The heating market in Sweden

- an overall view

Summary

Värmemarknad Sverige

The heating market in Sweden

- an overall picture

May 2014

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The Swedish Energy Agency's former Director General has been chairing the steering and reference groups

Researchers

The research team has been multi-disciplinary and, in the first phase of the project, consisting of researchers from the following universities, institutes and research companies:

Profu
SP Technical Research Institute of Sweden
Faculty of Engineering, Lund University
Halmstad University
KTH Royal Institute of Technology

Profu has been leading the project

Preface

The Swedish heating market is one of our largest energy markets. It has developed very positively the last 40 years and has steadily increased in size as a consequence of growing areas for heating. But, now the trend is that the increase is slowing down and in the long run we might even see a decreasing demand for heating. During the 70s oil was predominant, but today the heating market is more or less independent on fossil fuels. The emissions to the atmosphere are radically reduced and heating supply is becoming increasingly more energy efficient. In spite of the investments related to this, the heating costs' share of the households' expenditures has not increased very much.

Access to a reliable heating supply is an important societal function. In Sweden, we can heat our homes and premises in a very climate and environmentally friendly way. This contributes significantly to our ambition for a long term sustainable development. The heating market is now facing several huge challenges. Ambitious efficiency improvement targets, tougher competition between the different alternatives for heating, ever more internationalised politics and heating markets, and requirements for new regulations, are just a few examples. But, Sweden has yet no consistent strategy for meeting these challenges.

The project *The Heating Market in Sweden* is a multi-disciplinary project, which in its first phase was run during 2013 - 2014. The aim of the project is to draw an overall picture of the Swedish heating market and to present the opportunities and the challenges that the heating market is facing. The project has engaged many of the players on the heating market; heating users, heating producers, energy and facility suppliers, branch organisations, and authorities.

In the first phase of the project we have analysed the heating market and its development. We have looked at the development of the entire energy system, but local and regional aspects have also been considered, and our analysis is partly based on the latter.

The *Heating Market in Sweden* was sponsored by 15 financial partners. The steering group has carried the overall responsibility for the project. The reference group has followed the project and reviewed the results. This project organisation has ensured that results and reports have been delivered on time and to quality expectations.

We would like to warmly thank the project management and the researchers for an excellent project execution.

On behalf of the project's steering and reference groups, May 2014

Andres Muld
Chairman

Summary

The heating market is, besides the electricity market, the predominant energy market in Sweden. Space heating and hot tap water in homes, premises and industries represent a fourth of Sweden's energy consumption. The largest consumer group on the heating market is the single-family houses, followed by multi-family houses, premises and industries.

The heating market is dominated by four technologies: district heating, electric heating, heat pumps and biofuel boilers. District heating accounts for more than 50 % of the market energy-wise, whereas the electrically based technologies represent almost 50 % of the turn-over calculated in economic terms.

The heating market is both energy and resource efficient, and thereby very environmentally friendly. It plays a significant role in Sweden's ambition to achieve a sustainable development. At the same time, the actors on the market have managed to keep heating costs at a relatively low level, calculated as its share of the households' expenditures. This is of importance since sustainability is not only about the climate issue and energy efficiency, but also about providing energy at reasonable costs.

In the project "The heating market in Sweden", the actors active on the market today are represented: property owners and other heat customers, heat producers, authorities, branch organisations and installation and fuel experts. This publication is summarising the project's analyses and results from the first phase, carried out during the period 2012 – 2014.

Facts about the Swedish heating market

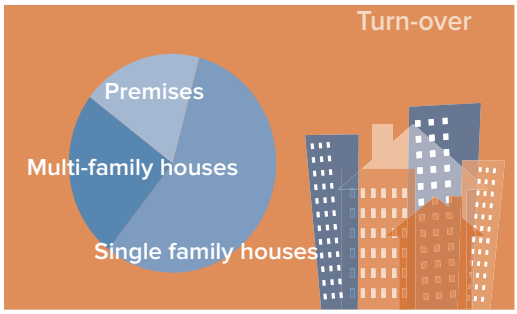
The heating market turn-over amounts to 100 billion SEK and 100 TWh per year.
The cost of the final energy is 75 % of the turn-over and the cost of the heating installations equals 20 %. Taxes represents a fourth of the total turn-over and of these VAT and electricity tax are the largest.

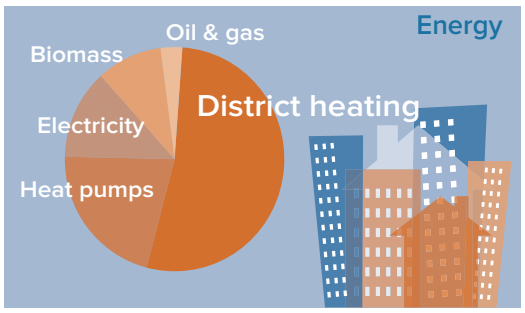
Single-family houses is the largest sub-market, in SEK as well as in TWh. It amounts to more than half of the turn-over in economic terms and covers about 40 percent of the energy demand. Multi-family houses account for 30 percent of the energy demand, and a little more than a fifth of the turn-over, while premises (commercial and official buildings) accounts for 25 percent of the demand and a sixth of the turn-over. Industries is the smallest consumer group.

