Overcoming barriers to energy efficiency retrofit measures in Swedish homes:
An actor and policy analysis

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Abstract – In order to avert the most serious impacts of climate change, the international community has called for reductions in carbon emissions of at least 80% by 2050. Emissions reductions on such a scale will require contributions from all sectors, not least of which are those from energy use in buildings. In Sweden, more than 12% of energy use is attributable to detached houses, and while energy efficiency measures are widely regarded as the most cost-effective form of emissions reductions, European and National policies relating to energy efficiency have widely overlooked this sector. Since approximately 80% of energy use in buildings occurs during the operational phase, and more than 90% of buildings likely to be in use in 2050 are already standing, the vast majority of energy and emissions savings from the housing sector will come through retrofit measures in existing buildings.

This study analyzes the policies and actors relevant to achieving energy savings through efficiency retrofit measures in the Swedish, owner-occupied, detached housing sector through qualitative research methods. Backcasting was considered as a potential alternative for policymaking and recommendations for improving the effectiveness of policies and reshaping actor relations are grounded in sustainability science as a conceptual framework. Findings suggest that current and proposed policies are neither likely to overcome the range of known barriers and stimulate the necessary energy reductions, nor do they address the misplaced incentive structures among actors that preclude energy savings on a wider scale.

Keywords: energy efficiency, retrofit, existing homes, policy instruments, actors, best practices

Word count: 15164

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List of Abbreviations

CO_2: Carbon dioxide
CO_2e: Carbon dioxide equivalent
EU: European Union
EPBD: Energy Performance in Buildings Directive
IEA: International Energy Agency
IPCC: Intergovernmental Panel on Climate Change
NEEAP: National Energy Efficiency Action Plan
OECD: Organization for Economic Cooperation and Development
PPM: Parts per million
WBCSD: World Business Council for Sustainable Development

1 Introduction

The rising threat of global climate change due to greenhouse gas emissions has led Ban Ki Moon (2008), Secretary General of the United Nations, to describe it as, "the major, overriding environmental issue of our time." To reduce the risks associated with climate change, the Intergovernmental Panel on Climate Change (IPCC) (2007) has called for reductions in greenhouse gas emissions of up to 80% by 2050. Reducing emissions on such a scale will require ambitious and persistent action on behalf of all parties and in all sectors.

The largest source of emissions is the energy supply (ibid), and buildings, having the longest service life of all energy-using products, are responsible for up to 40% of energy use in Europe (WBCSD, 2009). Reducing emissions from the built environment are, therefore, essential components of any climate strategy. Careful consideration, analysis and changes to how buildings use energy will result in measures that maximize efficiencies at both the supply and demand ends (Joelsson & Gustavsson, 2007).

While the development and diffusion of renewable and low carbon generation technologies has expanded in recent years (IEA, 2008), energy efficiency and conservation measures are still widely recognized as the most cost-effective and fastest way to reduce carbon emissions (Heiskanen et al., 2009). Studies have indicated that significant energy use reduction potentials remain untapped (ECOFYS, 2005; European Commission, 2009; Jarnehammar et al., 2009; McKinsey, 2009; WBCSD, 2009). The challenge lies in developing a set of policy instruments and relations between important actors that overcome a number of economic, organizational and knowledge barriers in order to capture such savings, much of which is possible through measures that are either profitable or have very short payback periods (Nässen et al., 2008; NEEAP, 2008; LBNL, 2010).

In Sweden, a range of reduction targets and policy instruments have been implemented, some of which serve to limit the amount of energy used in buildings, others to inform users about how energy is used or where use can be reduced, and still others aim to disseminate knowledge and best practices in the building sector (European Commission, 2008; NEEAP, 2008; McCormick & Neij, 2009; RAP, 2010). While efforts are notable, and Sweden is considered a leader in this sector, policies have had limited success in achieving verified and sustained energy savings (Nässen et al., 2008; Energy Efficiency Watch, 2009; McCormick & Neij, 2009).

Approximately 80% of building emissions take place during the operational phase (WBCSD, 2009) and up to 90% of buildings that will be standing in 2050 are already built (Swedish Ministry of Sustainable Development, 2006). Forty-two percent of the Swedish housing stock is comprised of detached homes, and in 2005, the sector represented more than 12% of national energy use, due in part to the heating demands of a cold climate (EUROSTAT, 2009; IEA, 2008; NEEAP, 2008). Despite this knowledge, large-scale efforts to improve the performance of the Swedish residential building stock have tended to revolve around the development of best practices in new buildings and the refurbishment of multi-family buildings, specifically those that were built during the 1960s and 1970s as part of the large-scale housing expansion known as the Million Homes Program (Swedish Ministry of the Environment, 2009).

Considerably less attention has been placed on the capturing of energy savings from existing, owner-occupied, detached homes.

Reducing energy use at the household level has been declared a national priority (NEEAP, 2008; Swedish Ministry of Commerce, Energy & Communications, 2009), and has been addressed tangentially in a range of national and European energy policies, but the pursuit of energy savings in owner-occupied homes represents a significant gap in the Swedish Government's comprehensive efforts to reduce emissions from the energy sector while also increasing the sustainability, competitiveness, and security of the energy supply (NEEAP, 2008).

Sweden has often been a first mover and trendsetter, having one of the strictest building codes in the world (IEA, 2008), and was one of the first EU Member States to implement the energy declaration system for buildings. In recent years, however, energy efficiency activities have slowed down (McCormick & Neij, 2009). At a time when efficiency and performance measures should be ramping up by actively supporting low energy retrofit projects and building long-term energy reduction targets into the building code, as is the case in the other Nordic countries (ibid), the momentum for change in Sweden is moving in the wrong direction. Though the energy performance of homes has improved since the 1990s, a multitude of economic, organizational and knowledge barriers remain, precluding further action (Nässen et al., 2008). Overcoming barriers in this sector has been a core component of revised policies in recent years, perhaps most notably in the Swedish National Energy Efficiency Action Plan (NEEAP, 2008), but ambiguity in the rules and regulations, misplaced incentives, and the short attention spans of policy makers leave much room for improvement (IPCC, 2007; Nässen et al., 2008; Heiskanen et al., 2009; WBCSD, 2009). It remains to be seen whether policies can be revised and adapted quickly and thoroughly enough to obtain energy savings and emissions reductions on the scale necessary to avert even the most catastrophic consequences of climate change. Perhaps a new approach to policymaking is necessary in this sector.

1.1 Research aim & questions

The aim of this study is to identify how policies and actors relevant to energy efficiency retrofit measures in Swedish, owner-occupied, detached houses are affecting the dissemination of knowledge and best practices in this sector. That is, how are policies and actor relations either contributing to or preventing energy efficiency savings from being captured?

The research aim will be pursued by means of the following research questions:

- How do existing policies and actor relations affect the dissemination of knowledge and best practices of energy efficiency retrofit measures in owner-occupied, detached houses in Sweden?

- What are the barriers to dissemination of knowledge and best practices in this sector?

- How can new perspectives, approaches and tools contribute to overcoming such barriers?

Unexpectedly, a wider and more holistic view of the challenge at hand requires an equally wide and holistic set of analytical tools, placing this research project squarely in the center of sustainability science. Backcasting (Lovins, 1978), provides a theoretical underpinning to the empirical data used to expand the understanding of collective influences impacting the effectiveness of policy instruments within the larger goal of reducing energy use in Swedish homes.

1.2 Significance and contribution

The significance and contribution of this study lie in its critical perspective on energy efficiency policies in Sweden, the consideration of actor relations as an essential component of policymaking, and addressing the potential for new tools and approaches to reduce, in some small part, "society's lack of critical understanding regarding which kinds of programs, institutional arrangements, and 'knowledge systems' can most effectively harness science and technology for sustainability" (Cash et al., 2003: 8086).

1.2.1 Energy efficiency policy evaluation

Sweden lacks a comprehensive and systematic approach to evaluating policy instruments for energy efficiency, instead evaluating policies on an 'ad hoc' basis (McCormick & Neij, 2009). This study contributes to the meager body of critical analysis of Swedish energy efficiency policies.

1.2.2 Social dimensions of policy instruments

There remains a lack of understanding regarding the social dimensions of policy instruments, especially as concerns policy measures in the pursuit of sustainability. A need to evaluate the success factors and barriers to both the development and implementation of policy measures in this field drives the analysis of how intermediary actors influence the retrofit process. For instance, how do competing incentives and motives of various actors enhance or hamper the role of energy savings in retrofit projects?

1.2.3 New perspectives, approaches & tools

The persistence of barriers to energy efficiency in buildings suggests that new methods for resolving such challenges is necessary, given their complex and interdependent nature (Dreborg, 1996). As an emerging research field, sustainability science offers an 'implementation-based' toolkit that draws from multiple disciplines and perspectives to form transdisciplinary responses, designed to be persistent under uncertainty about the future (Perrings, 2007). Therefore, a variety of theoretical tools serve to strengthen the findings and analysis of this project.

Analyzing policies for energy efficiency measures in the residential sector through a lens of sustainability science represents a new area of focus for sustainability science, contributing directly toward efforts to "'bend the curve' – or slow harmful trends, while accelerating favorable ones" (Raskin et al., 1998). This project is of particular relevance to two of the 'core questions' of sustainability science (Kates et al., 2001):

- What systems of incentive structures – including markets, rules, norms and scientific information – can most effectively improve social capacity to guide interactions between nature and society toward more sustainable trajectories?

- How can today's relatively independent activities of research planning, monitoring, assessment, and decision support be better integrated into systems for adaptive management and societal learning?

2 Conceptual Framework

In this section, the theoretical tools informing analysis and discussion of energy efficiency policies and actor relations are briefly introduced. While explicitly applying the theories outlined below is outside the scope of this research project, they serve an essential role in guiding the analytical process.

2.1 Sustainability science

Located at the intersection of many different disciplines, sustainability science is a research field that uses science and technology for a rethinking of the interaction between nature and society and developing paths toward sustainability (Clark & Dickson, 2003; Jäger, 2009). The Brundtland Commission's call for sustainable development is that which, "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). While a good starting point, it is fraught with difficulties in how to operationalize and integrate such an idea into decision-making. Sustainability science seeks to overcome such barriers and find practical solutions to problems of unsustainability (Jäger, 2009).

In sustainability science, the researcher employs a more holistic view and transdisciplinary approach to problem solving, engaging with other actors to link knowledge with action (Clark & Dickson, 2003; Jäger, 2009). The objective is to promote localized, place-based solutions to challenges including developing sustainable energy systems that carefully balance economic, environmental and social influences (see Fig. 1) (ibid).

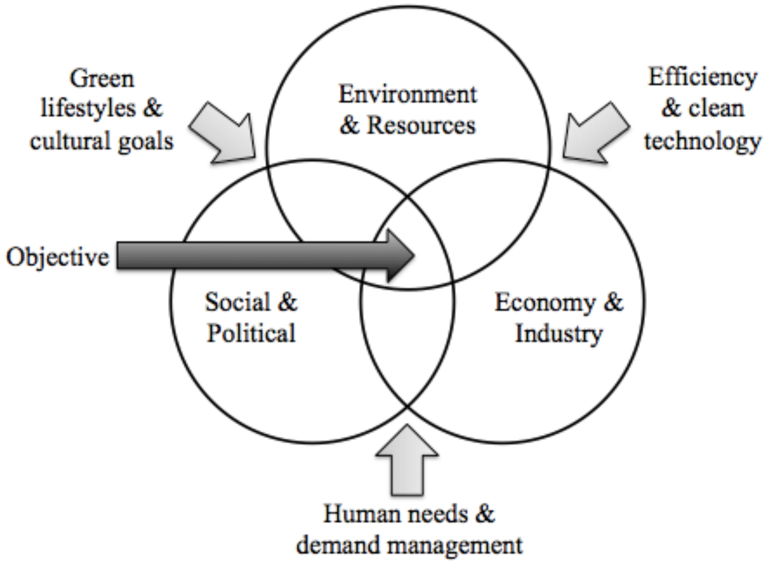

Figure 1 – Illustration of the relation between environmental, economic, and social influences. The objective of sustainability science is to achieve a careful balance between the three, illustrated by the dark arrow. (Source: Ravetz, 2000)

2.2 Backcasting

Backcasting is a tool originally developed for envisioning alternative energy futures, where various scenarios are evaluated through "backwards-looking analysis" (Lovins, 1977). The approach begins with a defined end point, or series of end points, followed by analysis to determine the relative feasibility of policy measures that would be required to arrive at such a destination (see Fig. 1). This is in contrast to more commonly used forecasting tools, which begin at the present and whose objective tends to focus on predicting likely futures (Rotmans et al., 2001).

