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Article

Incentives for Improving Energy Efficiency When Renovating Large-Scale Housing Estates: A Case Study of the Swedish Million Homes Programme

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Abstract: Sweden has adopted ambitious energy savings objectives for buildings, but at the current rate of energy efficiency investments the objectives are unlikely to be reached. In this article we report the early findings of how real estate owners reason and act in energy efficiency investment decisions. Based on the results from interviews with the real estate companies, the companies have been divided into four ideal types that illuminate the differences in energy efficiency ambition and strategies; the Strict Profit Maximizing Company, the Little Extra Company, the Policy Led Ambitious Company and the Administration Led Ambitious Company. The different strategies will determine how the companies respond to incentives to invest in energy efficiency, and affect the overall result in the energy efficiency work. The ideal types hence are important to have in mind when designing policies to increase energy efficiency.

Keywords: energy efficiency in buildings; sustainable renovation; incentives for energy efficiency; ideal types

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1. Introduction

Sweden built more than one million housing units between 1962 and 1975, and now it is time to renovate most of this stock. A number of renovation projects have been carried out and there seems to have been very large differences in how much focus there has been on energy efficiency in these projects. Given the government's ambitious energy savings goals, and that it could be argued that there is a "window of opportunity" when large investments are planned anyway, so it is worrying that more is not being done. In earlier studies [1,2] it is claimed that there are a large number of profitable energy savings investments that the real estate companies do not carry out. The general purpose of the research project that is reported here is to understand why this is the case and what can be done to increase energy-saving investments in the housing stock that is in need of renovation.

Our starting point was that it is important to understand why the firms do what they do, and therefore interviews were initially made with a selection of housing companies. What is reported in this paper is to a large extent "work-in-progress". The strategy followed here is that from the interviews we try to construct a number of "ideal-types" which describe how different types of firms act in relation to energy-saving investments. These ideal types can help us understand better the action of the companies and also make it possible to, in general terms, predict how they will respond to different policy measures.

The interviews are also used to develop a more precise set of hypotheses about why not more is done, and what can be done to influence the decisions, and this will be investigated more in detail in later stages of the project.

The structure of the paper is as follows. The opening sections give some background information, starting with the Swedish policies in Section 2, and describing the part of the housing stock in question, known as the Million Homes Programme, in Section 3. Section 4 describes the method and data/interview material used. Section 5 reports the results from the interviews and the analysis based on the ideal types. Section 6 concludes with a discussion of the results found and their implications.

2. Swedish Energy Policies

To put the question of energy efficiency in buildings (in Sweden) into context, former and current Swedish energy policies, as well as the current energy consumption situation will be presented here.

2.1. Earlier Energy Efficiency Programmes

Public action programmes for energy economy have been an important element in Swedish energy efficiency policy since the 1970s [3]. The most important early policy measures, during the 1970s and 1980s, were investment subsidies and information campaigns. During the 1990s two programmes were introduced. The energy policy decision of 1991 included support for procurement and introduction of energy efficient technology, demonstration of energy efficient technology in dwellings and premises, grants to pilot plants, and renewed support to information on energy efficiency. In the energy policy decision of 1997, the so called short term programme, additional measures were proposed, among others measures for decreasing electricity consumption.

In the 1990s an initiative was taken for an action programme for energy efficiency, focusing specifically on the Million Homes Programme [4]. This never led to any political decision; however it did lead the former Prime Minister Göran Persson to the introduction of the somewhat visionary term *People's New Green Home*.

While energy policies in the 1970s and 1980s primarily aimed to reduce energy consumption in order to lessen the oil dependence (and following a referendum in 1980 also to replace nuclear power energy), today's energy policies predominantly have climate effect reduction in focus [5-7].

The first climate policy was adopted in 1988. The aim was to stabilize CO_2 emissions at that time's level, but this objective was later expanded to include all greenhouse gas emissions in all sectors, and in 1993 a national climate strategy was adopted. The strategy was in line with the United Nations Framework Convention on Climate Change (UNFCCC) and aimed at stabilization of 1990's level no later than 2000, followed by reduction in emissions. Sweden has signed the Kyoto protocol [8].

