			
Reduced emissions of VOC		X		Local energy company owned by municipality
Reduced emissions of NOx		X		Local energy company owned by municipality
Reduced emissions of CO_2		X		Local energy company owned by municipality
Reduced emissions of SO_2		X		Local energy company owned by municipality
Start to recycle ash from combustion in the district heating plant	X			Local energy company owned by municipality
Start environmental reporting activities	X			
Reduced energy use in the public sector	X			
Follow up energy plan	X			

5.3 Discussion about the Findings in the Mapping Phase

The method development phase in this thesis is based, to some extent, on the results from the first studies. Before presenting the results of the method development, it is therefore of interest to discuss what may affect the scope of energy plans and whether goals in energy plans are fulfilled. This discussion provides background information to the pilot project presented in the next chapter.

What May Affect the Scope of Municipal Energy Plans?

It was shown at the beginning of this chapter that the scope of municipal energy planning has varied over time. There are more environmental analyses and assessments in recent energy plans than in those from the 1980s and 1990s, but comprehensive environmental assessments were rare. From technical solutions for energy efficiency and oil reduction in the 1980s, to a broader approach in the 1990s and 2000s, systems approaches have also changed. There has also been a shift from focus on emissions that lead to local environmental effects to a focus on climate change and emissions of CO_2. This fact together with the fact that environmental assessments in energy plans are very brief is problematic. Even though most energy plans include information about how energy use may effect the environment at different levels they seldom include deeper analyses or reflections over what implications this has for the municipality. The focus in energy plans on projects to reduce CO_2-emissions at the cost of an overall approach to several different aspects of energy use can lead to a narrow systems approach and a subsequent risk for problem shifting in the local energy system. Measures for reducing climate impacts by using more biomass may lead to changing the problems rather than truly reducing them. Even though increased use of biofuels lead to reduction of the use of fossil energy, the transition may lead to other implications such as an increased use of biomass for incineration may lead to more emissions of particles and volatile organic compounds. Furthermore, the extraction of biomass may have severe effects on local ecosystems.

The lack of comprehensive environmental assessments has also been observed in municipal comprehensive planning. Khakee (2000) concluded that a large number of all Swedish municipal comprehensive plans included no or very minuscule discussions about strategic considerations or environmental assessments. Åkerskog (2006) concludes that in none of 23 studied plans include a reference to significant environmental impacts that can be the result if the plan is implemented. These studies indicate that the lack of environmental assessments in municipal planning is a general problem. If planners avoid producing comprehensive environmental assessments, this brings forward an explanation of why comprehensive environmental assessments are not within the scope of energy planning either.

The variation of the scopes of municipal energy plans show that the energy planning has been very adaptive to external factors such as national energy policies and international trends. The empirical findings indicate that the variations of the scope of energy plans correspond to contemporary energy and environmental policies as well as possibilities for funding and other trends, Table 6. In Paper I it was concluded that the contents of the studied energy plans reflected the energy policy during the time of

adoption and that the focus of the studied municipal energy plans were to describe the energy systems. The descriptions from different eras had similar recurring contents that could be traced to current Swedish energy policies. Also in Paper II a strong connection to national policies could be seen, for example the focus on climate issues in the energy plans adopted between 2006 and 2008. It was also concluded in Paper II that these energy plans were more project oriented than energy plans adopted between 1995 and 1998. This meant that there were more goals for clearly defined projects. This project orientation was connected to the possibilities to apply for project funding in Klimp-programmes.

The adaptive nature of Swedish municipal energy planning can be explained by the fact that municipal energy planning was intended as a tool for the municipalities to manage the local energy system, not as a tool for state control (Statens Energiverk et al., 1988). The lack of rigid structures and sanctions opens for Swedish local authorities to choose to include issues that they regard important. This may make energy planning more useful and adaptive to the reality faced by Swedish local authorities. There is however also a risk that the energy planning becomes ad hoc, i.e. instead of being a strategic plan for a sustainable local energy system, the work with the energy plan becomes focused on current possibilities to receive project funding or whatever happens to be trendy at the moment.

Table 6. International trends, main objectives for national energy policies and key words for the energy plans from corresponding eras.

	1977-1984	**1985-1997**	**1997-1999**	**2006-2008**
Inter-national trends	Reduction of oil dependence	Local Agenda 21	Local Agenda 21 Kyoto Protocol	Kyoto protocol
Main objectives in national energy policy	Expansion of nuclear power Reduce oil dependency	Phase-out of nuclear energy Reduce oil dependency Reliable energy resources Energy efficiency	Transition of the energy system Competitive prices LIP Energy advisory services	Low climate impact Klimp Energy advisory services
Common themes in studied energy plans from the era	Nuclear power Local heating systems Efficiency in buildings Alternative energy technologies, e.g. heat pumps	Reduction of fossil fuels Efficiency District heating Reduction of emissions	System optimisation LA21 Wind power Biomass Sustainable development	Reduced climate impact Administrative measures Projects Energy security Energy advisory services

What May Affect Whether Goals are Fulfilled?