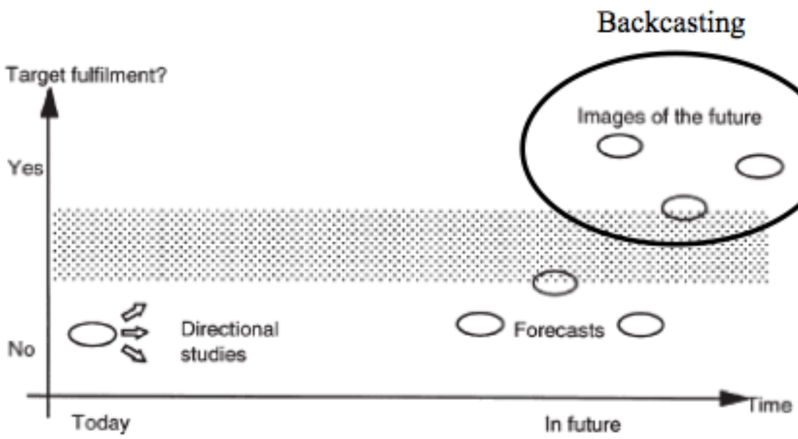

Figure 2: Backcasting – Directional studies offer short-term alternatives, and forecasts present likely future outcomes based on the present circumstances, but neither of these tools meet the target of sustainability (Y-axis). Analyzing alternative images of the future with backcasting presents the opportunity to work backwards from a set of criteria and determine the feasibility of various alternatives. (Source: Höjer & Mattsson, 2000)

Dreborg (1996) suggests that backcasting is most appropriate when the challenge to be addressed is a "major societal problem" and possesses the following characteristics:

- The problem to be studied is *complex*, affecting many different sectors and levels of society;
- There is a need for *major change*, i.e. when marginal changes within the prevailing order will not be sufficient;
- *Dominant trends are part of the problem* – these trends are often the cornerstones of forecasts;
- The problem to a great extent is a matter of *externalities*, which the market cannot treat satisfactorily;
- The time horizon is long enough to allow considerable scope for *deliberate choice*.

Furthermore, backcasting "lends itself to an examination of the social, environmental and political implications of different energy scenarios" (Robinson, 1982:344), which makes it a particularly appropriate tool in the context of this study.

While sustainability science and backcasting do not represent the only applicable tools for analyzing actor relations and policies for energy efficiency, they are appropriate frames for viewing the complex social, environmental, and economic spheres in which decision-making and action occurs.

3 Research Design

In this section, the case study methodology, data collection methods and tools for analysis are motivated, along with a discussion of the limitations of this study.

3.1 Case study methodology

This study identifies and interprets the complex characteristics and interactions among actors and policies relevant to energy efficiency retrofit measures in a narrow subset of the housing sector in Sweden. Yin (2008) discusses the usefulness of case studies in answering 'how' and 'why' research questions, typically when the area of study is a contemporary phenomenon with some real-life context and where it's not possible for the researcher to control events. This research project is multidimensional, explores complex social phenomena, and focuses on the way individuals interact and make decisions containing environmental, societal and economic criteria. Such factors further lend this project toward a case study approach (Moses & Knutsen, 2007; Yin, 2008).

In this study, an inductive, idiographic approach is used to reveal and interpret the details of policies and actor relations specific to the Swedish context. Data collection and analysis was interwoven from the outset, with the implications of analysis shaping the next steps of data collection (Bryman, 2004).

While the analysis and discussion deriving from the specific iterations of the case preclude the ability to generalize on a wider scale (Bryman, 2004; Golafshani, 2003), the Swedish experience does not occur in a vacuum. Notable characteristics, including relevant barriers, policies and actor relations are often similar in other settings, for instance other Nordic countries or housing sectors. This is not to argue that the results from this study are generalizable or wholly transferrable, but rather to note that the findings and recommendations may find some relevance and opportunity to inform discussion outside the scope of this study, as supported by Hoepfl (1997).

3.2 Data collection & analysis

In an attempt to strengthen the reliability and validity of the research, data collection and analysis relied upon multiple research methods and findings were verified through triangulation.

3.2.1 Literature review

As the initial step in the data collection process, a literature review was carried out surrounding energy efficiency efforts in Sweden. This included an exploration of energy use and savings potentials, the existing housing stock, identifying typical retrofit measures, and relevant policies or programs on both the national and European stages. The LibHub academic database and Google guided the search for relevant data sources. This process served to inform the researcher about existing efforts, priorities and knowledge in the field, but also identified potential research gaps, and provided an opportunity to focus attention on an underserved niche. Additionally, the literature review was helpful in illustrating mainstream approaches and challenges to reducing energy use in homes.

3.2.2 Interviews

After narrowing the research scope and conducting a literature review, key actors were identified. Contact was initiated with a wide range of individuals responsible for the implementation of energy efficiency policies and measures, including the Swedish Energy Agency, the National Board of Housing, Planning, & Building, Västra Götaland Region, Skåne Region, Skåne Länsstyrelsen, Skåne Regional Energy Agency, the trade association Energy Efficient Companies, and the energy efficiency renovation company Energieffektiva Hus AB. Semi-structured interviews were conducted with respondents, contributing to collection of data that represented perspectives from governmental and business interests, but was by no means comprehensive. All interviews were conducted by the researcher, and took place either in person or over the phone. Six interviews were conducted individually, and one interview was conducted with a group of three representatives. All interviews were recorded and transcribed.

The structure of interviews followed that of the research design, which was to identify the ways in which existing policies and actors affect the dissemination of knowledge and best practices, followed by a discussion of the perceived barriers to dissemination of knowledge and best practices, and finally consideration of how new perspectives, approaches, and tools could contribute to decision-making and overcoming barriers. See Appendix I for sample interview questions.

A semi-structured approach was adopted to obtain input from interviewees, both regarding their perspectives in response to questions, as well as what they chose to talk about as the interviews went “off topic”. The structure allowed for individual interviews to mirror more closely the interviewees’ perspectives on the relative importance of discussion topics, revealing to the researcher more than direct responses to the questions, but aspects of how the interviewee viewed and understood the challenges at hand (Bryman, 2004).

3.2.3 Data coding

Coding is the process by which data are broken down into component parts and organized in categories for elaboration in order to explain some real-world phenomena (Bryman, 2004). In this case, data from the literature review was coded and organized according to the key themes of energy savings potentials, energy reduction targets, policy instruments and implementation, actors and actor relations, technologies and retrofit measures, and barriers. Immediately following interviews, recordings were transcribed and coded according to the same themes, which allowed for initial analysis and the development of patterns, both in the literature and among actors, that informed priorities for future literature review and interviews. After all the interviews had been conducted, further analysis according to the aforementioned themes produced clear patterns and relative consistency among actors, which formed the basis of findings.

3.2.4 Reliability & validity

Though there is some uncertainty about the applicability of reliability and validity for judging the quality of qualitative research (Golafshani, 2003; Bryman, 2004), it is worthwhile to identify how this study addresses the basic criteria for quality research. Some authors argue that reliability and validity in qualitative research is determined by its dependability or trustworthiness (Golafshani, 2003), where “the researcher is the instrument” whose immersion in the research is necessary to observe and record social events (Patton, 20012:14). The challenge, therefore, is to somehow obtain the benefits of this privileged position, while seeking to eliminate bias and increase the truthfulness of the outcome (Denzin, 1978). While it is unlikely that bias has addressed fully – for instance, the researcher and all the interviewees were interested in climate change and reducing energy use, therefore the role of energy use in decision-making may be overstated – triangulation of data was employed as an attempt to reduce bias in the research design.

Triangulation can be defined as "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller, 2000:126). In this study, commentary from individual interviews weren't taken alone at face value, or assumed to be the final authority on policies and actor relations, but rather were coded according to themes, as mentioned above, and contributed to the collective body of data. From this body, common themes and sentiments emerged, all of which were corroborated among multiple sources, including both interviews and literature.

3.3 Limitations

Elements influencing the findings and recommendations are discussed below.

3.3.1 Case study selection

This study is limited to policies and actor relations relevant to existing, owner-occupied, detached houses. The objective in narrowing the scope of study to such a small subsector of the housing stock was to define a scenario where the policies, actors and relations among them could be clearly envisaged. A larger housing segment, all existing residential buildings, for example, or even all owner-occupied homes, presented too many variables and possibilities for actor relations to address properly under the time and space limitations.

3.3.2 Selection of actors

While homeowners are ultimately responsible for the use of energy in their homes, the focus of this study is on intermediary actors – defined for these purposes as those whose mandates, responsibilities and actions fall in the space between the definition of policy at the national or European level, and the homeowners themselves. That is to say, the actors interviewed for this study are not from the ministries that devise and decide about the policy goals themselves, but rather the agencies and administrative bodies that are responsible for implementing them, or the businesses that are guided by the incentive structures resulting from existing policies. Input from these actors is utilized as a means to better understand policies and actor relations, not as they were intended to be by politicians, but as they actually are upon implementation.

Until recently, energy efficiency promotion has largely relied on the agendas of national governments and utilities, filtering through to end-users (Heiskanen et al., 2009). However, the privatization of energy markets and development of markets for energy services has led to an influx of players with an interest in energy efficiency measures (ibid). The scope of study is, however, limited to the main actors with responsibilities pertaining to implementation of the major policies for energy efficiency, rather than all who affect the use of energy in this sector. The bulk of attention is placed on governmental agencies with mandates to implement or who enforce aspects of energy policies at the national, regional and local levels.

Additionally, the role contractors and manufacturers of “energy efficient” products are considered.

Finally, the limited time frame and low response rate from potential interviewees limited the number of interviews performed. Interviews with representatives from Boverket, Lund municipality, and WSP Environmental were requested on multiple occasions, but were declined or did not receive responses. Ideally, the pool of interviewees would have been expanded to include other actors, including utility companies, and follow-up interviews would have been performed with respondents willing to comment on analysis and recommendations, but this was not possible due to time constraints.

3.3.3 Challenges with communication

Conducting research in Sweden with only a limited knowledge of Swedish proved to be an important limiting factor on multiple fronts. Even though the translate function on Google Chrome and Google Translate provided access to some otherwise unavailable information, most academic literature and government publications were limited to journals, reports and other publications in English. While the availability of information in English is quite high, it is likely that access to Swedish publications would likely have yielded further insight, compared to what was available in English.

Similarly, the need to communicate in English could have reduced the interview response rate, and conducting interviews in English likely served as a distraction that influenced the ability of interviewees to clearly articulate their thoughts. It was seemingly evident in many interviews, that even though most subjects spoke English quite well, that arguments were simplified, if only slightly, which could have been due in part to the difficulties of communicating in a second language.

3.3.4 Main retrofit measures

Measures taken to improve the efficiency of energy use are wide-ranging, even when only considering those to be applied in existing detached homes. For the purpose of this study, “energy efficiency retrofit measures” refers to the following set of measures, either individually or in coordination with another: insulation replacement or enhancement, window replacement or enhancement, boiler or heat pump replacement, water heater replacement, or solar thermal water heating. Though air or duct sealing and lighting upgrades are important and popular measures, they are not considered as investment measures for the purposes of this study.

4 Case Study – Sweden

4.1 Energy use in Sweden

The Swedish economy is extremely energy intensive, but also has the lowest carbon intensity among members of the International Energy Agency (IEA, 2008). Driven by the heating demands of a cold climate and the energy requirements of heavy industry, high levels of energy use abound, but the associated carbon emissions have been mitigated by increased nuclear power capacity which has reduced the use of fossil fuels in the residential sector since the 1970s (IEA, 2008; NEEAP, 2008).