2.2. Current Energy Efficiency Programmes and Objectives

Today's energy efficiency policies are mainly based on guiding principles that were adopted in the beginning of the millennium, however, an important difference is that new policy objectives have been added [3].

Ever since the national climate strategy was adopted, the Swedish energy and climate policies have been closely tied together and strongly influenced by the EU policies, although many times more ambitious. One important issue has been the EU Directive 2006/32/EC on energy end-use efficiency and energy services (ESD), which requires all member states to draw up national action plans for energy efficiency. Energy efficiency is seen as a means to combat climate change, together with a higher degree of renewable energy sources. These two areas, along with a higher degree of renewable energy in the transport sector, are the plans of action to reach the overarching climate goal to reduce climate emissions by 40 percent [3]. Altogether this contributes to a secure and sustainable energy distribution.

The Swedish objectives are quantified as a 40 percent reduction in greenhouse gas emissions (in the non-trading sector), a 50 percent share of renewable energy, a 20 percent more efficient energy usage and a 10 percent share of renewable energy in the transport sector. These objectives are to be reached in 2020 and relate to the level of 1990. The ambition is that the energy savings will be reached through cost-effective measures, given the energy efficiency gap that has been identified [3].

The EU climate and energy goals, summarized in 20-20-20, imply a 20 percent reduction in greenhouse gas emissions (compared to 1990), and at least a 20 percent share of renewable energy sources by 2020. The EU also has goals for energy consumption in buildings, aiming at a 20 percent reduction by 2020 and at 50 percent improved efficiency by 2050.

In addition Sweden has 16 national, non-legally binding, environmental objectives that all strive toward a sustainable development, with the aim to solve the major environmental problems by 2020. The implementation of the objectives is divided between the national, regional and local level. The environmental objectives that directly relate to energy efficiency are a *Reduced Climate Impact*, *Clean Air*, *Natural Acidification Only* and *a Good Built Environment* [9].

2.3. The Public Sector as a Forerunner

A founding principle in the ESD is that the public, *i.e.*, the national, regional and local governments, should have a key role and be forerunners in the energy efficiency field.

However, the Swedish government has decided that the government alone shall take responsibility for being an example to other actors. Regional and local governments are instead offered the possibility to sign voluntary agreements on energy efficiency. Whether the municipal housing companies adopt a role as a forerunner or not has thus primarily become a local political issue, stated in the municipalities' steering directives to the Housing Company. This question is further complicated by the ongoing EU investigation concerning whether municipal housing companies should act on the same premises as private companies, or if certain exceptions for non-profitable housing companies should be adopted [10].

2.4. Energy Consumption in Sweden

In 2007 the total energy usage in Sweden, with a population of 9 million, amounted to 624 TWh, out of which 404 TWh was for end use consumption. The share of renewable energy was 43.9 percent, which was contributed mainly by electricity production through hydroelectric power. Not including district heating originating from renewable waste heat or renewable electricity in electric heating furnace, the total renewable district heating production was 25 TWh in 2006. The buildings and services sector consumed 35 percent, 143 TWh, of the total end use consumption, out of which 60 percent is used for heating and hot water. The sector consumed approximately 70 TWh of electricity, mainly for operating electricity for premises [11].

A total of 27.2 TWh of energy was used in 2007 for heating and hot water in multi-dwelling buildings (with a total of 180 million heated square meters in 2.4 million apartments). The predominant source of energy for this purpose in Sweden is district heating, by which 82 percent of the total area in multi-dwelling buildings were heated in 2007. This corresponds to an average usage of 151 kWh per square meter. During the same year oil heated approximately 1 percent of the multi-dwelling area. The total water consumption was 272 millions of cubic meters [12]. In most cities in Sweden the energy company is owned by the municipality and run on a break even principle.

3. The Million Homes Programme

Energy efficiency in existing buildings is a general problem, but has come even more into focus in Sweden given the ageing housing stock, of which a large part was built during the 1960s and 1970s, and hence is anticipated to be in need of extensive renovations within the next 5 to 10 years.