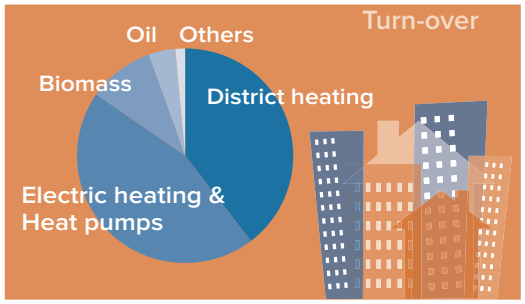
District heating is predominant in TWh and electricity-based heating (electric heating and heat pumps) in SEK. District heating stands for more than half of the total heating demand, and a third of the heating is based on electricity. District heating is the largest heating category in multi-family houses and premises, while electricity based heating is largest in single-family houses. Electric heating and heat pumps represent 45 % of the total turn-over in SEK, and district heating 40 %.

The heating market has significantly contributed to increased sustainability. As measured with the sustainability index that has been developed within the project, the heating market is the sector with the most positive development since 1970, and this positive development relates to climate and environmental impact as well as energy and resource efficiency. The industry sector also shows a positive development, while the transport sector has been less successful with its transformation.

The heating costs increase, but seen as the proportion of the household's expenditures the increase is small. The market has been successful in achieving enhanced sustainability, without significantly increasing the heating's share of the housing costs. At the same time as the energy system has been transformed, it has been possible to provide heating at a reasonable cost.







The heating market consists of many local markets. While, for instance, the electricity market is a cohesive market, the heating actors on local markets are competing with other local alternatives, which create special conditions. For instance, the price of district heating and electricity distribution vary greatly between different local markets, depending on the local conditions, e.g. size, settlement density and (for district heating) production mix.

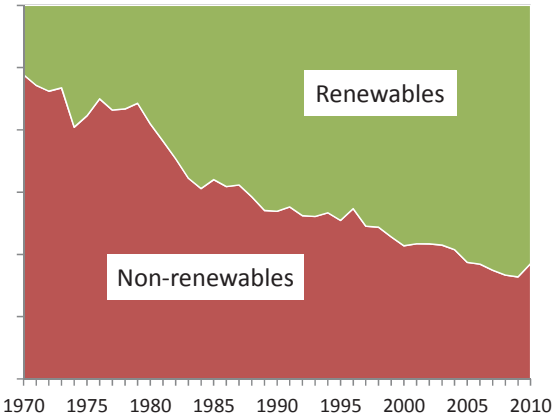
The direct use of fossil fuels on the heating market has almost ceased, only 3 TWh remains (30 TWh 20 years ago). Since district heating and electricity production in Sweden also have a relatively small share of fossil fuels, the emission of fossil carbon dioxide from heat production is small.

Important development trends for the heating market

The heating market will continue the sustainable development, and this even if a large part of the transformation is already completed. Our scenarios all show a continued positive trend, as measured with the project's energy and environmental sustainability index, and there is every reason to believe that the heating market will continue to contribute to Sweden's ambitions for a sustainable development.

Increased competition on the heating market. District heating, heat pumps, electric heating and biofuels are dominating the market today. Heat pumps are challenging electric heating, but also district heating more and more. But, the strategic strengths of district heating (cogeneration, waste heat, waste incineration and unrefined fuels) together with high heat density, still give it a strong competitiveness in urban areas. Our scenario analysis shows, for 2030, a market share for district heating in the interval 45 – 55 % and for heat pumps 25 – 35 % (to compare with a bit more than 50 % for district heating, and a bit more than 20 % for heat pumps today). The difference between scenarios is thus relatively large.

The heating market has obvious and strong connections to other markets. These connections work directly or indirectly and bring opportunities for development as well as restrictions. District heating has an especially large number of such connections, e.g. to electricity, waste management, industrial waste heat and biomass resources. The relation between the cooling market and the heating market is another example. In many premises there is a need for both heating and cooling. This is of special importance for heat pumps, and it can improve their competitiveness, but district cooling is also an alternative that is affected. The demand for cooling might increase as a result of the greenhouse effect, and from an improved standard of living. The heating market is also associated with markets that are not specifically energy related, e.g. IT, property development and consulting.



Slowly rising prices are forecasted for energy carriers on the heating market. For fossil fuels a relatively slow development of real prices is foreseen. This will, however, only have an indirect impact, since they can hardly be seen on the heating market today. The future electricity prices are closely linked to future European climate targets and are supposed to increase from current levels. It is hard to predict district heating prices since they vary from system to system. Also the price models are developing, towards better reflecting the underlying costs. This is most obvious for district heating, but an increasing number of electricity distribution companies are also reviewing their price models.