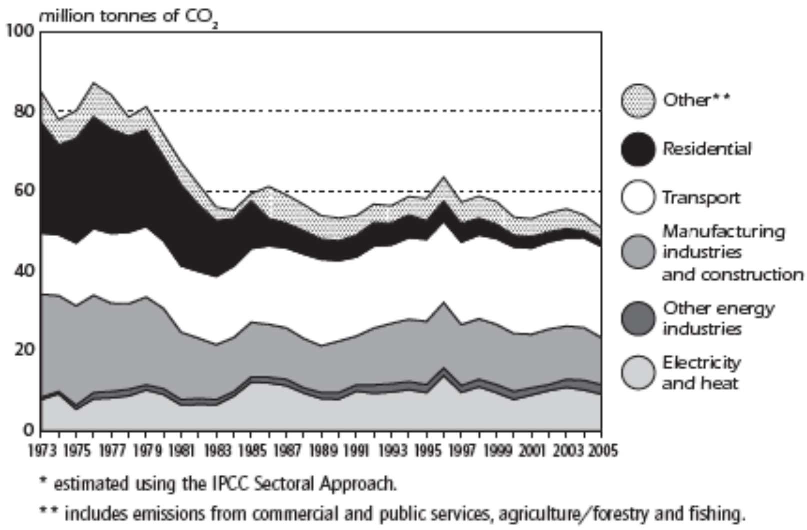

Figure 3 - CO2 emissions by sector, 1973 to 2005. Emissions from residential energy use, both in absolute terms and as a proportion of total emissions, have been in decline since the 1970s. (Source: IEA, 2008)

Despite having one of the highest per capita energy uses in the world, CO_2 emissions in 2005 were 5.6 tons per capita, less than half the OECD average (IEA, 2008). Overall CO_2 emissions have been in decline since 1973 (Fig. 3), when the oil crisis motivated the Government to increase efficiency measures and reduce reliance on oil. Emissions of the six greenhouse gases have been below 1990 levels since 1999 (ibid).

Emissions from the housing and services sector have declined significantly from the highs of the 1970s and are expected to remain stable through 2020 (ibid). Over the period 2001 – 2005, average energy end use in detached houses totaled approximately 38 terawatt-hours (TWh) for heating and hot water, and 11 TWh for property and household electricity, representing 12% of total end-use (NEEAP, 2008; IEA, 2008). The relatively low carbon intensity of fuels used to generate heat and electricity in the residential sector (Fig. 4) accounts for the discrepancy between the share of total energy end-use accounted for by the residential sector, and the share of overall CO_2 emissions by the residential sector (Fig. 3).

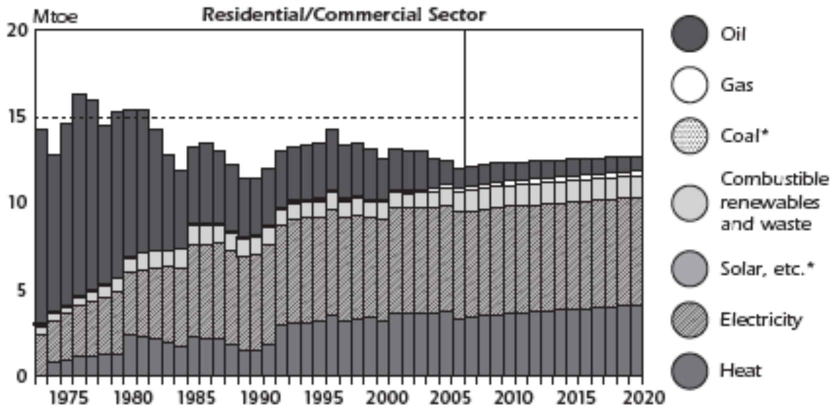

Figure 4 - Total final consumption of energy by source in the residential/commercial sector, 1973 – 2020. The sources of energy use in the residential sector have shifted dramatically since the 1970s, away from fossil fuels and toward more renewable sources. (Source: IEA, 2008)

National efforts including shifting residential heating systems away from oil heating, first toward direct electric heating and more recently toward district heating, an increase in the use of renewable energy sources (see Fig. 4, Table 1) and improved energy efficiency measures have contributed to the dramatic reduction in emissions from this sector (NEEAP, 2008; IEA, 2008; Nässen et al., 2008). Sweden utilizes the second highest proportion of both electrical energy and district heating in households in the European Union (EUROSTAT, 2009).

Table 1 - Final energy consumption in households, 2007. Energy consumption in Swedish households is significantly less dependent on fossil fuels than the EU as a whole. (Source: EUROSTAT, 2009)

	Final Energy Consumption of Households, 2007 (in total %)						
	Total (in thousands of tons of oil equivalent)	Natural Gas	Electrical Energy	Petroleum Products	Renewable Energy	District Heating	Solid Fuels
European Union	284 553	39.8	24.2	14.9	11.5	6.6	3.0
Sweden	6730	0.6	50.6	2.2	9.1	37.3	0.0

4.2 Swedish housing stock

Nearly half of the built environment in Sweden, accounting for 260 million of the 590 million square meters of building area, is comprised of small houses and agricultural buildings[1] and approximately 1.7 million houses and agricultural buildings adorn the Swedish landscape (NEEAP, 2008). Detached houses account for nearly half of the dwellings in Sweden and over 60% of households are owner-occupied[2] (see Table 2).

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[1] The NEEAP does not distinguish between residential buildings and agricultural buildings for calculation purposes and Sweden does not conduct a regular housing census. Detailed data about the

[2] The methodology EUROSTAT uses to calculate their statistics is unclear, but according to Swedish law, owner-occupation is only possible in detached or semi-detached houses (Boverket, 2005).

Table 2 - Households by type of dwelling, 2007. (Source: EUROSTAT, 2009)

Households by type of dwelling, %				Households by type of tenure, %			
	Flat	Detached house	Semi-detached house	Owner	Tenant paying rent at market rate	Tenant paying rent at reduced rate	Accommodation provided free
EU27	46	30	22	65	21	8	7
Sweden	51	42	7	62	36	3	0

The housing stock expanded greatly in the 1960s and 1970s and over a third of one- and two-family houses were built during this period (Mundaca & Neij, 2010). A special opportunity exists in buildings from this time period, since the first building performance standards including components for energy use wasn't enacted until 1977, and many of the buildings from this period are due for renovation measures (McCormick & Neij, 2009).

In detached houses, especially from this time period, the most common form of heating is electricity, which supplied nearly one-third of small houses in 2005 (Joelsson & Gustavsson, 2008), and over half of all households nationwide (Table 1; EUROSTAT, 2009). The heat pump[3] market is fully developed in Sweden with estimations suggesting that roughly 10% of detached houses use heat pumps for their primary heat source (NEEAP, 2008). More than one-quarter of houses had some kind of heat pump in 2005 (ibid). An investment grant for changing from direct electric heating to district heating or installing a heat pump was in place until 2010, and up to 80% of new homes have heat pumps installed (NEEAP, 2008; IEA, 2008). Though the use of oil-fired heating units is declining, they still represented approximately 15% of energy end-use in the housing and services sector in 2005 (NEEAP, 2008).

4.3 End-users

In Sweden, one of the most climate-aware societies in the world, 85% of the population consider themselves to be well informed about the consequences of climate change (Nair et al., 2010). Surveys show that up to three quarters of Swedes have taken some measures to reduce their household energy use, but that non-investment measures, such as turning down the thermostat, are far more common than those requiring investment, even though investment measures have been shown to have a higher potential for energy savings than non-investment measures (Eurobarometer, 2008; Nair et al., 2010). This could be due, in part, to the fact that an equal share of the population considers the higher cost of "climate-friendly" measures to be an obstacle to their uptake (Naturvårdsverket, 2008).

Research into why individuals may invest in energy efficiency measures has found that homeownership itself considerably influences the adoption of energy investment measures, and that a significant relationship exists between certain demographic factors, such as education, age and income, and the choice of efficiency measures

[3] A heat pump is a device that uses the mechanical principles of refrigeration to divert heat from one source to another. In Sweden, many homes are outfitted with pumps to extract heat from either the air, or ground, as a primary or secondary heating system.

(Black et al., 1985; Costanzo et al., 1986; Rehdanz, 2007; Nair et al., 2010). While it is commonly argued that energy price and up-front investment costs are the most significant factors for homeowners when making decisions about which efficiency measures to undertake (Respondents 1 and 3), others have argued that energy and investment costs are significant factors, but are not strong enough to drive investment in energy efficiency measures in and of themselves (Khan, 2006; LBNL, 210; Nair, 2010). Additionally, the inelasticity of energy use points to the limitations of price as a driver for efficiency investments, at least in the short-term (Jakob, 2006). It has also been shown that concern for the environment, personal comfort, indoor climate quality, personal habits and influence from friends and neighbors are significant factors that influence decision-making (Khan, 2006; Jarnehammar et al., 2009; LBNL, 2010).

Nair et al. (2010) have studied the range of personal and contextual factors that influence the adoption of energy efficiency measures (see Fig. 5) and have found that the uptake of measures to increase the energy efficiency of homes has been low, despite efforts by the government to stimulate investment in retrofit measures. In 2007, less than 20% of homeowners intended on making improvements to their building envelope or investing in heating system improvements over the next 3-4 years (Mahapatra & Gustavsson, 2008). Awareness of economic and informational support systems is lacking, since more than half of those who undertook investment measures, and more than 70% of those who undertook non-investment measures, were unaware of any governmental assistance to facilitate the adoption of such measures (Nair et al., 2010).

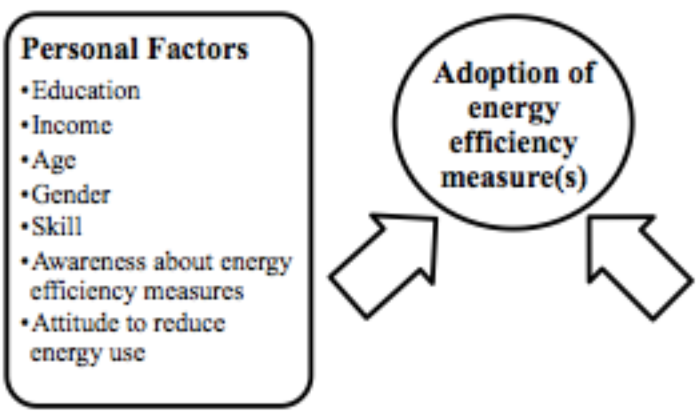

Figure 5 - Factors influencing homeowners' adoption of energy efficiency measures. (Source: Nair, 2010)

To summarize, energy use in the Swedish residential sector has declined in recent years, though not dramatically, and is projected to remain stable in the coming decades. Detached houses make up a significant portion of the housing stock, much of which is due to be renovated and represents the potential for significant energy savings. Homeowners in Sweden are very aware of the impact they have on the environment and how they contribute to climate change, but the uptake of efficiency measures is slow and could be significantly improved. Finally, there is a link between certain demographic characteristics and the likeliness of investing in efficiency measures that could be exploited to improve the effectiveness of policy instruments.

4.4 Barriers to energy efficiency retrofit measures

Despite rising energy prices, concern for climate change, and the range of benefits associated with improving the energy performance of one's home, significant portions of the energy and cost savings that are available through cost-effective retrofit measures remain untapped, but why? The main knowledge, economic and organizational barriers to implementing "best practices" in existing detached homes are outlined, based on the range of literature available (IPCC, 2007; Nässen et al., 2008; WEC, 2008; Jarnehammar et al., 2009; Heiskanen et al., 2009; WBCSD, 2009).

4.4.1 Knowledge barriers

- Best practices are often unknown by homeowners and contractors;
- Homeowners are responsible for decision making, but are often ill-informed, unable to adequately evaluate different options, and instead forced to rely on the suggestions of contractors and other craftsmen;
- Use of life-cycle costing or other long-term decision making tools is rare in this sector and the true costs of measures and energy use often remains unknown;
- Uncertainties and a gap between the perceived energy savings of particular measures and actual savings causes homeowners both to have unrealistic expectations about individual measures, as well as to underestimate the potential for savings with comprehensive measures;
- Energy use is invisible and the consequences of its use are not obvious.

4.4.2 Economic barriers

- Energy prices do not adequately account for social and environmental costs, even when including the energy tax – therefore, decisions based on cost calculations from current energy prices do not reflect true costs, both from an individual and societal perspective;
- Investment costs are given disproportionate weight in decision making, leading to decisions that may be more costly in the long-term;
- Involved parties often have a variety of incentives and motives for their behavior, and rarely do these motives align to deliver the best energy performance;
- Investment measures often require large amounts of capital or financing.