3.1. Background

The Million Homes Programme was the political decision to build one million dwellings to cope with the housing shortage and in many cases low housing standard of the 1960's. The decision was taken by the Swedish Parliament in 1965 and involved governmental subsidies to stimulate

construction. Because of the pressing time schedule and shortage of labor an industrial approach was adopted where pre-fabricated elements were used to a large extent. The goal was reached in 1974, when 1,006,000 dwellings of varying type had been built, of which two thirds were apartments in multi-dwelling units [13]. Another term, the Record Years, is sometimes mentioned in relation to the Million Homes Programme. This period dates back to 1961, and taken together during the period, 1961–1975 approximately 1.4 million dwellings were built of which two thirds were in large-scale housing estates. In this article no explicit distinction will be made between the buildings dating from the two periods, as many of the questions are applicable to the older part of the building stock as well.

The public owners, *i.e.*, municipal housing companies, took part to an increasing extent in building the Million Homes Programme and contributed with the construction of approximately 60 percent of the multifamily dwellings [13]. The municipal housing companies in Sweden build for a large section of the population and it is not social housing in the traditional sense. Out of the 650,000 multi-family apartments still left of the Million Homes Programme the municipal housing companies own almost 50 percent. However, it would be wrong to assume the same conditions for all public or all private owners respectively. In terms of size and economic strength there is as much variation between the public companies as it is between the private companies.

Both public and private owners operate under rent regulation. Rent is set following negotiations between the tenants' association and the municipal housing company, and the private companies have set their rent at the same level as in similar publicly owned and managed dwellings in the same area. Rent increases, except those reflecting general price changes, can only come about if a renovation increases the standard of the apartment but normally not because of energy efficiency measures. The vast majority pay an inclusive rent with respect to heating and hot water, but normally not with respect to electricity.

3.2. The Buildings' Condition Today

As it is now 40–45 years since the Million Homes Programme was built, the buildings' installations are now approaching the end of their technical life-length. Primarily this means that the main water and sewage pipes are in such bad condition that there is a high risk for damage by leakage. Furthermore the ventilation and electricity systems can be in need of replacement, all to maintain the living standard for the residents and the value of the buildings.

Apart from many installations being plain old, the Million Homes Programme in many cases suffers from additional difficulties typical for that period's buildings. New and untested construction techniques and materials as well as a too fast and sloppy work performance have led to other damages than those related to normal aging.

Many of the buildings have had problems with damaged balconies, facades and roofs, most often due to faulty techniques and materials. In addition the buildings were constructed before the higher demands on air tightness and insulation were introduced after the oil crisis, and hence heat losses can be substantial [14]. At the time of construction thermal bridges were not included in any requirements on energy economy, and as a result thermal bridges are frequent where e.g., balconies or wall elements are connected to the building envelope. The ventilation system is commonly based on mechanical

exhaust air with no heat recovery, or on natural ventilation. Taken together energy consumption for heating in buildings from the Record Years is on average 170 kWh per square meter and year, but can exceed 200 kWh for heating [15]. This can be compared to the current building regulations where the requirements are 110, 130 and 150 kWh, depending on the climate zone that the building is located in [16]. A very small part of this building stock has been demolished and there are currently no plans for major demolitions and redevelopment, even though there are some controversies about this.

3.3. Possible Energy Efficiency Measures in Existing Buildings

Given the fact that buildings have been pointed out as a sector with great potential for energy savings, the upcoming renovations of the Million Homes Programme are seen as a chance to undertake extensive energy efficiency measures. Many claim that the "window of opportunity" for renovation is now open and cannot be missed, since it is likely that it will take a long time until further renovation and maintaining work is performed.

Measures that can improve energy efficiency in a building can be divided into three categories. *First* there are the measures that aim to reduce heat leakage from the building envelope. This can be done by sealing leaks in the walls or around the windows, by replacing windows, by attending to thermal bridges, and by adding extra insulation to outer walls, basement floors and roofs. *Second* there are the measures that *recover energy*, which can be done by installing balanced ventilation with heat recovery, or by installing exhaust air heat pump or waste water recovery. *Thirdly* there are the measures that *limit the energy distribution*, such as adjusting temperatures, optimization of operating installations and installing more energy efficient equipment. Individual metering is another plausible measure but this aims to affect behavior so that energy isn ́t used at all, *i.e.*, is saved, rather than to use energy more effectively [15].