The results in Appendix showed that the most positive trends for fulfilment of goals in the seven studied energy plans adopted 1995 and 1998 were for issues within the power of the local authority. This was most apparent in the deeper study of Kungälv. The strong connection between what is the local authority can influence and whether goals are fulfilled raises the question whether energy planning should embrace issues that are not within their power. The Swedish Energy Agency stress in their programme Sustainable Municipalities that the municipal energy strategy only shall include activities within the power of the local authority (Swedish Energy Agency, 2008a). On the other hand is it stressed in energy planning literature (Jank, 2000; Rydén, 2001, 2006) that it is important to involve other actors in the planning process. It is argued also in Ling et al. (2002) that it is important to work towards a shared vision for the energy system, since that makes the process "living on its own," reducing the dependence on the local authority.

The lack of fulfilment of goals outside the power of the local authority in the Kungälv case may therefore also be explained by the traditional planning procedure preceding the energy plan. The energy planning process was conducted as a programme with regular meetings with local politicians. Before the adoption of the energy plan it was sent for remittance to several local actors. This traditional way of involving actors in the late stages of the planning process is perhaps not the most efficient way to gain legitimacy for the plan. Late involvement of stakeholders rather makes the knowledge gap between the expert planners and the public wider (Golobic and Marusic, 2007). In addition, it does not open for possibilities to shape shared visions outside the municipal organisation.

The most important factors for successful fulfilment of the energy plan in Kungälv were, according to one of the respondents, was the local authority received LIP funding and the shared vision of a fossil free municipality with the local energy company, especially the dedicated manager. It has been shown in other studies that the presence of funding programmes substantially contributes to the local work towards sustainability. For example, 70% of the questioned local authorities claim that LIP funding was positive for the compliance of LA21 activities in a study by Edström and Eckerberg (2002). Also the importance of dedicated persons in energy management has been observed in other studies, for example by Thollander (2008).

There are some other aspects for the fulfilment of goals that are of interest to discuss. On one hand, the rate of fulfilment is to some extent dependent on whether goals are possible to fulfil, or rather, whether it is possible to assess whether the goals are fulfilled. It is argued in energy planning literature (Rydén, 2001) and in the handbook to participants in the Sustainable Municipalities programme (Swedish Energy Agency, 2008a) that goals need to be realistic and measurable. Another energy planning handbook states that it is preferable that goals are possible to follow-up with the same methods as in the mapping phase of the energy planning process (KanEnergi, 2004). On the other hand, it can be discussed what the purpose of the energy plan is: is it to radically change the local energy system or is it to formulate goals that are easy to

obtain in order to show good results when it comes to fulfilment? It could be the case that the energy plan actually leads to changes in the energy system that are not easy to measure but lead to new cooperation between actors in the municipality with increased cooperation and innovation as a result. Are such results less valuable than measurable changes? It is not within the scope this thesis to examine the quality of expressed volition in the energy plans. It is nevertheless of importance to be aware of the fact that the measurable effectiveness of energy planning can be dependent on the nature of the goals set up for the energy plan or what the purpose of the energy planning is in the first place.

6 Tools for More Effective Energy Planning?

This chapter presents the main findings from the method development phase (Papers III-V), results that are used to answer RQC. First the development of an energy planning process based on four integrated decision-making tools is presented along with evaluations of this process. Thereafter the results are discussed in relation to RQC.

As presented before, the last research question, RQC, was "Can the use of decision-making tools make energy planning more effective?". Empirical evidence that is used for answering RQC is presented in Papers III-V.

6.1 Environmental Decision-Making Tools in a Pilot Project

In order to answer RQC, an energy planning process was designed, implemented and evaluated. This section presents the background to, and implementation of, the process in this pilot project. The main findings from the evaluations are also presented.

Development of the Planning Process

There were three main conclusions that were brought from the first studies in the mapping phase into the pilot project presented in Paper III; environmental assessments were rare in energy plans, many energy plans were rather descriptive in their character and that most goals that were fulfilled were issues more or less within direct power of the local authority. It was therefore the aim when designing the pilot project to include methods that could contribute to more comprehensive environmental assessments, a broad systems approach and involvement of stakeholders.

Paper III describes a pilot project where an energy planning process was implemented in the municipality Finspång. The ambition in the pilot project was to develop and test a "standard of good practice" for energy planning that included what is required by the SEA-directive (2001/42/EC) and the Swedish Act on Municipal Energy Planning (SFS 1977:439). The ambition was also to improve the quality of the energy planning process and its outcome by using public participation and apply a broader systems approach and far-reaching environmental assessments. The energy planning process was therefore based on four integrated decision-making tools; a Citizen's panel, scenarios, life cycle assessment (LCA) and qualitative environmental assessments.