4.4.3 Organizational barriers

- Cost-effectiveness and ease of implementation in households are hampered by high transaction and other costs, compared to other building sectors;
- Split incentives abound, even within owner-occupied houses – goals and incentives are not the same for those who invest in measures and those who reap the benefits;
- Lack of transparency about energy use and costs prevents individuals from determining how and where energy is being used, along with how best to reduce use.

The plethora of knowledge, economic, and organizational barriers allude to the complexity of decision-making and actor relations in this field. Many of the barriers are interrelated and therefore policies must address such challenges from a holistic perspective in order to successfully capture or encourage others to capture available energy savings.

4.5 Actor overview

The implementation of policy instruments on the national level requires coordination and cooperation between many different actors, all with varying mandates, competencies, motivations and incentives. Comprehensively reviewing the roles of actors connected to the implementation of policies is outside the scope of this paper, but the main actors are reviewed in order gain a cursory exposure to those active in transforming policies from ideas into action. Actors are overviewed in Figure 6 and their connection to particular policy instruments is addressed in Table 5.

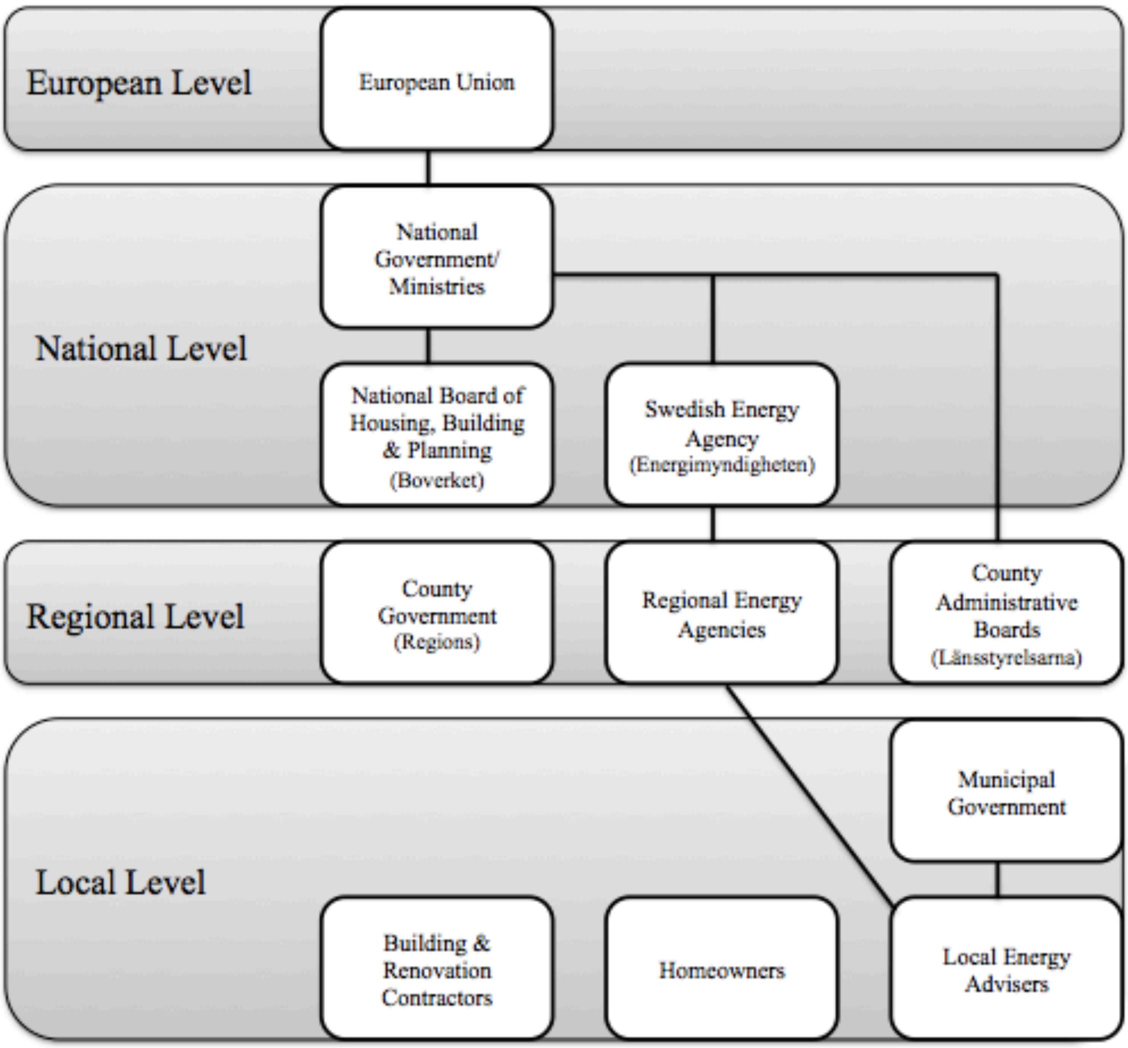

Figure 6 – Illustration of main actors implementing energy efficiency policies.

4.5.1 National government

Three ministries – Health & Social Affairs, Environment, and Enterprise, Energy & Communications – share overlapping responsibility for the adoption of Directives from the European level, the development of national energy and climate policies, and setting the national agenda for the promotion of energy efficiency measures in the built environment.

4.5.2 National agencies

The National Board of Housing, Building & Planning (Boverket) operates underneath the Ministry of Health & Social Affairs and is the main regulatory body responsible for developing many of the policy instruments, guidelines and decisions regarding to building performance. Their main duties include administering the building code, organizing initiatives on the national stage and delegating responsibility for implementation of projects to regional and/or local agencies.

Sweden's Energy Agency (Energimyndigheten) serves under the Ministry of Enterprise, Energy & Communications and organizes a variety of policy instruments in this sector, not least is the coordination of national and EU policies, including the National Energy Efficiency Action Plan (NEEAP). They also support the efforts of other actors and agencies, both financially and organizationally, with training sessions, conferences, and informational resources.

4.5.3 Regional agencies

Implementation of energy policies is often delegated to the 13 Regional Energy Agencies (REAs) and County Councils, from the Swedish Energy Agency. They are responsible for coordinating local initiatives, such as the passive house[4] center in Alingsås, where interested parties, including homeowners, contractors and craftsmen can learn about passive house construction and retrofits. REAs support local energy advisers with training sessions, and coordinate informational activities with target groups including homeowners, businesses, and craftsmen.

County Administrative Boards (Länsstyrelsarna) serve an intermediary role, coordinating national programs on a regional basis. They oversee investment subsidies and municipal enforcement of the building code, in addition to other areas. Officers are a source of information about incentives and regulations.

4.5.4 Local actors

Municipal Energy Advisers are employed in each municipality to inform and advise homeowners and small businesses about opportunities and measures to reduce energy use. Since they are often the only impartial voice a homeowner hears in the decision-making process, advisers play a crucial role in helping homeowners navigate the multitude of barriers to improving the performance of their homes. The positions are funded by the Swedish Energy Agency and are supported with training from the regional energy agencies.

Building and renovation contractors are critical actors given their role as experts in the applicability of different retrofit measures and how to adapt them to each project.

[4] Passive House is a design and construction concept for ultra-low energy buildings. Passive houses significantly reduce energy use through technical and design measures that minimize air leakage and heat loss. The standards for passive house certification are extremely stringent and it is widely recognized as the highest energy standard for newly constructed buildings.

In many cases, their advice is the only input a homeowner has when trying to decide between various measures, and the quality of their work heavily influences both the cost-effectiveness of investments and the perception of energy efficiency measures as tools to reduce energy use and utility bills.

Homeowners must ultimately decide in which measures to invest, when to invest, who to hire, and how to behave in their homes. The ability of homeowners to choose freely, combined with the incentives and motivations of other actors, makes for a complicated decision-making arena, one that is simultaneously simplified and complicated by the influence of policies and initiatives in this field.

5 Findings & Analysis

5.1 Energy efficiency policies in Sweden

Sweden has a long history of using policy instruments to influence energy use in the building sector, having employed many of the more than 30 different types of policy instruments for energy efficiency in buildings (UNEP & CEU, 2007; IEA, 2005a, 2005b in McCormick & Neij, 2009). The position of the current government is that "market forces cannot, owing to market imperfections, *independently* meet the need for a reduction in energy use of the scale now considered by many to be necessary within the EU" (NEEAP, 2008:54). The central role of retrofit measures in owner-occupied, detached houses has been singled out by Boverket (2005) as one of three sectors of the housing stock representing the greatest opportunity for energy savings. Since decision-making occurs at multiple levels, it's worthwhile to examine the range of relevant policies.[5]

5.1.1 European Directives

Energy policy is increasingly defined at the European level. At present, the Directive on Energy Performance of Buildings and the Directive on Energy End-Use Efficiency & Energy Services are the main elements of European energy policy of relevance for best practices in this sector and are outlined in Table 3.

European Directives identify priorities, which are then implemented individually by Member States. The Energy Performance of Buildings Directive (EPBD), for example, seeks to overcome knowledge and economic barriers through a range of measures designed to influence an equally diverse range of actors. Such measures, if properly implemented, have the potential to significantly impact the energy performance of existing homes, and overcome many of the barriers to knowledge and best practice in this sector. Unfortunately, there remains a large gap between the Directives as envisioned, and their practical impact on the national level since many of their recommendations are non-binding.

[5] For a more comprehensive view of energy efficiency policy instruments in Sweden, see McCormick & Neij (2009), IEA (2008), IEA (2011) and the Regulatory Assistance Project (2010).

Policy	Main Features
Directive on Energy Performance of Buildings (2010/31/EU; 2002/91/EC)	Develops a harmonized methodology for measuring energy performance of buildings; "Cost-optimality" guidelines to be devised for guiding decision-making and planning about building performance standards at the national level; Renovations should bring the energy performance of existing buildings in line with new building standards; Measures to transform all existing buildings into "very low energy buildings" must be planned for and taken; Building energy declaration or certification schemes, along with verification and enforcement mechanisms, to be devised and implemented; Regular inspection of heating systems is mandatory.
Directive on Energy End-Use Efficiency & Energy Services (2006/32/EC)	Member States to develop and implement plans for reduction of end-use energy demand; Calls for improved transparency and access to information about how energy is used in households; Improves end-use efficiency as a means to primary energy reduction.

Table 3 – EU Directives relevant to energy efficiency in residential buildings.

5.1.2 Long-term reduction targets

Alongside the Directives, three long-term energy efficiency or reduction targets have been adopted on the national level (See Table 4). A major strength of ambitious and broad, long-term targets is their ability to communicate the priorities of decision-makers to different actors and serve as an umbrella or thread, linking the variety of individual policy instruments. The strategic use of long-term targets, as keystones, has yet to be embraced in a clear and conscious manner.

At first glance, the targets seem reasonable, aiming to increase the efficiency of end-use by 50% by 2050, for example. Upon further inspection, however, questions arise about just how ambitious the these targets really are, and how effective they will be in accelerating the uptake of energy efficiency retrofit measures in any meaningful way.

Table 4 – Long-term energy reduction and energy efficiency targets in Sweden. (Sources: NEEAP (2008); Swedish Ministry of Sustainable Development (2006); Swedish Ministry of Commerce, Energy & Communications (2009))

Policy	Ministry Responsible for Implementation	Target	Target Year	Base Year
National Programme for Energy Efficiency & Energy-Smart Construction	Environment Ministry; Enterprise, Energy & Communications Ministry	20% increase in efficiency of end-use	2020	1995
		50% increase in efficiency of end-use	2050	
An Integrated Climate & Energy Policy	Environment Ministry	40% reduction in GHG emissions	2020	1990
		20% reduction in energy intensity		
National Energy Efficiency Action Plan: Implementation of the Energy End-Use Directive	Enterprise, Energy & Communications Ministry	Save 20% of primary energy	2020	2020

So far, the effectiveness of long-term targets has been inhibited by their significant and many caveats. According to the Integrated Climate & Energy Policy, emissions covered by the European Emissions Trading System (ETS), about 40% of total emissions in Sweden, are exempt from the target. Additionally, according to enacted and anticipated measures taken to reduce emissions under this plan, more than 75% of reductions will take place outside of Sweden, either in other EU Member States or in the developing world, rendering the target effectively meaningless in terms of its direct influence on the detached housing sector.