The measures in the third category are minor in comparison and often very cost effective. The measures in the first and second category can be minor or extensive, depending on the conditions of the buildings. Some buildings are well suited for e.g., installing heat recovery while in others there is a need to reconstruct much of the ventilation shafts to achieve this, and the same is true for insulation which easily can be added to some buildings while other need extensive modification. It is therefore hard to say generally that some measures of these two categories are cost effective and others are not. However, regardless of the initial conditions the measures are quite extensive and require planning. Also, the investments in the first category generally have a longer life-length than most of the installations from the second category.

4. Method and Data

This section starts by describing the method of using ideal types, and continues with a presentation of the interviews.

4.1. Ideal Types

Ideal types are used to extract and highlight the most important features of a phenomenon. The concept of ideal types was developed by the sociologist Max Weber, and is commonly adopted in economics, e.g., the concept of the perfect market. The researcher constructs the ideal type by accentuating one or more points, and grouping concrete individual phenomena into an analytical construct. The idea is that one can learn something about the world by constructing a rational ideal type and comparing it with reality. Hence, an ideal type is neither what the world is, nor what it should be, but rather what the world would be like if it operated according to a certain simplified mechanism [17,18].

The motive for using ideal types as an analytic framework is the differences and similarities between the companies that have become apparent in the interviews. The similarities are not big enough to permit an overall generalisation for all of the real estate companies' motives and behaviour, but neither are the differences big enough to claim that nothing can be predicted about the behaviour of one company from looking at the behaviour of another.

Depending on some key factors relevant to energy efficiency and investment decisions the companies have been grouped into categories, which help illuminating the important differences in this context. These involves factors like how extensive are the energy efficiency measures undertaken, at what stage in the process are the questions taken into account, who drives the questions, length of payback time or how certain are the estimated profits. A more detailed description of the classification can be found in appendix. The ideal types simplify what is complex and permit the companies anonymity. Each real estate company may not have its exact counterpart in an ideal type, but each company can be compared to the ideal types to see which ideal type it resembles the most. By showing the variance and width between the ideal types it can be showed that there are different types of real estate companies, and after adding knowledge about how common the different types are, the ideal types can be used to predict and explain the behaviour of the actual real estate companies.

Following the differences in attitudes and how decisions are made, the companies will also respond differently to (different) political measures to increase energy efficiency. Hence, at a later stage the ideal types can be used to design policy measures more effectively in order to reach a higher level of energy efficiency in buildings.

4.2. Interviews

During the period from April through September of 2009 representatives of sixteen real estate companies agreed to meet to give their view on energy efficiency and renovation of the Million Homes Programme. The purpose of the interviews was to get a broad view of how different kinds of real estate owners reason and act regarding these questions. A longer run purpose was for the interviews to serve as a basis for further questions and hypothesis testing in a future questionnaire to a larger sample of companies. The meetings were a form of semi-structured interviews with a pre-formulated questionnaire, where some questions were discussed only with some of the companies when it was of particular interest in that case, and other questions were added to the questionnaire along the way as experience and knowledge grew. The basic structure of the questionnaire can be found in appendix.

The interviews have been supplemented with information such as instructions from the board of directors and policy documents in order to construct the ideal types.

4.3. The Companies

The companies vary in size and range from approximately 3,000 through 34,000 apartments. The real estate companies are active in different parts of Sweden but are not geographically, nor size-wise representative for Sweden as a whole. As the interviews were made as part of an orientation phase the companies were only partly chosen strategically. They were primarily located in the central or southern part of Sweden, which among others include the largest Swedish public companies. The decision to focus on middle sized and large companies was seen as a screening criterion at this stage, in order to include as large part of the Million Homes Programme stock as possible. The chosen companies' respective share of Million Homes Programme buildings also differ, but the company whose absolute number of Million Homes Programme apartments was the smallest still had a share corresponding to approximately 20 percent of their apartment stock. This means that the question of the Million Homes Programme buildings is a major issue for all of these companies within the next 10 years. Public companies were matched with a small number of private companies to look for indications of different strategies for public and private companies. Out of the sixteen companies thirteen have public and three have private owners. Since there are Swedish examples of extensive sustainable renovation in the Million Homes Programme, there was an impression beforehand that there are ambitious and not ambitious companies, both of which were intended to be covered in the interviews.