A continuously decreasing heating demand. The population is expected to grow by almost 20 % up to 2050. With a constant area standard (m^2 per person), the heated area will increase accordingly. Owing to improved energy efficiency and a low heating demand in new buildings, lower energy demand are still anticipated on the heating market. By 2050 the total heating demand from housing and premises is calculated to be 60 – 90 TWh (70 – 90 TWh by 2030). This can be compared to

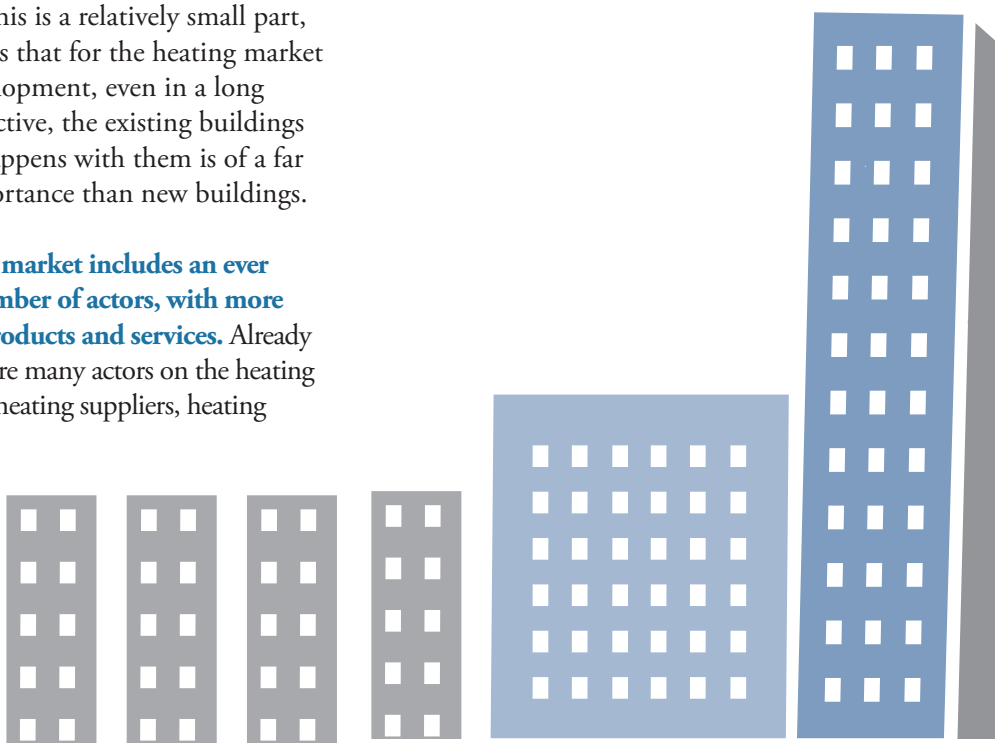
the demand today, which is about 90 TWh/year.

The potential for further energy efficiency improvements in existing buildings is large. If the full potential is realised, the energy demand for heating of existing buildings can be cut in half by 2050 compared to 1995. A number of factors, e.g. policy instruments, capital investments and new business models, have an influence on how much of this potential that will be realised, and how fast it will happen. In our scenarios different outcomes and their consequences are analysed.

New buildings will have increasingly lower specific heating demands. Zero energy houses, passive houses, energy-plus houses – what is really technically reasonable/feasible, and what are the consequences? Our conclusion is that new buildings, since they are energy efficient and few compared to existing buildings, only will represent 10 – 15 % of the total energy demand by 2050 (5 -7 % by 2030). This is a relatively small part, which means that for the heating market and its development, even in a long term perspective, the existing buildings and what happens with them is of a far greater importance than new buildings.

The heating market includes an ever growing number of actors, with more and more products and services. Already today there are many actors on the heating market (e.g. heating suppliers, heating buyers, tenants, end users, consultants, equipment suppliers, financiers, production managers, etc). New actors appear (e.g. IT companies and alarm suppliers), and the current ones expand their services and product lines. For example, the heating suppliers offer energy services, measured data management and statistics, energy performance contracting, facility management, etc. New and enhanced collaborations between the actors on the market are expected to emerge.

Heating buyers/heating consumers expect a distinct product, with a relevant pricing and the right environmental properties. There are indications that customers are becoming increasingly more active on the market. The relationship between producers and customers are growing more important. Historically, the district heating companies have failed in customer relationship management, which in a sense has been beneficial to the heat pump expansion. Today every supplier has a clear focus on the customer dialogue, and



the improved collaboration is useful for all parties involved, as well as for the development of a sustainable energy system. The demand for increased comfort will continue to grow. Voluntary energy and environmental classification of buildings will also become more important.