The decision to use and combine these four tools in an SEA process was based on the fact that they have been claimed to have potential to address aspects such as those identified as shortages in municipal energy planning. The energy planning process that was tested in Finspång included a number of steps, Table 9. The steps were inspired by the phases of an EA described in the SEA directive (2001/42/EC, 2001) and a number of handbooks for local energy planning (California Energy Commission, 1997; Jank, 2000; Joanneum Research, 2000; Johansson, 2001; Swedish Energy Agency, 1998b, 2001a, 2001b). Further descriptions of the energy planning processes can be found in Paper III.

It was concluded in Paper III that the implementation of the process involved a number of methodological and practical challenges, i.e. scenario methods, public

participation and LCAs were combined in a way that required methodology development. It was also a challenge to combine quantitative environmental assessment methods, such as LCAs with qualitative methods to assess environmental impact of alternative developments of an entire municipal energy system. Thus the use of far-reaching EA and scenario methods was also demanding, in both time and resources.

Table 7. Summary of the pilot energy-planning process in Finspång. For each step a general description is given as well as the applied planning tools, output, and who participated. Background to the process and methodological choices are further described in Paper III.

Step	Task	Description	Tool Applied	Output	Participants
0	Start of process	The municipal workgroup was selected, objectives defined and time schedule established.	---	---	Researchers, civil servants, politicians
1	Collection of background information	Information and analyses of the current energy system.	---	Background information report	Researchers, municipal workgroup
	Appointment of Citizen's panel	A Citizen's panel was appointed after advertisement in newspapers and networking.	• Citizen's panel	---	Civil servants
2	Workshop: "Visionary image of the future"	Workshop with structured brainstorming about Finspång in 2040. Selection of most attractive ideas based on voting.	• Back casting • LCA • Citizen's panel	A list of ideas of a sustainable municipality 2040	Researchers, citizens, municipal workgroup
3	Choice of visionary image	The research group composed desirable future image based on ideas from step 2. The image was revised after step 4.	• Back casting	A visionary future image of the municipality 2040	Researchers
4	Workshop: "Development of external scenarios"	Structured brainstorming on outside factors that may affect Finspång's local energy system	• External scenarios • Citizen's panel	Four external scenarios	Researchers, citizens, municipal workgroup
5	Workshop: "Suggestions of actions and strategies"	Group discussions on actions and strategies for a sustainable energy system as described in the visionary future image (step 3) for each external scenario	• External scenarios and back casting • Citizen's panel	A list of suggested actions and strategies	Researchers, citizens, municipal workgroup
6	Selection of actions and strategies	Choice of actions that are estimated possible to act upon	---	A list of 60 actions and strategies	Municipal workgroup
7	Environmental assessment	Qualitative and quantitative assessment of the actions and strategies in relation to the external scenarios and regional environmental goals.	• External scenarios • LCA and qualitative assessment	10 actions tested for robustness with LCA 50 actions assessed qualitatively	Researchers, municipal workgroup
8	Valuation and choice of robust strategies	Choice of robust actions and strategies – actions and strategies that show positive EAs in several external scenarios.	• External scenarios • LCA and qualitative assessment	A shortened list of actions and strategies with EA results	Municipal workgroup, researchers
9	Feedback to the Citizen's panel	Feed-back meeting with the Citizen's panel. Information and discussions about steps 6-8.	• Citizen's panel	A revised list of actions and strategies	Municipal workgroup, Citizens
10	Implementation part	Specification and concretisation of actions and strategies for the energy plan.	---	A specified list of actions and strategies for the energy plan	Civil servants (researchers advisory)

Evaluation of the Process and its Outcome

The implementation of the proposed energy planning process was evaluated in two steps. First the participants' experiences were studied (Paper IV) and then the contribution of the decision-making tools was evaluated (Paper V). The first step had the primary aim to find out whether the practitioners regarded the tools as useful. All participants from the municipal workgroup and the research group were invited to participate in focus group discussions. The intention was to find out what the participants learnt during the project and to generate ideas for further method developments. It was also of importance that those involved in the process were allowed to give their reflections under free forms. Therefore it was decided that the municipal workgroup and the research group should participate in different discussions.

The results from the interviews pointed towards the need to discuss the scope of the planning in advance and not to rely on the background report to raise all relevant issues. For example, both groups concluded that there were some issues, such as energy security issues, that were never brought up during the process. Instead there was much focus on "the environment." It was also concluded in this study that the choice of indicators for environmental assessments can be part of the scoping process.

The importance of clear responsibilities and dialogue became evident as both the municipal workgroup and the researchers concluded that responsibilities in the process had been unclear. The steps in the planning process were not fully developed as the project started and much time and effort was spent on refining the application of the decision-making tools. However, even though the municipal workgroup found it confusing when they did not know exactly what was going to happen, they found the possibilities to adapt the process beneficial. They also mentioned the importance of adaptability of the process when they were asked for what advice they would give another local authority about to initiate an energy planning process.

The focus group discussions also revealed that the pilot project had provided opportunities for learning and that the involvement of a Citizen's panel was appreciated by the participants. The municipal workgroup meant, for example, that the dialogue with the panel had been much more constructive than the traditional remittance procedures. The municipal workgroup also meant that that the work during the energy planning process led to a breakthrough in the communication within the local authority.