Similarly, the National Energy Efficiency Action Plan (NEEAP) has been criticized both for excluding emissions that fall under ETS, as well as for the fact that the "action plan" reads more like a white paper. Its analysis of barriers to the uptake of efficiency measures and best practices, and recommendations for action are noteworthy, but its proposals have no guarantee of being implemented, and often are not. The analysis is also vague, noting for instance that for the purposes of decision-making, cost-effectiveness should be analyzed from a "socio-economic perspective," but the term is never defined or elaborated upon. The Government would do well to heed the insight and conclusions of the NEEAP, but so far its realized impact on actual policies has proven unreliable.

The National Programme for Energy Efficient & Energy-Smart Construction, contains perhaps the most ambitious target for energy efficiency, but only mentions the contribution of improvements in the existing housing stock within the context of providing economic support to replace heating systems, and obtain savings from already-planned renovation projects. It does not identify what could be done to encourage the uptake of additional retrofit measures or development of best practices.

The three long-term targets also make for a disorienting mix of objectives, calculation methodologies and mandates. Together, there are five different reduction targets with two different target years and three different base years, under the guidance of two and sometimes three different ministries. Each target has a different set of qualifying criteria. Methods of implementation associated with each sometime overlap. It's clear that there is plenty of concern among the top level of decision-makers for making long-term reduction targets, but less concern for developing intermediary measures to meet the targets. General skepticism of the targets was clear among interviewees:

> "One thing that I think is a disaster, really, is that now, for the first time, we have a target for energy efficiency. We used to have no targets at all, and suddenly I think we have four different targets, different base years and they all express this target differently. You can't compare these different goals. They have different percentages, different years, and so on. We have these targets but we do not have a plan for how to fulfill it" (Respondent #8).
>
> "General awareness of the targets is quite low" (Respondent #1).
>
> "I'm not sure, but of course we have to believe. It's going to be quite tough" (Respondent #4).

Criticism of the long-term goals must, however, be tempered. Even if the targets themselves are not ambitious enough to motivate significant and sustained improvements in the performance of owner-occupied, detached homes, or are not deployed strategically in an attempt to reshape the system of incentive structures among actors, they have successfully spotlighted the role of energy efficiency in climate change mitigation strategies. They have also jump-started a conversation about energy efficiency that may spur developments to reduce energy use that would not have occurred absent such targets. More attention, with a critical eye, must be focused on the individual policy measures and the extent of their influence on the development of best practices in this field.

5.2 Policy instruments

Since the Oil Crisis in 1973, improving energy efficiency in Swedish homes has maintained broad levels of support. The impact of past and present policies is evident in the relatively high performance of Swedish homes, especially when compared with much of the rest of the European building stock. At present, existing policy measures consist of mostly traditional instruments, such as the building code, energy taxes, investment grants and informational campaigns (See Table 5). There are also more innovative tools, like the local energy adviser program, in which each municipality employs a consultant to provide advice to homeowners about ways to save energy in their homes. To properly review even the main policies outlined in the table below is outside the scope of this study, but as pertains to their impact on the development and dissemination of knowledge and best practices in this sector, a brief note on each is warranted.

Table 5 – Current energy efficiency policy instruments in Sweden. (Sources: Boverket, 2005; Khan, 2006; Swedish Ministry of Sustainable Development, 2006; IEA, 2008; European Commission, 2008 & 2009; Swedish Ministry of Commerce, Energy & Communications, 2008 & 2009; Swedish Ministry of Environment, 2009; McCormick & Neij, 2009)

Policy Instrument	Agency Responsible for Implementation	Type of Instrument	Objective
Energy tax	Finance Ministry	Economic	Induce reduced energy use through cost-effective means; Provide revenue to the general budget that can be used, in theory, to fund efficiency measures.
Building code	Boverket	Regulatory	Set minimum performance guidelines for all buildings and for major renovations from October 2011.
Energy declarations	Boverket, Swedish Energy Agency	Informational	Provide a consistent method for measuring, verifying and comparing energy use of buildings; Suggest cost-effective efficiency measures.
Solar hot water investment grant	Boverket, Länsstyrelsen	Economic	Incentivize bringing new technologies to market or accelerate the uptake of measures.
Information campaigns	Boverket, Swedish Energy Agency, EPA, Regional Energy Agencies	Informational	Inform and advise homeowners of ways to save energy – both through behavioral means and investment measures; Display best practices.
Local Energy Adviser Programme	Energy Agency, Regional Energy Agencies	Informational	Advise homeowners of different supports, options and trade-offs between energy efficiency measures.

Regulatory, economic and informational approaches are employed in a piecemeal manner and existing measures are steps in the right direction, but they fail to sufficiently engage actors in a coordinated manner to truly promote best practices, rather than just "better" practices.

On the surface, Swedish policymakers have successfully retained the public perception that policy measures have been highly successful in reducing energy use in homes to the lowest possible levels, given existing technologies and the limitations of cost-effective measures. According to actors in the field, however, existing policies fail to both support the capturing of energy savings through cost-effective or even profitable measures, as well as to influence the incentives among actors to reward energy savings over the adoption of particular technologies or measures.

Existing policies may have the intended effect of marginally reducing energy use among households, but they are unlikely to result in reductions on the scale necessary to avert the most serious consequences of climate change. Where policies have been shown to support incremental reductions in energy use among individual households (for example, stricter building codes or increased energy tax), the IEA (2008) has predicted that energy use among Swedish households as a whole is likely to remain relatively constant over the next 30 years.

Rather than devise a set of policy measures that both reward innovation and energy savings and dissuade or punish the status quo, the existing approach consists of individual measures that often make sense in isolation, but are perverted when enacted in the larger social context. Unintended consequences stemming from a lack of foresight about how individual measures will interact with others, how financial and other motivations among actors could corrupt its original intention, or how loopholes and failure to properly implement measures could open them up to manipulation, have further diminished the effectiveness of existing policies in promoting best practices in this field. It is worthwhile to observe how these traits are manifest in each of the main policy instruments.

5.2.1 Energy tax

The energy tax is the main policy instrument to influence energy use in households, and as part of the climate policy, energy taxes are likely to be increased, according to the Swedish Energy Agency (Respondent #9). While taxes are recognized as a cost-effective tool for increasing the efficiency of energy use, the extent to which it can be deployed strategically is limited. Taxes neither ensure efficient use, nor do they guarantee that the price of energy will accurately reflect the true cost of its use to society and the environment. Even the most ambitious tax fails to internalize many of the social and environmental externalities. The inelasticity of energy prices, combined with low levels of awareness among homeowners for how much they pay in energy taxes, further constrains its effectiveness. The energy tax has an important role to play, but it cannot be the main tool to reduce energy use.

5.2.2 Building code

The building code is a conservative policy tool, designed to establish a minimum performance level for newly constructed buildings. It is commonly described within the building performance community as the worst performing building that is allowable by law (Respondent #3). Among interviewees, there was broad consensus that the building code could be made much stricter, perhaps by up to 75%, with little or no effect on project cost when taking a broad life-cycle perspective (Respondents #1, #2, #3, #4, #5, #6, #7, #8, #9). The major opponent of a significant tightening of the building code is Boverket, ultimately the only agency that matters, since they're responsible for devising the code. Believing they have reached the limitations of current practices to deliver high building performance via cost-effective measures, they are resistant to significantly tighten the code (Respondent #9). Their justification for such a claim is unclear, since they have been unable to present the methodology for coming to such a decision (Respondent #8).

There is, at present, no plan to revamp the building code from serving as a tool that delineates the worst-case scenario, toward its use to drive innovation in the home performance industry. The latest version of the EPBD requires national definitions for Passive House and Minergie[6] standards, but they will first be defined for new buildings, and only later will they be extended to retrofit projects. The expectations for how this will impact the existing housing sector, at least in the short term, are low, given that Boverket is focusing on new building standards and has little to nothing to say about when they will get around to developing standards for existing buildings (Respondents #8 and #9). One interviewee, familiar with the inner-workings of Boverket noted, "We also wrote a letter on that and we'll see what happens, but probably they will not change it so much because they never do" (Respondent #8).

According to a new law, in October of 2011, significant renovation projects in existing homes will be required, "in principle," to improve the performance of parts of the home to the standards of newly constructed buildings. Boverket is responsible for devising instructions and guidelines for how actors are to abide by the new regulations, but have failed to do so, claiming that they are preoccupied developing the Passive House and Minergie standards for new buildings (Respondents #8 and #9). The practical effect is that without guidelines clarifying how the rules are to be interpreted, implemented and enforced, actors face the equivalent of an unfunded mandate, where regulations are not accompanied by the proper support mechanisms to enable practitioners to perform effectively.

5.2.3 Energy declarations & other informational tools

The energy declaration system was supposed to serve as a mechanism to inform homeowners about energy use in their homes, identify potential steps for reductions through cost-effective measures, and inform potential buyers and sellers about the building's performance. So far, however, the program has fallen far short, and authorities have called for a review to determine how the program should be improved (Respondents #1, #4, #5, #6, #8). The declarations have initiated a conversation about energy efficiency among some homeowners, but the program lacks an enforcement mechanism to ensure that all homeowners have their homes audited properly. Many homeowners have ignored the mandate and foregone the declaration entirely (Respondent #8). Others have attempted to save money by hiring auditors to perform their analysis remotely, rather than visit the home in person to evaluate and devise a list of measures appropriate for that particular house, as was intended (Respondent #5). The system has the potential to inform homeowners about the particular measures they can take to reduce their energy use, but has been inadequately implemented. Without substantial changes, including an enforcement mechanism, it will continue to fail in its role to overcome some of the knowledge barriers among homeowners.

A consistent feature of respondent feedback was the way in which they highlighted their role in improving access to information to overcome certain knowledge barriers. Information campaigns take a variety of forms; from energy declarations and demonstration projects, to mailings, expos, and seminars, just to name a few. Interviewees were proud of their contribution in this arena, while simultaneously

[6] Minergie is a building certification scheme, similar to Passive House, though less stringent and more flexible. As a result, it is more attractive for retrofit projects in existing buildings, compared to the Passive standard.

admitting that the potential for informational tools to influence energy use was limited. Indeed, improving access to information is important, but it is widely known, especially within the building performance community, that information is not the same as knowledge, and that information and even access to capital, are often not enough to spur investment in energy savings (LBNL, 2010).

5.2.4 Investment grants

Investment grants and subsidies of various sorts have been widely used in Sweden, and are a popular policy instrument among decision-makers. They are easy to implement, can be clearly marketed, and their success in selling a particular technology or measure can be quantified in a relatively straightforward manner. Grants and subsidies are also multifunctional; they are economic instruments, but as homeowners learn about them and inquire among friends, neighbors and experts, they become informational tools that have the potential to lead to further investment (Respondents #1 and #7).

While support programs are not always tied to a specific technology, at present there is a grant to support the uptake of solar thermal hot water systems. Programs in the past have, among other things, supported the replacement of oil furnaces and electric resistance heaters with biomass boilers and heat pumps. There have been very few analyses in Sweden of the cost-effectiveness of grants and subsidies as measures to reduce energy use in the longer-term, though they are effective at promoting the adoption of particular technologies (Respondents #4, #7, #8).

The diffusion of heat pumps to the market in Sweden has been cited as an example of a successful use of grants and subsidies for energy efficiency, though even this "success story" is not without criticism. Respondent #1 noted that the heat pump subsidy drove many homeowners to purchase heat pumps, but that there were "probably more air-based heat pumps in Sweden than there should be," due to the fact that profit margins for installers were higher for air-based heat pumps, compared to ground-based systems. Since the subsidy didn't require that the heat pump with the best energy performance or payback be installed, air-based systems were effectively prioritized over the more efficient ground-based systems.

Similarly, Respondent #8 described the impact of the grant for biomass boilers as disastrous, since the announcement of the grant prior to its coming into effect led to a drop in demand as homeowners waited for the grant to purchase a new boiler. At the same time, the subsidy attracted new firms to the field and flooded the market. Many of the new manufacturers sold products that were cheaper and of questionable quality, squeezing out others who designed quality products that were slightly more expensive. The net effects were that the subsidy may have made a handful of firms profitable, but did not address quality control or ensure that products effectively delivered energy savings to homeowners (Respondents #1, #3, #8).