All technologies on the heating market are evolving, energy converting technologies as well as energy efficiency measures. Most attention is drawn to the development of heat pumps, where the coefficient of performance is continuously improved. This results in a declining electricity use, even in the scenarios with an increasing market share for electricity based heating. New techniques for district heating distribution to heat-sparse areas are being developed simultaneously with low temperature systems. Pellet boilers are becoming more reliable. Direct use of biofuels for heating is declining as a consequence of decreasing heating demand and better boiler efficiency. The use of solar energy is expanding.

Ever more complex solutions to meet the energy demand from buildings are emerging (heating, cooling, electricity, energy storage, etc.), with combinations of different technologies (where buildings are sometimes net producers). New thinking and innovation are key words. Wind power and solar power are today combined with electric heating and heat pumps. Maybe pellet boilers will find a role in combination with heat pumps? Perhaps we will see “district heating connections” in the form of heat pumps extracting heat from the return lines in the district heating system? District heating might also become more important in making use of excess heat from buildings.

Challenges and future scenarios for the heating market

We have also identified several challenges facing the heating market. Some of these are rather expressed as future scenarios and for them the challenges are of an indirect nature, i.e. how can these scenarios be realised as real development.

- It is important to give the heating market a more central role in politics and planning, in Sweden as well as in EU. This is a challenge.
- Which direction of change will be dominating on the heating market? More energy efficient houses, more individualised technologies or more energy exchange in combined systems?
- Taxes, fees, building standards and other regulatory frameworks have all a huge influence on the choice of heating system and on the trade-off between energy efficiency optimisation and energy supply.
- Energy efficiency optimisation – a great potential, but difficult to implement.
- The renovation and the energy efficiency optimisation in the million programme building stock is a large challenge by itself.
- It might be a challenge for some district heating companies to maintain profitability while they have a huge decrease in delivery.
- The market for heat pumps is changing, from a conversion to an exchange market.
- Large heat consumers are calling for more of integrated solutions that are supporting their business. Also single-family house owners are becoming more interested in their energy use.
- When electricity and district heating production become free from fossil fuels, heating will be fully fossil fuel free – how can we get there?
- In the long term, the heating market might turn into an energy market.
- New collaborations can be expected among the actors on the heating market.
- The sustainable city. The actors on the heating market expand their collaboration with municipalities and cities.
- The heating market will also be influenced by information and communication technologies (ICT) and smart grids.

These challenges and future scenarios are described in more detail on page 45 – 50.

Content

Introduction

The heating market is, besides the electricity market, the predominant energy market in Sweden. Today, the demand for heating and hot tap water amounts to about 100 TWh/year. Four means of heating predominates the heating market; district heating, electric heating, heat pumps and biofuel boilers. District heating accounts for a bit more than 50 % of the market calculated as useful energy. Electric heating and heat pumps represent just over 30 % and biofuel boilers have approximately 10 % of the market.

The heating market was expanding volume-wise for a long time as an effect of an increase of the heated areas, but since a couple of years the trend is a slower increase due to energy efficiency improvements in the existing building stock, and we can now see a small reduction in volume. New buildings are energy efficient, and the demand they add is not fully compensating for the demand reduction in the existing buildings.

The heating market is today very climate and environmentally friendly. It plays a significant role in Sweden's ambition to achieve a sustainable development. But for the actors on the heating market, sustainability is not only about the climate issue and energy efficiency, it is also about providing heating at reasonable costs.

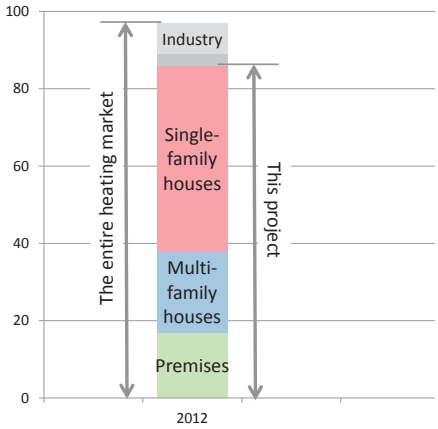
In this multi-disciplinary research project we have analysed the heating market and its development. We have looked at the development of the entire energy system, and analysed what impact future energy and climate policies might have, but local and regional aspects have also been considered. We have described a number of future scenarios for 2030 and 2050, and we have identified opportunities and challenges that the heating market might be faced with the coming decades.

The turnover on the heating market

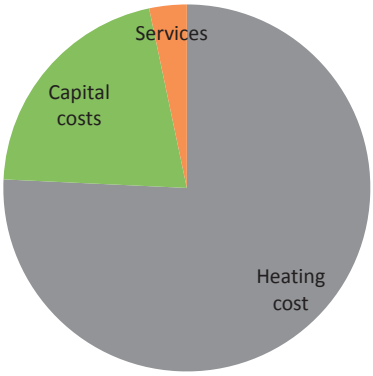
The heating market has a turnover of approximately 100 billion SEK per year. Single-family houses is the largest user group, followed by multi-family houses, premises and industry. This project includes single-family houses, multi-family houses and premises, but not industry or holiday cottages[1].