Paper V analysed whether the application of decision-making tools lead to "better" energy planning. The analysed aspects were "broad scope," "legitimacy" and "comprehensive environmental assessments." To be able to do this, the results from the pilot project, the Finspång energy plan was compared to a reference set of contemporary energy plans. The contents of the energy plan were also analysed with the aim to track the impact of the Citizen's panel in the plan.

The comparison with the other contemporary energy plans indicated that the four decision-making tools contributed to a broader scope and more comprehensive environmental assessments. It was found that the Finspång energy plan included almost all issues brought up as volition in the reference energy plans. General descriptions about energy related environmental aspects did not differ substantially from the

reference energy plans, but the environmental assessments based on the national environmental quality objectives as indicators were unique. The analysis of the contribution of the Citizen's panel together with the results from the focus group discussions indicated that the energy planning process possesses good prerequisites for a legitimate plan. Table 8 summarises findings from Papers III-V.

Table 8. Summary of the findings from the focus group discussions and evaluations presented in Papers III-V.

Topic	Findings
Application of Scenario Tools	Was found complicated among some of the citizens (to discuss measures within external scenarios that they did not agree with) The combination of external scenarios and environmental assessment tools was more complicated than anticipated Lead to learning
Application of Environmental Assessment Tools	LCA was possible for only 1/6 of the total amount of the suggested actions LCA results were not included in the final energy plan The members of the municipal workgroup were surprised that several actions did not show better results in the long run The scenario tools could support a broader approach than actually applied The qualitative approach using the national environmental quality objectives as indicators was unique and regarded as useful among the municipal workgroup
Application of Citizen's Panel	It was hard to recruit people for the panel, especially from industry The open dialogue was appreciated by the municipal workgroup Contributed to legitimacy; a large number of suggestions from the panel were used in the energy plan. The suggestions were generally supported by the public (Wiklund and Viklund, Manuscript) About 50% of all actions and goals in the energy plan did originated from the Citizen's panel
Lessons learned from the process (by the municipal workgroup)	It is important to appoint a diverse workgroup to work with the energy planning process It is important that someone acts as process leader and that tasks and roles are clearly defined It is good to adjust the process to established routines and networks for the work; it was concluded that it is important not to invent entirely new organisations for the energy planning process A pre-defined process provides good support. The process should however not be rigid The scoping at the beginning of the process is important It is important to allow the process to take time It can be fruitful to involve the public and it is good to keep an open dialogue with local industries Environmental assessments are beneficial, but it is important not to make things too complicated Informal, but regular meetings with politicians was a time-efficient way to work

6.2 Towards Effective Energy Planning?

As presented above, the process was appreciated by the municipal workgroup because of the opportunities for learning, the improved communication within the local authority and stakeholders, and the open dialogue with the Citizen's panel. But did the process possess properties for being effective? Did the use of decision-making tools contribute to more effective energy planning? The following sections discuss the results from Papers III-V in terms of effectiveness, that is, scope and legitimacy.

Using Tools for a Broad Scope

All tools that were applied in the pilot energy planning process had the aim to promote a broader scope in the energy planning. The combination of backcasting and external scenarios were used with the aim to promote learning and a wide variety of aspects of the energy system. The Citizen's panel was used to bring forward opinions from the public and the tools for environmental assessment were used for bringing in more environmental aspects into energy planning. The applications of these tools are discussed below in terms of environmental assessments and systems approach.

Tools for More Comprehensive Environmental Assessments

Literature suggests that there is a need to combine qualitative and quantitative tools for the EA. It is argued in literature on decision-making tools that complex decision making could benefit by using a combination of different tools (English et al., 1999; Wrisberg and de Haes, 2002). Pietrapertosa et al. (In Press) and Hochschorner and Finnveden (2003) have shown that advantages arise from combining tools of methods since it allows the user to take advantage of the strengths of each methodology. Also Hobbs and Horn (1997) are in favour of using multiple methods with arguments such as, "increased validity of results lead to better confidence in the quality of the decisions." However, the municipal workgroup chose not to include the comprehensive results from the combination of LCA-studies and external scenarios in the energy plan. Instead they presented short discussions about the suggested actions in terms of the environmental quality objectives. Despite this relatively simple method for environmental assessment it was found in Paper V that the Finspång energy plan included more comprehensive environmental assessments than other contemporary energy plans.

Tools for a Broad Systems Approach

The experiences presented in Papers IV and V showed that the use of tools can provide a broader knowledge base for the planning decisions. There were however also issues that were not brought up in the energy planning process, for example supply security issues. A way to facilitate that wide range of issues are brought up in the process is to involve stakeholders. Steele (2001) concludes that stakeholder involvement may contribute to "situated knowledge," a greater understanding of problems and situations they are close to, but also breadth and reflection. A participatory approach to energy planning may also be possible to combine with systems analyses. Buchholtz et al. (2007) describe an approach where data used in a multi-criteria analysis tool were gathered together with stakeholders from different parts of the energy system. They

argue that the participatory approach was favourable, i.e. it allowed to both obtain good data and to engage people in the decision process. This may be a suitable approach for municipal energy planning as well. Actively inviting different stakeholders in the information gathering for the analyses in the planning process can be an efficient way to combine systems analyses and also benefit from the broader approach given by stakeholder participation.