When planned strategically, grant and subsidy programs can be effective instruments to support quality craftsmanship and the diffusion of energy efficiency technologies. Past experience in Sweden has shown, however, that support systems are often short-lived and inconsistent, and lack many of the quality control and enforcement mechanisms necessary to ensure they achieve the intended objectives.

5.2.5 Local energy adviser program

Directly addressing the knowledge and informational barriers facing homeowners, local energy advisers serve an essential role as free, objective consultants, assisting homeowners who typically only have contact with contractors and suppliers, actors who often have financial incentives and cannot necessarily be relied upon to keep the interests of homeowners and larger societal goals in mind.

The services provided by advisers are well received and address critical knowledge barriers, though the realized energy savings resulting from the program are severely hampered by limitations placed on the advisers' activities and conduct (Respondent #1). The need to "remain objective" prevents advisers from initiating contact with households, prescribing specific measures, or recommending individual firms. Rather, they may only respond to contact initiated by homeowners, answer general questions and provide insight to the trade-offs between various options, after the homeowner has obtained price estimates on their own. These guidelines are well intentioned and reflect the need to remain free from industry influence and the impression of soliciting on behalf of particular interests, but the overarching limitations significantly impede the ability of advisers to elicit energy savings among those who stand to benefit the most. The program at present places the onus for action on the homeowner at each step of the way, directly in contrast to the argument that the number of steps required for homeowners to turn the intention to save energy into actual savings should be minimized (LBNL, 2010). Additionally, the typical homeowner who is aware of and takes advantage of the program is self-selecting and tends to represent a segment of the population that is more prone to investing in such measures anyway (Respondents #1 and #8). It may be the case that the remaining two-thirds of Swedes who are unaware of the program stand to benefit most from its services, and adapting the program to engage others could yield savings a magnitude of order higher than at present.

5.3 Barriers to efficiency measures in Sweden

Thus far, the discussion has broadly outlined the challenge at hand within the larger context of climate change, the barriers to reducing energy use in the residential building sector, the various actors involved with implementing such measures. the overarching and specific policies and instruments in effect. Examining the reality of how such measures affect the dissemination of knowledge and best practices requires revisiting some of the barriers to energy efficiency; both in general and how barriers unique to the Swedish setting further retard progress.

It's worth repeating that decision-makers, at even the top levels, are well aware of many barriers to savings from energy efficiency policies. Both the NEEAP and EPBD, for example, clearly state that elements of their recommendations are designed to overcome known barriers, but often fall short on the implementation of measures to adequately do so. Three aspects of this failure, mainly, a lack of interest from decision-makers, challenges to defining best practices, and organizational and knowledge consideration, are of particular interest and are discussed here, linking a general discussion of barriers to their iteration in the Swedish context.

5.3.1 Lack of interest from decision-makers

Perhaps the clearest sentiment, stemming from both policies and actors, is that capturing energy savings through efficiency measures in existing, owner-occupied, detached homes is not a priority in Sweden (Respondents #1, #3, #4, #5, #8, #9). Energy efficiency in a larger sense receives plenty of attention and investment, though it tends to be in the new building, multi-family building, or publicly owned building sectors. The attention given to privately owned homes mainly consists of spillover from other sectors. When considering the expansion of the building code to include retrofit projects, for instance, or when best practice measures are developed for new homes and also happen to be implemented in existing homes (Respondent #9). In fact, it can easily be argued that none of the policy instruments addressed in Table 5 are pointed decidedly toward retrofitting existing homes, but rather are instruments for new homes that also find relevance in existing homes.

The spillover effect could explain why a majority of interviewees (Respondents #3, #4, #5, #7, #8) responded in one way or another that there were not many policy measures directed toward reducing energy use in private homes. Boverket was actually the most forthright. "Regarding policies for energy efficiency retrofitting Boverket do not have any such policy or make any special efforts to maximize the energy efficiency measures when buildings are retrofitted" (email communication, 29/3/11). When questioned further, most interviewees elaborated that there were actually a handful of instruments that applied to the privately owned housing sector, like the local energy adviser program and the investment grant, but that such measures were few and far between. Attention, interest, and resources lie elsewhere.

Low levels of knowledge among homeowners about how to reduce energy use, even through cost-effective or profitable measures, is inhibited further by the fact that homes are often designed and manipulated for comfort over, and sometimes at the expense of, efficiency. Irrational and erratic decision-making about how homeowners invest limited resources increases the perceived risk of investing public funds in this sector (Respondents #1, #3, #5, #6). Working with professional building owners and others who have an economic incentive to maximize efficiency and cost savings is, understandably so, viewed as a safer investment and more effective way to elicit energy savings from the building stock.

Developing best practices in other sectors is attractive for many reasons. Technologies and demonstration projects for new buildings tend to be more popular and newsworthy. New build projects and installations of renewable energy generation are more visible than efficiency measures and thus more attractive to politicians. Individuals often misperceive the amount of energy used by different segments of the building stock, and similarly, the savings that are possible from efficiency measures. High transaction costs in the private, detached housing sector reduce the cost-effectiveness of investments compared to publicly owned, larger, or new buildings. The practical consequence of this oversight is that even cost-effective savings from buildings representing over 12% of annual energy use are essentially excluded from national efforts targeting the efficient use of energy.

That policies account for existing, owner-occupied houses as an afterthought is a major finding, and remains in itself a critical barrier to the development and dissemination of best practices in this sector. If policies influencing the uptake of energy efficiency measures are not designed and implemented strategically, how can they realistically be expected to retain positive influence over the medium to long term in a changing technological, economic and social environment? In light of the wide range of knowledge about barriers, policies must be given clear guidelines with objectives and incorporate evaluation and feedback mechanisms.

5.3.2 Challenges to defining best practices

Unlike with new buildings where measures related to both energy use and cost-effectiveness can be modeled and replicated with relative ease, the uniqueness of individual existing buildings adds another variable with the capacity to influence the investment cost, payback time, and general applicability of particular measures. Energy savings potential can vary significantly, even between similar houses, and in-depth evaluations are often required on a case-by-case basis. These elements, in combination with access to capital as a limiting factor, complicate even the definition of best practices.

Whereas the range of potential retrofit measures is relatively straightforward, the cost-effectiveness of particular measures and combinations of measures are dependent on a number of criteria and can vary widely, even within this narrow sector and in Sweden. Cost calculations carried out by Joelsson & Gustavsson (2008), for example, illustrate large discrepancies in the economics of various heating system, insulation and window replacement measures that are dependent on, among other things, local climatic conditions, energy prices and taxes, and the choice of energy supply. The cost-effectiveness of retrofit measures is further influenced by whether measures are taken independently or in coordination with other measures, as well as whether the measure is considered necessary or elective. For example, the payback period for installing additional exterior insulation is considerably different if the homeowner is already planning on replacing the building façade, as opposed to a home where the façade didn’t need to be replaced.

In this sector there exists no singular best practice, but many, localized, best practices. Accelerating their implementation in the existing building stock requires a workforce that is both educated in building science principles and well trained, able to both evaluate the trade-offs between different investment (and non-investment) measures, and clearly communicate trade-offs to homeowners. While there is a burgeoning home performance community in Sweden, the workforce and knowledge base necessary to fully transform the existing building stock are still far off (Respondents #3 and #8; NEEAP, 2008; LBNL, 2010).

5.3.3 Organizational & knowledge considerations

Despite increasing knowledge and awareness of best practices among decision-makers, those in the home performance industry and homeowners themselves, the organizational nature of building and retrofit projects remains itself an impediment to capturing savings on a larger scale. Since actors typically come together for a specific project and disperse shortly thereafter, the retention of institutional learning is limited (Sorell et al., 2004). In an arena where many actors with varying knowledge bases and areas of expertise come together to complete a task with minimal communication between parties and where strict time demands reward efficient work over high quality work, there is an impetus for tradesmen to perform to the specifications of the least common denominator, the building code (or even worse).

One practical consequence of using the building code as a minimum standard is that the pursuit of more ambitious energy performance is dissuaded, given the extra time, energy, attention, and resources required to coordinate between actors and ensure the quality and precision demanded by the higher standards. Respondent #3 articulated the difficulties of coordinating actors to ensure that everyone was performing the task as required in order to achieve the best energy performance.

The Swedish Energy Agency and regional energy agencies have hosted seminars and training sessions to improve the capacity of craftsmen to perform work to higher standards. On a wider scale, however, the lack of support and few incentives have relegated high performance work to a niche market. For better or worse, performing to the building code specifications remains the most common practice, which boosts its profile and importance, even for existing buildings.

If it can be said that the organization of building retrofit projects tends to discourage working beyond the least common denominator, knowledge gaps are further exacerbated by the role of the contractor or tradesman as an expert. Homeowners are ultimately responsible for decision-making at the household level, but are often ill informed and rely on the expertise of professionals in the field for good advice. That might not be problematic except for the fact that life-cycle costing and other long-term decision-making tools are rarely used in this sector, leaving many professionals in this field woefully underprepared and unaware of what the best practices even are (Respondents #1, #2, #3, #4, #8, #9).

Similarly, a lack of transparency about how energy is used in the home influences the prioritization of investment measures by homeowners, as discrepancies between how energy is used in the home, the perceived savings from individual measures and the potential savings through comprehensive measures inhibit action. When it comes to evaluating investment possibilities, the “first cost” of a particular measure receives disproportionate weight, leading homeowners further away from life-cycle energy and cost savings, and toward reducing upfront investment costs, regardless of the long-term implications.

This dissonance is intrinsically connected to the challenge of limited access to capital, and how homeowners must prioritize between energy retrofit and general renovation measures. At present, there are no preferred lending rates or added benefits to investing in energy efficiency, compared to replacing a kitchen or installing a jacuzzi bathtub. Consequently, energy-related retrofit measures must compete directly with other home improvement measures, but are effectively discouraged since kitchen and bathroom upgrades have been shown to improve the value of the house, but energy efficiency has yet to develop the same level of influence on home valuations, despite their added benefits (Respondents #1, #3, #4, #5, #6).

As has been shown, barriers to increased energy efficiency and implementation of best practices are both wide-ranging and interrelated. They exist within a complex social web of actors and incentive structures, both implicit and explicit, that preclude their extraction and analysis, ceteris peribus. Any meaningful attempt to reduce energy use on the scale required therefore necessitates strategic action with a holistic perspective, one that is ambitious and proactive, yet flexible and responsive.

6 Discussion & Recommendations

The objective of this study was three-fold, to explore how existing policies and actor relations affect the dissemination of knowledge and best practices of energy efficiency retrofit measures in owner-occupied, detached houses in Sweden, to identify the barriers to dissemination of knowledge and best practices in this sector, and offer pathways for how new perspectives, approaches and tools can contribute to overcoming such barriers.

The first two elements have been addressed, making it clear that at present, neither the policy instruments, nor the typical relations between actors have been particularly successful in supporting the large-scale dissemination of knowledge and best practices in a way that will result in achieving the necessary energy use and emissions reductions by 2050.

Energy efficiency policies have largely ignored the privately owned detached housing sector, those that do address this sector have not outlined ambitious action, and the social component of policies is something that has, so far, been widely overlooked. In other words, the standard, forecast-based policymaking approach has failed. The ineffectiveness of existing policies, lack of attention from decision-makers, and failure to account for the social component of policies highlights "society's lack of critical understanding regarding which kinds of programs, institutional arrangements, and 'knowledge systems' can most effectively harness science and technology for sustainability" (Cash et al., 2003:8086). There is, however, an alternative.

6.1 Moving from forecasting to backcasting

The challenge of how to best harness the interests of diverse actors who all operate in a complex web with competing influences is daunting, but not impossible. The current approach to future planning, forecasting, is designed to project likely outcomes based on current conditions and trends (See Figs. 2 and 7) (Robinson, 1982). It is a common method for planning and decision-making, but does not support the kind of new and innovative thinking that is necessary to tackle the complex social, environmental, and economic challenges of sustainability (Exton & Totterdill, 2009).