The part of the heating market included in the project has a turnover of 85 billion SEK per year. The distribution of this turnover is presented in the figures on the next opening. The pictures shows how the turnover is spread across fixed vs. variable costs, among different user groups, per energy category and means of heating, and also the proportion taxes represent.

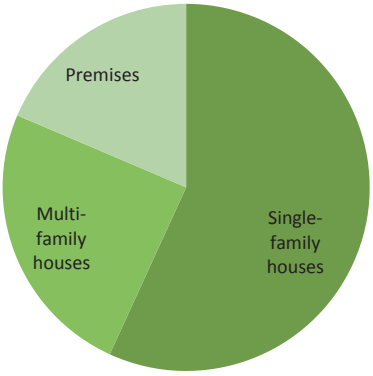
The heating market turns over approximately 100 SEK / year. This project includes single-family houses, multi-family houses and premises, altogether about 85 billion SEK / year.



[1] The industrial premises included in the heating market are those resembling regular office buildings. There are around 50 million square meters of this category of premises. They are often to be found on industrial properties and they appear in all statistics in the category ”industry”. Holiday cottages are also excluded from the analyses in this project. A SCB investigation from 2011 estimates the number to 600 000 and that they use app. 3.5 TWh of electricity (heating and household electricity) and 1 TWh of firewood.



The turnover on the heating market distributed over cost types



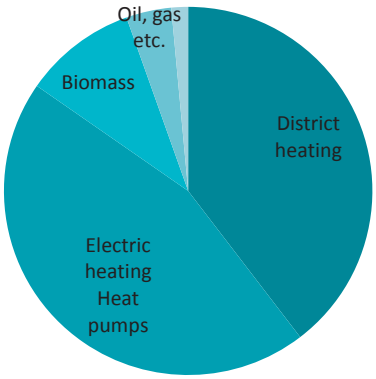
The turnover on the heating market distributed over the three user categories included in the project

The ”variable heating costs”, i.e. the costs of the final energy carriers represent three quarters of the turnover, as seen in the picture above. The costs have been calculated using representative prices of the different energy carriers, district heating, electricity, biofuel (firewood, pellets), oil, and other (e.g. natural gas) for each of the user groups.”Capital costs” consists of investment costs converted to yearly costs using the annuity method. Included are all costs for the final users – district heating substations, heat pumps, electric boilers, direct acting electric heating, and boilers using firewood, pellets, oil and gas. The capital costs related to the production of district heating and electricity are not included since they are included in the costs for the energy carriers. The cost type “services” includes expenses for operations and maintenance, e.g. inspections and regular repairs. As can be seen in the figure above, the aggregated cost for installations and services account for a fourth of the total turnover on the heating market.

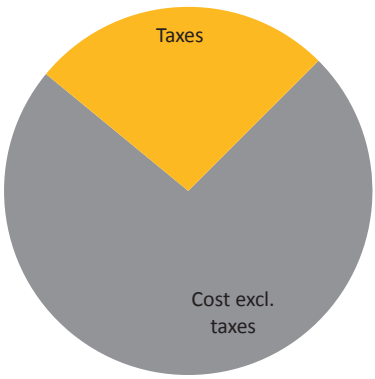
The turnover for different user groups is distributed as shown in the figure above to the right. The largest part relates to single-family houses, a bit more than 55 %. This in spite of single-family houses only representing 40 % of the heating market energy-wise. An explanation to the relatively high turnover is a “disadvantage of scale”. Energy and energy converting equipment have a higher specific price for single-family houses compared with multi-family houses and premises. Another explanation is that single-family house areas are “energy sparse”, which results in comparatively high costs for e.g. district heating.

About 25 % of the turnover is related to multi-family houses and 15-20 % to premises. The turnover for premises is low, even if the turnover of energy is only slightly lower than for multi-family houses, since they to a lesser extent are burdened with VAT. A third way of presenting the cost is to allocate them to the different energy carriers used. Such a distribution can be seen in the figure on the next side to the left. Included are the costs for the energy carriers as well as the energy converting equipment associated with the respective energy carrier.

From the picture it can be concluded that the two totally predominant energy carriers from an economic perspective are electricity and district heating. The same energy carriers are also predominant energy-wise. Electricity



The turnover on the heating market distributed over the different energy carriers



Taxes' share of the turnover on the heating market

based heating, i.e. electric heating and heat pumps accounts energy-wise for 35 % of the heating market and district heating for almost 55 %. Money-wise, electric heating and heat pumps represent 45 % and district heating 40 % of the total turnover. The reason why the electricity based technologies stands for a high share of the costs is that they are dominating the heating of single-family house, where the specific costs, as already mentioned, are higher. Finally, also the taxes' share of the heating market's total turnover is shown. Taxes represent a bit more than 25 %.The major tax cost is VAT, followed by the electricity tax.