Table 1. Interviewed real estate companies, type of ownership and size.

Company	Public/private	Size
A	Public	Small
B	Public	Large
C	Private	Small
D	Public	Large
E	Public	Large
F	Public	Large
G	Public	Small
H	Public	Large
I	Public	Small
J	Private	Small
K	Public	Large
L	Public	Large
M	Public	Small
N	Public	Small
O	Private	Small
P	Public	Large

The companies have been represented by experts, strategists, coordinators and controllers in the energy/environment field, by project leaders, heads of business units such as Residential Buildings,

Technique or Environment, and in one case by the Managing Director. All of the real estate companies, except for one, have some sort of expressed objective to reduce energy consumption, but all were of course aware of the questions of energy efficiency. The companies represented are briefly presented in Table 1, and in this table the limit between large and small was drawn at 15,000 apartments. This limit can possibly be further refined to include middle sized companies when the sample grows bigger. One of the companies included among the private (Company O) is owned by a pension fund.

5. Analysis: Ideal Types

This section will present the results from the interviews that were held with real estate companies in order to get a better understanding of how they reason and act regarding energy efficiency measures in existing buildings. The results from the interviews have led to the classification of real estate companies into four ideal types, which are presented below. They are ranked according to level of ambition in relation to energy-efficiency measures.

5.1. The Strict Profit Maximizing Company (SPMC)

The strict profit maximizing real estate owner is risk averse and undertakes only those energy efficiency measures that are strictly profitable in the short run to medium run. For this kind of company an implemented energy related project is one with higher expected returns than that of a competing project, and the profitability has to be unquestionable in the profit estimates.

A typical approach is to talk about *saving*, *i.e.*, not using, energy rather than making the actual energy use more efficient. One example would be to turn off the lights (e.g., by using timers) as opposed to changing the lights for more efficient ones, however, both of those approaches are usually part of the energy efficiency work of any real estate company.

Common energy saving measures for the SPMC are found in the third category of Section 3.3, and include adjusting the temperature in the apartments or the staircases, changing the light bulbs for low energy lights or changing equipment in need of replacement for more energy efficient one (which is not necessarily a choice based on energy awareness). These are measures that don ́t require a lot of investment cost or other resources, but that show an almost immediate pay-off, both in terms of energy consumption and operating costs. More extensive energy efficiency measures are possible, but must be profitable in terms of significantly lower operating costs (or give a clear profit in terms of goodwill) to cover the investment cost in maybe five years.

Out of the sixteen interviewed firms four can be categorized into this category. It would be intuitive to sort all the private companies into this category but only the two smaller of them, companies C and J, are strict profit maximizing in the sense defined here. Two large, municipal housing companies, B and E, are also close to this type. Companies B and E don ́t necessarily allow a longer payoff time, but may do so in specific cases and hence can be considered profit maximizing in the medium run.

5.2. The Little Extra Company (LEC)

Some companies do a little extra above the strictly profitable limit, to show environmental responsibility or because they value energy efficiency higher than the profit maximizing firm does (based on other assumptions about the net operation costs or the value of goodwill). This implies the cost estimates tend to be a little more optimistic in favor of energy efficiency measures, but it is not seen as a tradeoff between energy efficiency and economic goals. Although not always clearly defined, the LEC have got objectives concerning energy efficiency, but these objectives are not given first priority.

The LEC will do all those profitable investments in energy savings that the SPMC does, but also make allowances for energy efficiency measures in e.g., renovation calculations. This type of company will not go through with an investment that implies a loss in order to reduce energy consumption, but is willing to lower demands on return and is more likely to choose an energy efficient product when facing competing alternatives of different energy standard, even if there is no detailed calculation that shows that this is more profitable.

Common strategies for the LEC is to choose the energy efficient alternative when the product has reached the end of its life length and needs replacement either way, or to advance measures that were not yet due, in order to improve energy efficiency. This type of company is also more open to "package solutions" to finance investments in energy efficiency, *i.e.*, a very profitable measure finances the energy savings brought about by other less (/not) profitable measures. By seeing a number of measures as an energy efficiency package, the package as a whole can be profitable even if some of the individual measures need not to be (or is to a less extent).