Backcasting, on the other hand, contends that starting at the finish line and working backwards toward the present encourages the consideration of a "broader scope of solutions to strategic societal problems" (Dreborg, 1996:824) that allow for more deliberate policymaking. This is of critical importance, considering,

> "The impossibility to predict our own future decisions to the extent that they are influenced by future knowledge. An actor's intentions and decision in a situation are largely determined by the ideas and knowledge available to him or her. New knowledge may tip the balance in favour of one of the alternatives…new knowledge and new ideas may lead to the identification of some entirely new options" (ibid).

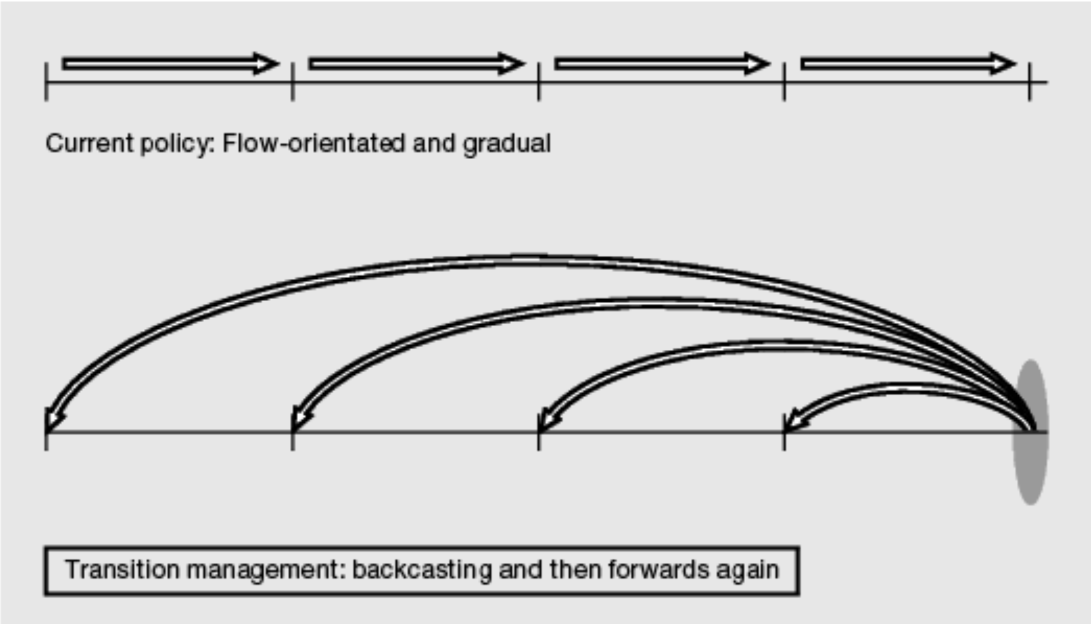

Figure 7 - Forecasting vs. backcasting models. Current approaches to policymaking start with the present and move forward based on likely outcomes of existing circumstances. Backcasting takes a different approach, starting the end-goal and developing potential pathways to achieve it based on unfolding events and developments over time. (Source: Rotmans et al., 2001)

In working backwards from 2050 and analyzing the feasibility of various pathways, a range of viable alternatives can be devised. The pathways themselves should not be confined to existing measures or technologies since future knowledge and technical potential is unknown. There are certainly difficulties in arguing for a policymaking process that relies so heavily on hypothetical developments, but in the case of residential energy efficiency, the technological potential already exists, so it is more of a question of how best to build a set of actor relations that deliver a certain end that is widely recognized as achievable.

Given the complexities of actor relations and decision-making in this sector, the backcasting approach represents a qualitatively superior tool for planning and policymaking. If the present approach results in policy instruments that are overly reliant on the status quo, are seemingly detached from the larger context and long-term objectives, and fail to consider or evaluate the influence of measures on said goals, the backcasting approach represents the opposite. Instead, devising and implementing policies via backcasting would inherently require that their actual impact be evaluated and analyzed, and considered within the larger context of the policy objectives since backcasting is a consistently reiterative process.

While actually performing a backcasting analysis is outside the scope of this paper, its main tenets are used to guide discussion and recommendations. Given the complexities of decision-making, actor relations, and resource limitations, it appears that backcasting would be an appropriate analytical fit. Performing a backcasting analysis represents a suitable next step in the research.

6.2 Improving policy tools to support energy savings

In comparison to many others in Europe, Sweden is in a privileged position. Even if there aren't very many measures in effect at the moment, the long history of using instruments to improve energy efficiency has built a knowledge base and awareness among homeowners that enables more decisive action, moving forward. There are a number of policy measures that could be adapted in light of the findings from this study, with guidance from a sustainability science perspective, and in consideration of the alternative backcasting approach.

6.2.1 Long-term targets

Improving the long-term reduction targets would be an important first step. Emissions come from all sectors, and given that more than 12% of total energy use is attributable to the detached housing sector, this segment of the building stock should not be excluded from climate, energy, and efficiency policies. The targets themselves should be significantly strengthened to reflect the scale of reductions that must be achieved, which is at least 80%, and should occur within Sweden. Investing in measures to reduce emissions outside the country is an important component of any climate strategy, but it is not the same as implementing domestic measures. Foreign investment measures do nothing to increase efficiency or reduce emissions in Sweden. Without a core commitment from decision-makers to take the necessary steps, there is little point in continuing the rhetoric about the threat of climate change.

Past research about the uptake of energy efficiency measures, as well as the general diffusion of innovations, provides a strong foundation on which to build a long-term plan for transforming the existing building stock. Nair (2010), identifies a number of relevant personal factors that contribute to the adoption of measures (See Fig. 5), including education, income, age, skill, awareness, and attitude. Additionally, building age, thermal comfort, perceived energy cost, past investment, and location influence the likelihood of building owners investing in measures (ibid). If the Swedish government conducted a formal census of the building stock, energy use "hotspots" could be identified, and together with the demographic information of likely adopters, a targeted approach to improving the building stock could be undertaken. For instance, young, educated, high-earning households living in homes from the 1960s and 1970s, could be targeted as a potential "hotspot" with a high likelihood of willingness to invest in efficiency measures.

Diffusion of Innovations is a theory designed to explain the uptake of new ideas and technologies across different cultures and social settings (See Fig. 8) (Rogers, 2003). In the context of improving energy efficiency, the theory provides a useful reference for building a critical mass of adopters, both for investing in particular measures, as well as improving home performance overall.

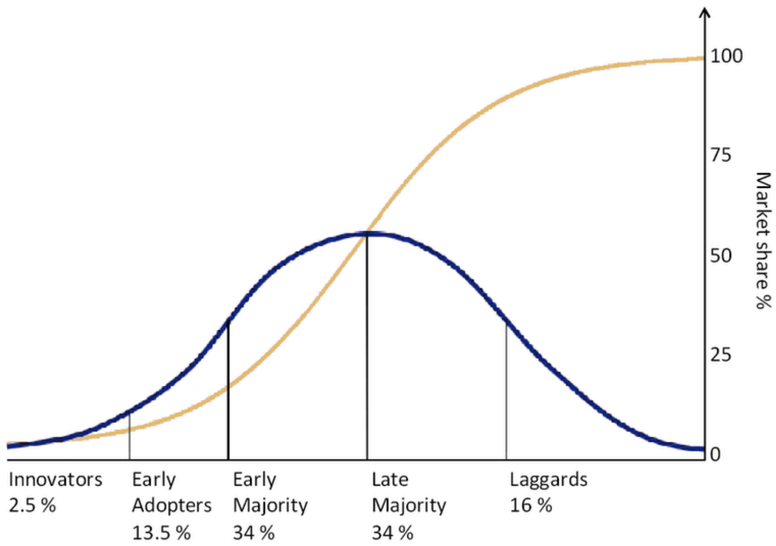

Figure 8 – Diffusion of innovation curve. The diffusion of innovations occurs along a bell curve, delineated by five different adopter groups. The innovation is considered self-sustaining when a critical mass is reached among adopters. The s-curve represents the diffusion of an innovation in relation to the adopter groups and as a percentage of market share. (Source: Wikimedia Commons, 2011)

Additional research has identified how idea sharing and feedback from friends, neighbors, community- and thought leaders can impact the adoption of efficiency measures (LBNL, 2010). Together, this core data provides a strong underpinning for developing an action plan for how to efficiently and effectively target policies toward different segments of the population and building stock.

6.2.2 Building regulations

Concrete steps should be taken to clarify and strengthen the manner by which existing buildings will be brought up to the performance standards of new buildings. Buildings should be set to approach net-zero energy use by 2021, but the target is non-binding.

The EPBD requires definitions for Minergie and Passive House standards, but how they will be interpreted and apply to existing buildings is unclear. Sorting out this discrepancy and providing all relevant parties with the regulatory framework by which targets will be met is essential. Interpreting, applying, enforcing, and strengthening the building code is an important component. Boverket has no plans, at least in the short- and medium-terms, to dramatically revamp the way the building code works, which is unfortunate, given that alternative building code models provide guidance for how it could be improved. The Danish code is one such model. It articulates specifications for three performance levels[7], a baseline, 50% better efficiency than the baseline (class 2), and 75% better efficiency than the baseline (class 1). Rules also stipulate that in future years, class 2, and eventually class 1 will become the baseline performance level. Contractors, craftsmen and homeowners can easily weigh the trade-offs between different classes and decide which measures are necessary to achieve a given performance level. This longer term regulatory plan

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[7] The three performance classes were initiated before 2010. In 2010, class 2 became the baseline performance standard, and class 1 is scheduled to become the baseline standard in 2015.

provides stability and allows parties to plan for the future, since they know when the rules will change, and by how much. In this iteration, the codes serve both as regulatory and informational tools. This type of building code mechanism is more in line with the tenets of backcasting, as its dynamism and forward-looking view support progress and flexibility over time.

6.2.3 Building a qualified workforce

Building a qualified workforce remains a challenge and requires a redoubling of efforts to develop competencies for understanding and implementing best practices among building professionals. Existing training and certification programs are expensive and not widely used (Respondent #3). Expanding the number of certified building professionals would be a positive step in both building a qualified workforce and engaging that community on a path toward continued learning. In the United States, the Building Performance Institute represents a potential model for home performance certification that is both widely recognized and respected. They provide training and require that certified professionals obtain a number of continuing education credits on an annual basis, to keep up with industry innovations and best practices. Since the Regional Energy Agencies and Swedish Energy Agency already perform training sessions with building professionals, they could lead the effort in Sweden.

6.2.4 Inter and intra agency communication

Communication and feedback must be improved within and between agencies. Whether its confusion over how to implement the building code, input for how to improve existing policies, or concerns about mandates and responsibilities of different actors, the large number of agencies and parties involved with home energy efficiency serves to obfuscate the distinction between actors, their roles, and their responsibilities. The complex web of government agencies builds a culture where many are involved, yet no one is ultimately responsible, and limits the effectiveness of efforts to improve efficiency.

6.2.5 Policy evaluation

Policy evaluation, analysis and revision must improve substantially if any type of long-term target is to be met. Current efforts to evaluate policies in a systematic way are virtually non-existent. Third party watchdog or independent academic evaluations have been helpful in pointing out shortcomings of programs, but is not an acceptable approach. Many policy instruments have been enacted, but rarely are the impacts of policies on energy savings quantified or analyzed. To gain a better understanding of what works and what doesn't, all policies must have built in feedback, evaluation and revision mechanisms.

6.2.6 Energy declaration system

The energy declaration system may only be an informational tool, but it has the potential to be an influential one, driving energy use onto the agenda for homeowners and initiating conversations with experts, neighbors and friends about how to save money and energy. In order for its potential to be realized, loopholes in the law must be closed and recommendations contained in the declaration must be based on expert analysis and with individual home inspections, not simply generic suggestions pulled from the internet. When a proper home audit takes place, the evaluator is supposed to include a list of cost-effective measures that could be done to improve home performance. At present, those recommendations are largely disregarded, but homeowners could be further enticed to implement such measures. If revolving funds were made available to homeowners for investing in efficiency measures, perhaps in a similar fashion as the Energy Savings Trust in Denmark, homeowners could be required to implement measures that improve the performance of their homes at no cost to themselves.