Heating demand

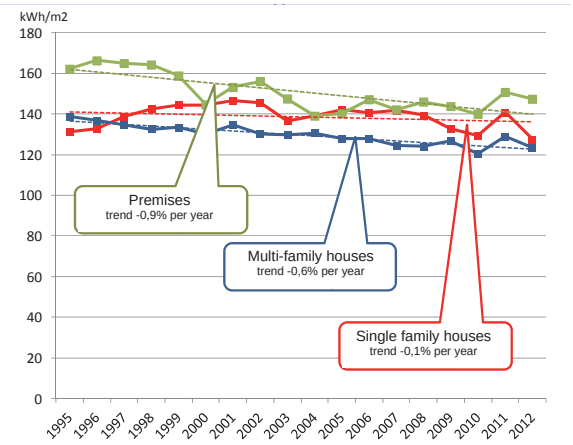
There are in total 2.3 million delivery points for heat (heating and hot tap water) in the heated building stock. The heat buyers group is large and heterogeneous with small as well as large owners, varying from uninterested to highly knowledgeable. There are both uncomplicated and complex buildings, as well as new and old ones.

The heating market for homes and premises was 2012 amounting to a little bit less than 90 TWh final heat (industry and holiday cottages not included). Single-family houses are predominant in the number of buyers (app. 2 million) as well as in share of the total heat (a bit more than 40 %). The project's scenario analysis shows a couple of possible development paths for the heating market, where heating consumption will be in the interval 65 - 90 TWh by 2030, and between 60 and 90 TWh by 2050 (these scenarios are presented in more detail later on). Obviously, the variance in the prognosis for future heat production is large, from a reduction by more than 30 % to a small increase.

The analysis of basic data, which is thoroughly discussed in the project's in-depth report *Framtida värmeanvändning i Sverige ("Future use of heat in Sweden",* only available in Swedish), has revealed some interesting facts, e.g. the massive

increase in total efficiency (useful energy / final energy) during the period 1995 – 2012. This is a result of heat pumps replacing boilers and direct acting electric heating in single-family houses, district heating replacing oil-fired and electric boilers in all types of houses and the fact that technical development has brought a general improvement of efficiency and coefficients of performance. The scenario analysis suggests that this development is most likely to continue.

The reduction in heat consumption during 1995 – 2012 has been calculated with several different sets of supporting data, and the conclusion is that there is a steady trend since long of energy efficiency improvement in multi-family houses and premises. This is most obvious for premises, where the specific heat consumption per square meter has been reduced by the magnitude of one percent per year.



Specific heat demand in the Swedish building stock

For multi-family houses the analysis indicates a yearly reduction by just over a half percent. The trend for the largest group, single-family houses is different. For this category the change in specific heat consumption is very modest, in spite of efficiency improvement measures being taken even there.

To try to understand how the heating market will develop, the segmentation of the heat users has been developed further than the usual categorisation by type of house, owner types, year of construction etc. In a specific study, the municipal and the private owners of multi-family houses were subdivided into three categories according to their ambition to take energy efficiency measures. Generally, the municipal housing companies can be found in the "more ambitious" group. This might reflect that these companies have decided to achieve the environmental targets even if this occasionally has resulted in a low or uncertain profit. Also for owners of premises there has been a segmentation with the large category "limited companies" subdivided into groups related to their presumed capacity to implement efficiency improvements.

The analysis of the future efficiency improvements is based on and brings forward a couple of important investigations among the large amount of reports available on the subject. Large works as BETSI and the Eneff investigations show that the "engineering potential", the potential to implement profitable efficiency improvement measures in the entire building stock, even in a relatively short perspective, is very large, in the magnitude of 30 – 40 %. A number of implemented projects show profitability in the same order. Seen in a longer perspective, the potential will be even higher when coordinated with renovations. However, generalising this to a large scale implementation in the total building stock cannot easily be done. The user side is characterised by a large number of different owners and these actors must be encouraged to take interest in, investigate in, believe in, decide on, fund and implement a very large number of small and large projects. The obstacles are many, some can be overcome, and some cannot.