Potential Method Development of Environmental Assessments and a Broad Systems Approach

It seems that there are some drawbacks using comprehensive decision-making tools. Papers IV and V show that the use of tools allows a broader knowledgebase for the planning decisions, but also that the application of tools involves much hard work. Especially the application of scenario tools and life cycle assessments in energy planning would need much simplification if they should be viable as tools for municipal energy planning. A Citizen's panel participating in parts of the process and qualitative discussions based on environmental goals for environmental assessments are on the other hand relatively simple tools that are easy to combine and apply in an energy planning process.

Even if the Citizen's panel and qualitative environmental assessment seem to be appropriate tools for municipal energy planning, these two tools will however not guarantee a broad systems approach. Here a dilemma emerges; the sophisticated tools that embrace large amounts of data and aspects are complicated and demanding to use, even for experts. This dilemma is well-known in the environmental systems analysis field. It is on one hand argued that efforts spent on the environmental assessments lead to learning that is valuable (Bengtsson, 2002) and that more detailed data leads to more accurate decisions (Speier, 1998). On the other hand, the use of comprehensive tools is demanding in both time and resources and may cause an "analytical paralysis," (Hertwich et al., 1997) or even that the tools are not used at all (Lindahl, 2005).

Literature on environmental assessments bring to light that it is important that the methods used are simple (Partidário, 2003) and time-efficient (International Association for Impact Assessment, 2002). Also, Svensson (2006) showed that the use of relatively simple indicators can be very useful in decision-making situations. The results presented in Paper II showed that environmental analyses and assessments in the energy plans adopted between 2006 and 2008 often were limited to CO_2-emissions and climate change. In Paper V it was found that the use of the environmental quality objectives as indicators for environmental assessments in the pilot project lead to more comprehensive assessments than those in other contemporary energy plans. Combining these two observations leads to the conclusion that relatively simple methods could lead to more comprehensive environmental assessments in municipal energy plans than what is common today and thus improve the current standard of practice.

Another aspect on this is that environmental assessments at a strategic level, such as in municipal energy planning, may not need to be very sophisticated. Sheate et al. (2003) mean that environmental assessments at a strategic level are more about process than methodology and that the importance is rather placed on communication and

participation with stakeholders. Therefore it may be possible to reach informed decisions in energy planning based on discussions with stakeholders and a relatively simple approach to environmental assessments. For example, stakeholders could be invited to discuss certain aspects of the local energy system in terms of the national environmental quality objectives. More comprehensive methods are perhaps more suitable for more advanced purposes such as major investment decisions for transport infrastructure or new energy plants, decisions that are likely to have major and long term effects on the energy system.

Legitimacy in Energy Planning

It is argued in this thesis that it is of importance that energy planning is legitimate, i.e. that it is accepted, in order to be effective. As presented in Chapter 3, legitimacy may be both within the organisation and toward external actors. Suchman (1995) calls these two types of legitimacy *institutional* and *strategic*. In this thesis the focus is mainly on institutional legitimacy, since it is the view of the author that it is of greatest importance that energy planning is accepted and legitimate within the local authority. If the energy issues should be part of all different roles the local authority might have, the energy plan also needs to be accepted within all parts of the local authority. (Some examples of such roles were presented in Figure 2, chapter 2.)

In the ideal case energy issues would be ubiquitous in the local authority. Taking efficient energy use into account during planning, purchasing or education would be a part of everyday routines. Then the energy plan would be culturally supported, or part of the *cultural-cognitive* legitimacy according to Scott (2008). Finspång, the municipality in the pilot project is perhaps on its way towards that state. The energy planning process has led to new projects, networks and workgroups. Thereafter, energy issues began to become an important issue within the local authority or, as the municipal workgroup put it, the energy planning started a “revolution” when it came to communicating about energy issues (Paper IV). But, how could local authorities reach this cultural support for the energy planning?

The Finspång workgroup meant that it is important to build the work on existing work structures and not invent new types. Similar ideas are also stressed in energy planning literature (Jank, 2000; Klimatkommunerna, 2008). Building the work on existing structures is done, for example, to facilitate the work on an organisational and administrative level. It can also facilitate institutional legitimacy for the energy planning process. Schwartz (1997) observed Swedish companies in their approach to environmental issues and concluded that their work repeated historical patterns. By adapting their environmental management to well-known procedures they gained internal acceptance for the work. This approach can however also be contra-productive. Theories on organisational change (for example Senge et al. (2005) and Senge (2006)) state that old organisational structures may prohibit change. If a radical change in the way the local authority acts in certain situations are wanted, it may be better to invent new groups and structures.