Four out of the sixteen companies have been identified as belonging to this category. One of these, company O, is a small, private company, but its owner structure may allow or encourage it to undertake measures to improve energy efficiency that are possibly profitable only in the longer run. The other three companies, F, H and P are large, municipal housing companies.

5.3. The Policy Led Ambitious Company (PLAC)

In this type of company the official energy efficiency goals are ambitious and come, to a large extent, in the form of owners' directives or the like. Energy efficiency has been given high priority and is seen as a greater good, or it is seen as something that is necessary in the long run and might as well be undertaken now. Another possibility is that the owners through energy efficient renovation want to fulfill some other goal (e.g., to combat unemployment or social decline).

The PLAC undertakes the profitable measures and is open to package solutions, but since the instruction to give priority to energy efficiency comes from the owners, this company also has a greater freedom to undertake measures that cannot be shown to be profitable. Profitability is however the ideal and this kind of company may well justify an economic loss by arguing that it internalizes the damages of greenhouse gas emissions, and the profit estimates are "manipulated" to show a profitable investment where the company wants to see it, e.g., by assuming high future energy prices.

The PLAC will consider energy efficiency measures from all the three categories, but since decisions are influenced by (company) politics there may be a difference in where in the planning

process the measures are first considered. In the "worst case scenario" owner directives are given late in the process, hence increasing the risk that costs will be higher because of ad hoc solutions, however, this is not necessarily so for all the PLACs.

Four public companies have been sorted into this category. Three, D, K and L, are large and one, N, is small. These companies have got instructions to undertake energy efficiency measures, preferably in the renovation phase, and sometimes with an expressed permission to ignore profitability. This is not to say that energy efficiency work would not have happened without the initiative taken by the owners, but under the PLAC conditions no "organizational fight" is needed, and the employees only have to act upon the instructions given.

5.4. The Administration Led Ambitious Company (ALAC)

The Administration Led Ambitious Company has ambitious energy strivings but these arise mainly from the employees in the company, most often found in the managerial body. As with the PLAC economic profitability is not the obvious objective, but it may be harder to gain acceptance for expensive measures. Even if the owners are supportive of the overall ambition, they are not who initiated the ambitious energy efficiency strategy, and there might therefore be more conflicts within the managerial group in this case.

The ALAC undertakes the same measures as the PLAC, but since the ideas (may) have been present in the organization a longer time, they may also have had the time to be integrated properly in the renovation planning process, and therefore the risk of ad hoc solutions is smaller.

As noted, the ALAC will undertake measures from all three categories, and this will be done in a holistic way, although pilot projects are commonly used to start the process, to reduce the risk and to take advantage of the learning process.

The four small, public companies A, G, I and M all fit into this category. The smallness of the company may give the necessary conditions for employees to strongly influence the decision making process, through the work of individual enthusiasts.

5.5. Overview of Ideal Types

To get a better overview the companies are presented according to ideal type in Table 2. The Strict Profit Maximizing Companies are a mix of public, private, small and large companies, whereas the Little Extra Company, the Policy Led Ambitious Company and the Administration Led Ambitious Company are somewhat more homogeneous categories.

Table 2. Real estate companies sorted by ideal type.

SPMC	**LEC**	**PLAC**	**ALAC**
B (public, large)	F (public, large)	D (public, large)	A (public, small)
C (private, small)	H (public, large)	K (public, large)	G (public, small)
E (public, large)	O (private, small) [vii]	L (public, large)	I (public, small)
J (private, small)	P (public, large)	N (public, small)	M (public, small)

6. Conclusions and Discussion about Future Research

6.1. Conclusions

Given the results from the interviews we have seen that there is a variety in real estate companies' approaches to energy efficiency investments, which implies that we cannot expect a common response from them—not in the current situation, nor given possible future policy measures.

What drives companies to adopt one strategy rather than another can depend on a number of factors, a few of these have already been touched upon above. For example, a real estate company that has a strong economic position and gets instructions from the owners to reduce energy consumption will become a PLAC and energy consumption will be reduced. On the other hand, a company that goes through hard times with falling demand is more likely not to make big investments in energy efficiency, and to become a SPMC by necessity. Another factor influencing on the energy strategy adopted is related to the building stock in question. A company that has a large share of the building stock from this period, a share that is in a poor state of repair, may not afford to do anything more than what is strictly profitable, while a company that has a smaller share of this type of housing might afford to do a little extra and become a LEC-company.