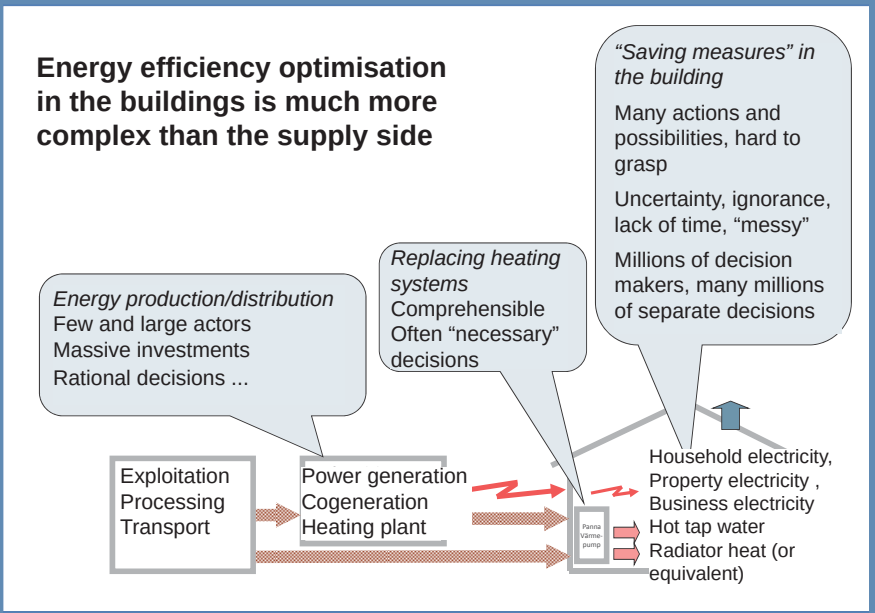
New buildings

New buildings are characterised by increasingly lower specific heating demands. Zero energy houses, passive houses and plus energy houses - What is technically feasible / possible, and what are the consequences? Our estimation is that new buildings, since they are energy efficient and relatively few in relation to the existing buildings, only will account for 10 – 15 % of the energy demand by 2050 (5- 7 % by 2030). This is a comparatively small share, which means that for the heating market and its development, even in the long run, the existing buildings and what happens with them, will be much more important than the new buildings.

Energy efficiency improvements – many actors and lots of decisions

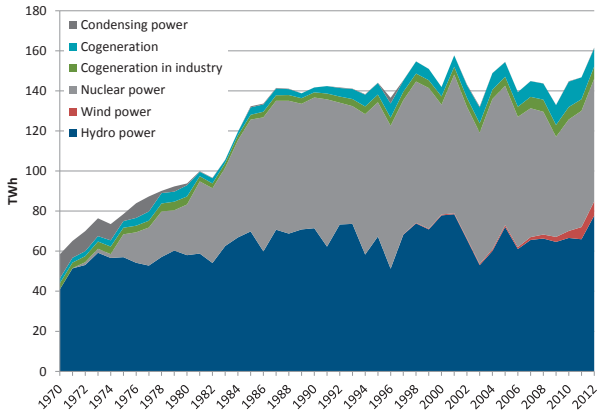
The user side, and its decision makers, consists of many different actors, whereof many do not have energy matters as their main interest. Anyone about to decide on efficiency improvements in their house must take a stand on a lot of issues they are not comfortable with. And the implementation might be burdensome and disrupting. Generally, it is easier to exchange heating system (convert), in principle one single decision, often triggered by a boiler break-down or intolerably high energy costs. On the supplier side we have a totally different picture, characterized by a few actors, with energy as their profession, and by big decisions with large effects.

This must be kept in mind to understand what is done – or rather – what is not done, of all the opportunities on the user side. Also, measures taken in the house is not only a question for the property owner / heat buyer but also for the tenants, maintenance staff, family members, boards etc.



The development of electricity and district heating production

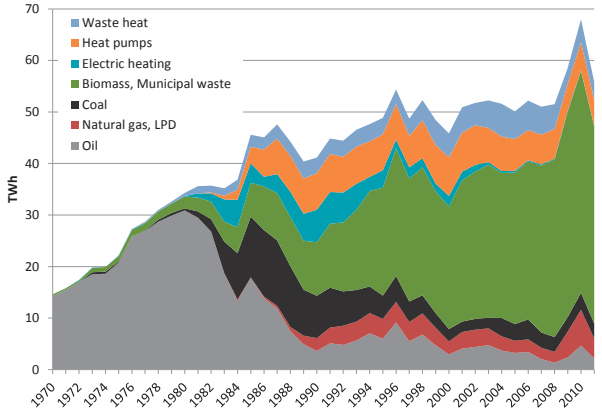
The two most important energy carriers on the Swedish heating market are district heating and electricity. The production of these energy carriers has gone through a remarkable change the last decades. The two figures below (from the Swedish Energy Agency´s *Energiläget 2013 ("Energy in Sweden 2013"))* show how the production has changed.



Sweden's electricity generation per power category and total electricity use 1979 – 2012 (TWh)

The most significant change in electricity generation happened between 1974 and 1986 when nuclear power was implemented on a large scale. Before that, hydropower was totally dominating. For the last 20 years the contribution from cogeneration and wind power has increased but compared to hydropower and nuclear power they are still small.

For district heating production even larger changes can be seen. From the almost total dependency on oil in the 70s, we are now in a situation where district heating production is dominated by biofuels. The largest differentiation between different fuels could be seen in the 80s when oil, coal, biofuels, heat pumps and electric boilers contributed to the same degree.