Another aspect of adapting the energy planning process to existing structures is that it may be easier to find dedicated persons to workgroups and among politicians.

Those already engaged in similar issues are likely to be devoted to the energy planning as well (Klimatkommunerna, 2008). This was certainly the case in the pilot project. The municipal workgroup consisted of people dedicated to energy and environmental issues and were therefore also keen to work throughout the process. There is however a risk to base the energy planning entirely on the work of ambitious and dedicated persons. If another of their professional tasks become more prioritised, it can be hard for the process leader to claim for their attendance (Klimatkommunerna, 2008). If the persons in the planning process instead are told to participate by their superior, it is easier to put pressure on them when they are needed in the process. This kind of commitment may form normative legitimacy. *Normative* legitimacy is a weaker type than the cultural-cognitive (Scott, 2008). People may feel morally obliged to participate in the energy planning process, or the implementation of the energy plan, but the work will probably not be as dedicated as if they had chosen to participate of their own conviction.

A third way to deal with the work in the energy planning process is to engage consultants to work with the energy plan. Such solutions have been rather common (Paper I) and may be tempting when civil servants have a heavy workload or if the competence in the local authority is regarded insufficient. However, there is a risk when delegating the work with the energy plan. Consulting external experts can lead to a knowledge gap between the ones who conduct the energy planning and other parts of the organisation that should then be involved in the implementation of the plan. For example, the methods used in the planning process may be regarded too complicated to understand and therefore is its legitimacy undermined. This situation was in fact mentioned by the Finspång municipal workgroup in their focus group discussion. They doubted that people in general would be able to understand the complicated procedures for life cycle assessments within the four external scenarios (Paper IV). The results from the LCA studies were also left out of the energy plan.

Institutional legitimacy may also be created by external factors, for example when other organisations seem to be more legitimate or successful. Then the ways that the perceived successful organisation's way of working can be copied in order to form legitimacy (DiMaggio and Powell, 1983; Suchman, 1995). This kind of legitimacy is interesting to relate to the current national initiatives for supporting local authorities in their work with energy and climate strategies. Fell (2008) describes the favourable conditions when the participants in the Sustainable Municipalities programme formed networks and started to support each other. Also from the Climate Municipalities project similar reports are given (Lamppa, 2008). In short, this means that if several municipalities act in a certain way and that is regarded positive, others start to follow suit. If many local authorities act the same way, the acts start to be regarded as rational. If they are rational, they are legitimate. Therefore these two national initiatives will probably be very important for the future basis for legitimacy in municipal energy planning.

The third, and last, level of institutional legitimacy according to Scott (1998; 2008) is the *regulative*. Municipal energy planning is required by Swedish law (SFS 1977:439). It could therefore be argued that energy planning should be legitimate. However many local authorities have historically ignored the law (Swedish Energy

Agency, 2002, 2006; Swedish National Audit Office, 1991). Also from this perspective the national initiatives to support local authorities are interesting to discuss. As described in Chapter 3, the participants in the Sustainable Municipalities programme are obliged to produce an energy strategy. This requirement does however not refer to the Act on Municipal Energy Planning. Local authorities are here encouraged to produce a less ambitious document, since results from participating in the programme are considered more important than producing documentation (Swedish Energy Agency, 2008a). This choice is interesting from the legitimacy point of view. When the Energy Authority chooses not to promote municipalities work with their energy strategies within the existing legal framework for energy planning, this may undermine the legitimacy for energy planning as a whole.

There is yet another dimension of legitimacy relevant for energy planning, the *strategic* towards stakeholders (Suchman, 1995). In Chapter 3 it was mentioned that Swedish local authorities have very diverse roles and therefore have many possibilities to influence other actors in the municipality. Consequently is it of importance that the energy plan is accepted among these actors. Strategic legitimacy is to a large extent built on what the organisation communicates to the surroundings (Elsbach, 1994). Communication that contributes to the acceptance of the energy planning process and the energy plan can vary widely. One example from the pilot project in Finspång is that the municipal workgroup initialised a dialogue with local industries during the process. These dialogues have led to the initialisation of cooperation projects and national attention to the municipality (Paper IV). Such projects will probably contribute to the legitimacy of the energy plan. Another example is that the project got much attention among the public and other stakeholders because of the unique character of the project and involvement of a research group. Also the municipal workgroup contributed to external attention by participating in different events where they presented the project.

The last, but perhaps not the least, important factor that could contribute to strategic legitimacy is public participation. The Citizen's panel that was involved in the pilot project most certainly contributed to strategic legitimacy. Not only could the panel contribute to spreading information that an energy planning process was running, the panel's suggestions were also well represented in the energy plan. A survey to 1,000 households in Finspång also showed that these suggestions were generally supported by the public (Wiklund and Viklund, Manuscript).