What are the prospects of reaching the energy efficiency objectives, given the types of companies identified in the study? The SPMCs will not undertake extensive energy efficiency measures unless the investments are clearly profitable in a rather short term. This means that this category of companies, that already does little, will be marginally affected by most policy measures. Unless very generous subsidies are given, the investments will probably not become profitable enough for this type of company.

The LECs will continue doing marginal extra measures, and this group may be more affected by policy intervention. Many countries have introduced such subsidies (see e.g., Amstalden *et al.* 2007 that describe the situation in Switzerland [19]), but a risk is that companies postpone measures if they anticipate that subsidies are coming.

The ALACs and the PLACs are already on their way to achieving the ambitious objectives within their own stocks. However, a risk with the PLACs is the high dependence on policy decisions, meaning a shift in government may change the picture rapidly. If an energy aware political majority loses power, energy efficiency work may be cancelled. On the other hand, if an energy aware majority comes into power large investments may be done that aren ť well thought through, and this can lead to set-backs. Hence, the PLAC is an unstable structure that should not be relied upon too heavily in the energy efficiency work. A similar type of instability can be expected in the ALAC-company, as changes in the administrative staff can lead to policy changes.

The overall result in succeeding to reach the energy savings objectives will then depend on how many companies undertake energy efficiency measures, and on how much these companies do. With today's rate of investment energy efficiency objectives will not be met and at least two of the ideal types will not be more than marginally affected by indirect policy intervention. A more direct intervention might thus be called for, but the design of this should take into account how the real estate market is structured and on what the existing incentives and obstacles are.

6.2. Future Research Issues

One important remaining issue is to find out how large share of the companies are close to each of the ideal types. As mentioned above we plan a questionnaire to collect information about this. The research carried out so far also raises a number of further issues:

How many measures are "really" profitable? The result so far indicate that the belief that there is a large number of measures that are profitable, but not carried out might be mistaken. The impression from the interviews is that the firms that make large-scale energy related investments when they renovate cannot show that this is profitable and often add other more broad arguments—in terms of pilot studies and that they want to show that they are willing to contribute to the national goals about energy saving. If it turns out that many measures are not profitable, and if the SPMCs and LECs represents the majority of the Swedish real estate companies, it is either necessary with some kind of subsidy if the government want the companies to do more, or that energy taxes are raised. More direct regulations might also be needed.

How is profitability really calculated? Calculating profitability of an investment is not easy and a number of assumptions must be made. Perhaps the companies are making mistaken assumptions and therefore come to the conclusion that measures are not profitable? There are three points where such "mistakes" are possible, and that is assumptions about costs, revenue (energy saving and energy prices) and the discount rate. An example could be that the firms are using their traditional discount rates which might be around 5–8 percent. During the last ten years the interest rate has however on average been clearly below that, and the aggressive use of interest rate reductions by Central Banks in recession, might lead to lower average interest rate of the business cycle, so maybe a "correct" discount rate would be 3–5 percent. Such a change could to a large degree affect the profitability of long run investments.

How can policy affect firms that are not profit-maximizers? If the companies, in line with the theory put forward by Herbert Simon, are "satisficers" and currently are making a reasonable profit they might not be interested in doing things to increase profits more. The Swedish property owners' association has argued that many small property owners do not even do the simplest and most profitable things, like adjusting heating and ventilation equipment [20]. In our sample no such companies were found but this could be seen as a fifth ideal type. One way to affect the "satisficing" firms could be to give information about what can be done, and all Swedish properties must now have an "energy declaration" that should be posted in the hallway. This declaration not only describes the current energy status of the building but should also list measures that (easily) could reduce the energy consumption. As it might not "look good" if the company does not carry out these measures and some environmentally aware tenants might complain if this is not done, it might actually affect the "lazier" satisficing companies. The Swedish Property Federation is discussing a campaign focusing on these owners where the basic message should be how simple, how cheap and how profitable these measures are—but also that everyone has to contribute if the national goals should be reached!