Access to capital remains a significant challenge among households, and high transaction costs reduce the business incentive for energy performance contracting to expand into the detached housing sector. Providing revolving funds and requirements that poorly performing homes be upgraded could also serve to stimulate demand for high performance work by contractors and craftsmen. This has the potential to be both a short- and longer-term stimulant, as technologies and building practices evolve over the next few decades.

6.2.7 The local energy adviser program

The local energy adviser program is already well received, but has the potential to be much more effective. In an effort to remain neutral, advisers are not allowed to reach out to individual households, but must wait for homeowners to initiate contact. While this position makes sense if authorities are concerned with whom the adviser might choose to reach out to or spend time with, it prevents the adviser from reaching households that are, for whatever reason, less predisposed toward seeking assistance on matters concerning energy use, and may likely stand to benefit most from implementing efficiency measures.

Together with expanded use of contractor certification schemes, if advisers had access to a list of reputable firms who carry out high quality work, they could reduce the likelihood of homeowners hiring a contractor that is unskilled or unfamiliar with building performance best practices. A preferred contractor system would also drive demand for certification programs and support continuing education among craftsmen. This approach could also reduce the number of steps required by homeowners to turn their intentions into action.

6.3 Access to real-time energy use data

Out of the many methods of influencing the behavior of end-users, real-time data feedback about how energy is used in the home has the potential to engage users and empower them to take control of and reduce their energy consumption unlike any other. At present, homeowners are provided with little feedback about their energy use other than receiving a bill at the end of each month. Instantaneous feedback is essential to informing homeowners about where energy is being used in the home in a way that allows them to act. Many utility companies have sponsored "smart meter" programs that provide next-day energy use data, but it might as well be thirty days later, since it doesn't give homeowners the means to react, and reduce energy use on the spot.

6.4 Residential energy service company business model

The energy service company is an emerging business model, expanding mostly in the large-scale building sector, among schools, hospitals, commercial, and industrial properties. Under the energy service company model, access to energy is provided as a service, in comparison to the traditional model in which utility companies sell energy to an end-user. This business model incentivizes conservation and energy efficiency, since the company providing the service typically quotes a fee for providing the service, and is responsible for making the investments or taking the measures necessary to deliver the service at the given price. Profit to the company increase as efficiency increases. If the investments or measures do not cover the costs of the energy consumed, the company is responsible for paying the difference.

The residential energy service company model holds promise in its potential to radically change the relationship between homeowners, contractors or building professionals, and utility companies. At present, homeowners tend to be uninformed decision-makers, contractors and building professionals are not required to guarantee the quality or performance of their work, and utility companies have a profit motive to sell more, not less, electricity. An adaptation of the energy service business model could overcome many of the economic incentives currently held by other actors, the knowledge barriers possessed by homeowners and some building professionals, as well as the challenge of access to capital that many homeowners face. Their profit motive would support saving energy, not using more, with higher savings resulting in higher profits.

The energy service model has yet to permeate the residential building sector in any meaningful way, mostly due to the high transaction costs associated with conducting energy performance work on a small scale, in addition to the challenges posed by the complexities of user behavior in owner-occupied houses (Respondents #1 and #3). Both of these barriers could be overcome through increased effort and resources devoted to developing an iteration of the energy service company business model for the residential building stock.

6.5 Targeted grants and subsidies

Thus far, grant and subsidy programs have proven to be effective in getting homeowners to invest in the particular energy efficiency measures they are supporting, but have not been overwhelmingly successful in promoting energy savings in general. The desire to concoct economic incentive programs that are easy to administer, promote, or communicate to homeowners may have taken precedence over building effective programs, but there are alternatives. Programs that take account of the complexities of energy use in homes, promote further investment, and target "hotspots" in the housing stock, could serve to both save energy initially and build momentum toward a critical mass of energy savings efforts.

Support for comprehensive energy audits of all owner-occupied, detached homes is a fundamental element of any such plan. Conducting a proper census of the national housing stock could provide insight to the performance level of buildings across the country, highlighting energy use patterns and which measures are most in need. Whether they're houses built during a certain time period, representing a certain architectural style, or happen to be owned by certain demographics, the data could emphasize which elements of the housing stock are in need of particular attention.

Homeowners could be persuaded through tax incentives, local competitions in the community, or pilot project programs to take more ambitious measures, such as deep energy retrofits, a comprehensive retrofit that reduces energy use by 50% or more.

7 Further Research & Conclusion

The challenges of drastically reducing energy use in the existing, owner-occupied, detached housing sector are complex, relying on input and communication from a range of actors who are equally independent, and respond to varying motives and incentive structures. This study was merely one attempt to make some sense of how the existing policies influence relations between actors and the development and dissemination of knowledge and best practices within one sector and in one country. The findings and analysis contained herein are not intended to represent comprehensive solutions to the challenges at hand. One does hope, however, that they make some contribution to a growing understanding that the current approaches to policymaking are inadequate, and that by reframing the debate in different terms it may be possible to use a more holistic perspective to elicit a different set of policy tools that contribute to more suitable short-, medium-, and long-term strategies.

7.1 Further research

This study was an initial look at the social component of policy implementation in Sweden, but it did not systematically analyze the influence of actors on decision-making. The analysis and recommendations contained in this study would be strengthened by doing so. Together with expanded interview and additional data collection, the findings of this study could be greatly improved.

Analyzing the data through additional lenses could strengthen the theoretical component of this study. Transition theory and nested decision-making could expand on the greater attempt to transition the existing building stock to low-energy or net-zero buildings, while accounting for the social component of the transition process. Actor-network theory is a theoretical tool for understanding the challenges of adopting innovative measures, integrating technological and social perspectives, and may provide valuable insight to the challenge of convincing so many independent actors to move in the same direction. Finally, visualizing the relations between actors with a causal loop diagram would improve this thesis both by more completely illustrating the relations between actors, and as an analytical keystone.

Despite one of the main findings being that decision-makers have not dedicated enough attention to the existing, owner-occupied, detached housing sector, this paper chose to explore alternative policymaking pathways, rather than determine possible explanations for why this sector receives so little attention. As a result, this question remains an unanswered, yet important element of the overall landscape.

Backcasting was considered as an alternative policymaking tool, but was not applied as such. Further investigating the potential for backcasting in this field is an important next step.

7.2 Conclusion

Achieving the significant energy use reductions necessary to avert the most serious consequences of climate change will require radical improvements in efficiency in all sectors, not least from existing owner-occupied, detached homes. It was the purpose of this study to contribute to the development of knowledge surrounding how barriers to energy efficiency improvements can be overcome in the existing detached housing sector, and propose a set of policy measures that can positively affect the knowledge and dissemination of best practices to actors at all levels. Findings showed that to activate such energy savings, the Swedish government must significantly improve the quality of policies in effect to elicit energy savings, while taking into consideration their impact on relations between actors in this field.

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Appendix I: Sample Interview Questions

Actors:
What kind of projects or products are you involved with that might be relevant to small houses?

How is your office or agency active in this sector?

When talking about improvements in the context of single-family homes, who would you say are the main actors?

Who are the people that are involved from the policy making and implementation sides?

Is there anybody from the governmental side that reaches out to consumers, or is it only responsive?

Do the regional energy offices try to reach out and contact consumers in any other ways?

Do you think that the REAs or anybody should do more to reach out to potential customers?

Are there any particular networks or programs that focus on owner-occupied houses, detached houses?

Are there any networks in the area that focus on sharing knowledge about best practices in this sector?

Are there any industry networks, or are you part of any other networks?

Are you aware of particular firms or individuals that do energy efficiency improvements for houses?

What does your region do that pushes beyond the national policies?

Do you focus on educating different players, like contractors, builders and homeowners?

How do you see the role of the regional agency in the big picture? Are you mainly focused on educational and outreach projects, or what else?

Do you get the impression that consumers are moving fast enough to meet the long-term goals?

Is there anybody that you know of who is involved with trying to implement best practices rather than just the measures that are convenient or easy?

Do you feel that politicians have been supportive of your programs?

What do you do that focuses on knowledge exchange between actors?

Is your business focused mostly on deep retrofits, whole house retrofits, or do you them all?

When you talk to customers, are they likely to have very specific tasks in mind, like they want to replace their windows, or they want to seal their house, rather than consulting for improvements in general?

What are your thoughts on the level of knowledge about energy efficiency best practices among general contractors?

When you’re on a project, what types of other people do you work with?

When you’re coordinating projects, do you work with each of them to give clear directions?

Do you think energy efficiency is becoming increasingly important, or are investment costs still the main consideration?

Does your company finance projects, or do you secure funding elsewhere?

What are some ways to engage contractors and other firms that perform this work to transform the market?

What are some of the things that your association advocates for?

When you’re meeting with policy makers, what measures are you pushing for?

How do government agencies reach out to different sectors to improve the effectiveness of policies?

Do you foresee an increasing role for decisions made at the European level in this sector?

Policies:
From a business perspective, what are your thoughts on the current incentives for energy efficiency in houses?

Do you think the current incentives do a good job to promote energy savings or are they not likely to be very useful in the long run?

What do you perceive as the challenges with the existing policies and where they can be improved?

Do the long-term goals have mechanism to achieve them, or do they just hope for the best?

How do you think existing policies will need to change in order to reach the long-term targets?

What is the likelihood of meeting the long-term energy goals?

Are the long-term energy targets a pressing topic in your office?

Do you think houses could reasonably use much less energy than they do at present?

Should the building code be stricter?

How could the building code be improved?

Is there a set timeline for when it should be revised, or is it just as the agency sees fit?

Are there any concrete plans to tighten the building code?

Is it likely that the next version of the building code will be quite similar, just stricter, or is there also a push for more radical change?

Are you familiar with how the new building code regulations affecting retrofit projects will be implemented?

How can actors in this field be encouraged to deliver results beyond the specifications of the building code?

What do you think could be done to improve their performance?

How could the energy declaration system be improved?

What are your thoughts on having a subsidy to get an energy audit or make a master plan to retrofit the house?

What is your position on using taxes or subsidies to support specific measures, rather than just measures to increase efficiency in general?

What is the agency's perspective on increasing taxes, in particular the energy tax, to reduce energy consumption?

What are your thoughts on using new types of tax incentives to influence investment in efficiency measures?

Information, Education, and Barriers:

What would you say are the most important factors when considering home improvement measures?

What are the main sources of information for consumers, as pertains to energy efficiency investments?

What's your impression of the information that's available to consumers for investment measures? Is it relatively easy to access?

What tools are available to help homeowners make the best decision when deciding to do work on their homes?

How do you feel about the training from the regional energy office? Do you feel like it's productive and helpful?

Is the training for local energy advisers relatively consistent?

What type of seminars do you host? Are they typically isolated events or are there different types of networks in the area that link agencies with builders to try and keep the knowledge circulating?

Are there networks that are trying to educate different actors about best practices and try to persuade them to work to a higher quality standard rather than just maximize short-term profit margins?

How do you explain cost calculations to homeowners? Do you just talk about investment costs and payoff, or do you also talk about other benefits like noise reduction and indoor air quality, etc.?

What do you see as barriers to increased energy efficiency in the owner-occupied, detached housing sector?

What are some of the challenges to increasing the importance of energy efficiency when making decisions about retrofit projects?

How do you think the issue of limited access to capital can be overcome?

What are the challenges with measuring energy use in existing buildings?

Do you foresee any potential technological breakthroughs that could radically change the environment for these types of improvements?

LCC:

Which factors do you consider when you're directing somebody toward a particular measure? Are you just focusing more on the current price of electricity, on the current incentive schemes, are you also thinking about future energy prices, etc.?

What are the main factors you think customers consider when weighing whether to invest in energy efficiency?

How can the importance of investment costs be reduced, and expand the use of a life cycle perspective?

Is your office working to expand the use of life cycle costing, or at least to extend the vision of people who are involved with making these investments to consider more than just the short term, up front investment costs?

Does your agency have experience using life cycle costing to educate consumers, craftsmen, or others who are involved with these types of projects?

Do you see life cycle costing as becoming more important in these types of decisions?

What are your thoughts about the potential for developing a standard model for life cycle costing? Is it even a good idea?

Do you see a potential business model in financing efficiency improvements on a small scale?

What is the potential for energy performance contracting in the privately owned, detached housing sector in Sweden?