6.3 Reflections on Learning in Energy Planning

The concept of learning means that there is a connection between what we learn and what we do. That means that people must be able to see the need for change before planned change can occur and additionally work out and implement solutions that respond to the triggers of change (Argyris and Schön, 1995). It is not within the scope of this thesis to identify and analyse learning processes in energy planning. The author however observed a number of situations where energy planning seemed to contribute to learning. Some of these are presented below together with some reflections over energy planning as a process of learning.

The municipal workgroup in Finspång acknowledged the learning the energy planning process had led to. For example they appreciated that they obtained insight in how environmental assessments can be made (Paper IV). They also chose to use a relatively simple method for the environmental assessments in the energy plan as they chose to discuss groups of similar goals in terms of a number of indicators based on the environmental quality objectives. Even though they did not perform any complicated analyses, they could identify conflicting goals and strategies, and thereafter highlight them. If they had used a predefined template for environmental assessments for different energy solutions, they would perhaps put forward material for a well informed decision, but they would still have no insight to why the results were produced as such. With the more demanding procedures they now encompassed, the civil servants meant that they now "know how to make environmental assessments" in other planning contexts. They also acknowledged that they would be able to answer questions about the results in the environmental assessments in the plan.

Another aspect of energy planning as an opportunity for learning is involvement of stakeholders. It was mentioned in the discussion about combination of tools that stakeholders could be involved in the information gathering work for the process. Such involvement can also lead to mutual learning, learning that leads to a shared vision of a desirable future. Not only can this support legitimacy for the plan, but it can also decrease the dependence of the local authority as the process starts to "live its own life." (Ling et al., 2002) This aspect is very interesting in local authorities that do not own their energy company or have large energy demanding industries that are outside of their control.

7 Conclusions and Implications

This chapter presents a summary of answers to the three research questions. These answers are also related to the aim of the thesis. The main findings from the appended papers are presented in terms of implications to policy and contribution to practice. Some suggestions for future research are also given.

The aim of this thesis was to investigate whether municipal energy planning can be an effective tool for managing local energy systems. Effective was defined as "having the desired effect," effects that lead to the desired changes in the local energy system. This was analysed in terms of the scope, what the energy planning encompasses and legitimacy, that the plan actually leads to any change.

7.1 Answering the Research Questions

In order to explore the effectiveness of energy planning, the author used three research questions, i.e. RQA-RQC. Results in relation to each question were presented in Chapters 5 and 6. The main findings are summarised below.

RQA: What is the scope of municipal energy plans?

The scope of energy plans has varied over time. The studied contemporary plans (adopted 2006-2008) generally had a broader scope than the older ones. Moreover, the scope has also varied with international trends and national energy policies. One example of this can be portrayed by the fact that Local Agenda 21 issues were included in energy plans in the 1990s and many of the contemporary plans refer to the Climate Investment Programmes and the Kyoto Protocol.

When it comes to environmental assessments it was concluded that these were rare and rudimentary in the 1980s, more commonly occurring in the 1990s and present in all the studied contemporary energy plans. The scope of environmental assessments were however broader in the 1990s as the energy plans often referred to a wide range of emissions and effects of energy resource extraction. The newer plans mainly referred to emissions of carbon dioxide and climate change.

In regards to the systems approach, it was observed that the system boundaries had widened over time and a broader range of issues were included in the energy plans adopted between 2006 and 2008. In the 1980s the focus was generally upon descriptions of the current energy system and technical solutions for efficient energy use. In the 1990s optimisations of the district heating grid and sustainability issues were common. Measures in recent energy plans were to a large extent directed at local authority activities including exercise of authority as well as providing information and advise on behavioural issues.

RQB: Are goals in the energy plans fulfilled?

It was found in this thesis that goals that were within direct power of the local authority were fulfilled to a greater extent than those that involved external actors. Also, it was found that technical goals, for example regarding district heating expansion, were

fulfilled to a greater extent than overall goals for reduced energy use. The fulfilment of goals could also, to some extent, be connected to the Local Investment Programme, LIP.

RQC: Can the use of decision-making tools make municipal energy planning more effective?

It was found in this thesis that decision-making tools can be used to achieve a broader scope in energy planning. Relatively simple methods for environmental assessments would improve today's standards of environmental assessments in energy plans. A Citizen's panel can contribute to legitimacy and scenario tools may be useful for broadening the scope of the energy planning.

It was also found that the use of tools can provide good opportunities for learning. Learning can be achieved when using decision-making tools to collect and analyse data, but also from the involvement of stakeholders in the process. Mutual learning is a good way to reach a common understanding of problems and possibilities and hence lead to a shared vision of a future energy system. This shared vision can facilitate the implementation of the ideas and also reduce the dependence on the local authority in the implementation of the energy plan.

To conclude, the results from this thesis indicate that energy planning has potential for being effective as well as lead to learning. Below is a summary of possible implications to policy and contribution to practice.

7.2 Implications

Some of the results from this thesis can contribute both to policy about the management of energy issues at the local level and to energy planning practice. As mentioned earlier energy planning has been questioned for being ineffective (Swedish National Audit Office, 1991) and that other factors than the energy plan influence the development of local energy systems (Lindquist, 2000; Olerup, 2000; Palm, 2004).