Are measures affected by "perverse" incentive structure (split incentives)? This issue has come up during some of the interviews and concerns:

Cost-based rents: The Swedish municipal housing companies' rents are determined by negotiation with the local tenants' union. These negotiations often start from how costs develop in the firm. If

energy costs are falling, because of energy reducing investments this might lead to a demand for reduction in rents, or at least a smaller increase. In this way the profit for the firm is reduced.

Individual metering: If the tenant directly pays at least part of the energy cost, and the landlord makes an investment, part of the gain would go to the tenant in the form of reduced costs, leaving less profit for the landlord.

The tariff structure of the energy company: In most cities in Sweden the housing stock is heated through district heating, and the energy company is owned by the municipality and run on a break even principle. As earlier described district heating is most common in Sweden for heating the housing stock. The energy companies' tariff is sometimes constructed in such a way that there is a large fixed part that does not change with energy consumption, and sometimes when their sales go down because of energy savings they increase their tariffs to cover the total cost. All this means that the final reduction in cost for the housing company that reduces their energy consumption might be rather low, lower than the "actual cost" saved. Of course, if the true short run saving in costs is low, then there is no perverse incentive. There are e.g., cases where heating comes from excess heat from nearby plants and where the true cost reduction actually is small.

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Appendix A. Structure of Questionnaire for Interviews with Real Estate Companies

The stock: Size of the stock, current renovation state

Energy efficiency in general and for the company: Views on profitability. Main drivers of policies. Who initiates energy efficiency measures?

Energy efficiency in conjunction with renovation: Views on coordination possibilities. Measures carried out and motives for these.

Investment assessments: Views on future energy prices, payback periods, how the risk is assessed, effect on rent levels, financing of energy efficiency measures.

Other issues: How do the energy declarations affect the company? The role of the government and need for support and probable future legislation. Attitudes towards individual metering and effect on decisions by tenants and landlords.

Appendix B. Detail on Classification of Companies

The companies have been classified using a combination of their answers to interview questions and their policy and steering documents.

Objectives/Scope of Measures

In some cases it was known in advance that extensive energy efficiency measures had been made, and these companies could be sorted into ambitious companies right away. This was the case for the Administration Led Ambitious Companies (ALACs) A and G. For other companies it was not until the interview that it became known that the company does work extensively with energy efficiency investments. This was the case for ALACs I and M, but also for all of the Policy Led Ambitious Companies (PLACs). Companies I and M were both in more of a planning phase so there is no absolute guarantee that they carry out all of the measures in the end, however, it was expressed officially on the company webpage and in documents, and they had both signed a Swedish declaration of purpose for public real estate companies, which has got more ambitious energy objectives than the official Swedish objectives. The PLACs had directives from the board, and also in the case of companies D, K and L extra financing to improve energy efficiency, and hence are expected to follow through with this. The Little Extra Companies (LECs) were sifted out from the not ambitious companies through their intention to improve energy efficiency as an end in itself, expressed through energy efficiency objectives (although not as ambitious as those above). The Strict Profit Maximizing Companies (SPMCs) all agreed that extensive measures were unlikely to be undertaken since other investments have better returns. They carry out the savings measures that have a guaranteed fast payback.

Profitability

From the interviews it was clear that the ALACs and the PLACs saw profitability in the very long run, and viewed energy efficiency measures as insurance more than as a safe investment. Companies D, K and L even had an expressed permission from the board to overlook profitability in order to fulfill energy efficiency objectives as well as employment objectives. The SPMCs on the other hand only carry through energy efficiency investments that have better expected returns than a competing project, which according to them was rare. As earlier mentioned, they do however carry out the savings measures, which will pay back almost immediately. The LECs make a more optimistic assessment of the parameters affecting profitability than do the SPMCs, but differed from the more ambitious

companies in not being able to justify profitability only in the very long run, the LECs did need at least a medium run payback.

Initiator/Driving Force

One hypothesis before the interviews was that the extensive measures won´t be initiated "by themselves" but rather need a real driving force. For the ALACs the administration worked rather independently and planted the ideas of energy efficiency in the board, whereas the PLACs (however supportive of the ideas) to a larger extent merely followed orders.