Policy Implications

There are currently several different terms in use for similar work. Except for municipal energy planning are terms such as "energy strategies" and "climate strategies" used. In common for all these are that they refer to strategic work with energy issues at the local level. The differences may seem rhetorical, but there is an implication with this development. Energy and climate strategies are not municipal energy planning, and therefore these documents fall out of the legal framework postulated by the Act on Municipal Energy Planning. Subsequently there are no requirements for environmental assessments and that the planning should be conducted in cooperation with different stakeholders.

This thesis has shown that the scope of environmental analyses and assessments in contemporary energy plans were limited and it was argued that there is a risk for problem shifting as a consequence from this. When producing strategies for local energy systems there is a need to assess what these strategies might lead to in terms of environmental impacts. It is also the author's view that this strategic energy work should also embrace issues that are normally outside the assignments of the local

authorities. It was indeed shown in this thesis that goals that were within the direct power of the local authority were fulfilled to a greater extent, but this is merely a further argument for including other issues in the energy plan. Swedish local authorities have many diverse roles and many possibilities to affect the development of the local energy system. It is therefore argued here that local authorities should take this chance and cooperate with different stakeholder instead of "minding their own affairs." Only in cooperation and through learning about what needs to be done to reach a sustainable energy system can a desirable future be reached.

Ultimately, it is the author's view that programmes for supporting local authorities in their work towards energy and climate strategies can be very valuable for legitimising strategic work with energy issues at the local level. Moreover, such projects and programmes can provide valuable support to small municipalities as they serve as arenas for discussion, networking and mutual learning.

Contribution to Practice

Some of the findings in this thesis may contribute to energy planning practices. A selection of these findings is presented below as general advice for practitioners:

- Too much focus on climate issues and the lack of comprehensive environmental assessments may lead to problem shifting. It is therefore of importance to include environmental assessments in the energy planning process.
- The use of decision-making tools can contribute to energy planning. It is the author's view that relatively simple tools have the most potential, i.e. tools need not be elementary even if they are simple. However, if the tools are too complicated they will probably not be used.
- Involving stakeholders in the planning process has multiple benefits. Stakeholders can contribute to the collection of information and provide local knowledge. The involvement of stakeholder also contributes to legitimacy of the energy plan. Furthermore, shared views of a desirable future energy system can reduce the dependence of the local authority when it comes to implementing the plan.
- Participation in a project or programme with the aim to support strategic work on energy issues can provide legitimacy for the energy plan. Such support is probably also very valuable for municipalities with limited resources. The use of external consultants should however be handled with care. If the external resources take too much of the workload there is a risk that the local authority loses valuable opportunities for learning and shared visions. There is instead a risk that a knowledge gap is created and that the energy plan loses legitimacy.

Lastly, the author wishes to make a final remark. Energy planning is a process and it *is* demanding in time and resources. It is therefore important not to have too high expectations on what can be achieved during a first process. Perhaps the scope of the energy plan needs to be somewhat limited to make the work feasible. Also, it is important to keep in mind that implementation work is also a process that leads to

learning and new ideas. What is not included in the energy plan can always be included in a revision.

7.3 Ideas for Future Research

This thesis has explored some aspects of energy planning and the author has realised that there are many more topics to explore. A short list of project ideas for future research and further exploration of municipal energy planning are presented below:

Simplified Tools to Avoid the Risk of Problem Shifting

The aim of such a project would be to develop and evaluate tools for environmental assessment in energy planning, or municipal planning in general. Possible research questions in the project could be:

- Is it possible to develop tools or methods that are both comprehensive and feasible?
- What are the trade-offs between accuracy and feasibility?

How to Organise Efficient Energy Planning Processes

This kind of project could include application of methods from organisational management in energy planning and implementation processes. Possible research questions could be:

- What factors affect the efficiency of energy planning processes?
- Is there a trade-off between efficiency and learning?

Energy Planning as a Learning Process

Another aspect of energy planning that could be interesting to explore further is organisational learning. Possible research questions could be:

- What kinds of learning take place during energy planning processes?
- How can learning be facilitated in municipal energy planning?
- What benefits could arise from deeper learning?

Energy Planning and Public-Private Partnerships

This kind of project would aim at exploring the potentials in cooperation between local authorities and local industries. Research questions that might be asked are for example:

- How can energy planning be used for building relations, networks and business with local enterprises?
- What benefits can be reach through cooperation between local authorities and local industries when it comes to dealing with strategic energy issues?

Evaluation of Programmes and Projects Aimed at Supporting Local Authorities in Strategic Work with Energy Issues

It would be of great interest to compare different initiatives for supporting local authorities in their strategic energy work. Questions that could be asked are for example:

- How do the working processes towards the local strategies differ between the participating municipalities?
- Do the outcomes differ?
- How valuable are the networks and external resources for the work?
- Do the projects live up to the participants' expectations?
- Are there differences in the success of implementing the strategies?

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