Final energy for district heating production 1970 – 2011 (TWh)

The energy conversion

The heating market is dominated by district heating, electricity based heating (conventional electric heating as well as heat pumps) and biofuels. The use of fossil fuels such as oil and natural gas has almost completely ceased. Only 3 TWh/year remains (30 TWh/year 20 years ago).

District heating is largest, with a market share of 50 % of the heating demand. Delivery 2012 was approximately 48 TWh. It is likely that we will see a slow decrease in district heating delivery. Our scenario analysis (see below) shows a huge variation though. For 2050 the interval is 27 – 51 TWh.

The technology development for district heating distribution is focused on lowering the grid temperatures. This is desirable for several reasons:

- Better conditions for integration of renewables, e.g. solar power, and different kinds of residual heat with different temperatures, e.g. from industrial processes.
- Better efficiency in energy transformation for most of the production categories, e.g. cogeneration, boilers with flue gas condensation and heat pumps, as well as lower losses in heat storage and distribution.
- Opportunities for using less expensive materials for distribution.

For the sector in its entirety the savings amount to approximately 1 billion SEK per year, if the return temperatures could be lowered to what is technically feasible today.

A third of the heating is currently based on electricity. ***Heat pumps*** have, over time, increased their share in this category (we include heat pumps in electricity based heating, but it should be kept in mind that two thirds of the heat production by heat pumps is free energy from ground, water or air). Heat pumps are expected to continue to grow their market share, at the expense of electric heating and other heating alternatives. As a result of this development and an expected improvement of the heat pumps' coefficient of performance, the electricity use for heating is declining, despite the growing market share. Today there are more than a million heat pumps installed in Sweden, mainly in single-family houses. During the recent years, the number of sold heat pumps has diminished since the single-family house market is being transformed into an exchange market, i.e. an old heat pump is exchanged for a new one. This market is smaller than the conversion market we have seen the last 20 year. The expected areas of growth are pure tap-water heat pumps e.g. in single-family houses heated by direct acting electrical heating and heat pumps for larger properties and industrial applications.

Heating based on ***biofuels*** (firewood and pellets) represents 10 % of the heating market. This market share is basically kept stable at the same level in the scenario analysis. The biofuel delivery will however decline as a result of the expected improvements of efficiency. There are several areas where the technical potential, primarily for the pellet boilers, is not fully exploited. As examples can be mentioned; advanced control systems, physical integration of the burner with the construction of the boiler and optimisation of the heat transmitting details e.g. with regards to the risk for or the utilisation of flue gas condensation. If these opportunities for improvements are realised, the average boiler efficiency can be expected to improve.

The historical development of the district heating

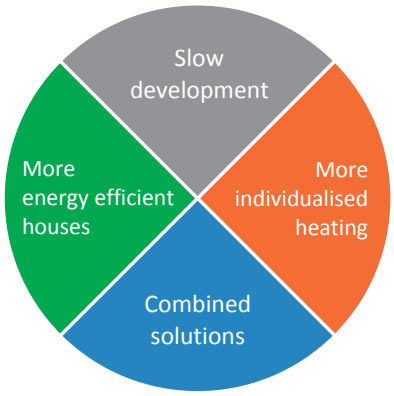
It can be worthwhile looking at the development in a longer perspective, let us say 100 years. That long ago the single-family houses had lots of fireplaces, mainly stoves. After this central heating was introduced (waterborne heating systems) with only one fireplace as heating source. The oil crisis in the 70s indicated that oil, which had been used up to then, was maybe not the solution for the future. Nuclear power and electric heating was the answer. This change was supported by state subsidies for converting from oil to electricity. Later on, alternative energy sources were evaluated and they increased in use as a way of conserving electricity and to tackle the climate issue. In Sweden we had an expansion of biofuels, heat pumps and district heating. The intensity in this switch-over varied with the price of oil and the energy politics. The number of heat pumps has since the 90s grown considerably. Oil for single-family houses is almost not used any more.

The development for multi-family houses and premises resembled that for single-family houses up to when the district heating expansion took off in the 60s. The driving force behind the district heating expansion was to replace the oil-fired boilers in every house with a system where the production was concentrated to a few boilers. Thus, it was possible to benefit from large-scale benefits like replacing expensive light fuel oil with more inexpensive heavy fuel oil, and pulling down many of the chimneys in the cities. The two oil crises in the 70s triggered massive efforts to reduce the oil dependency. District heating continued to grow and new types of energy were introduced, initially coal and electricity, thereafter biofuels and waste. Policy instruments have been crucial to this development. Today, more than 90 % of the multi-family houses and 70 % of the premises are connected to district heating.

Four scenarios for the development of the heating market

The population is expected to grow by almost 20 % until 2050. With a constant area standard, the heated area will grow by the same factor. Still, due to energy efficiency improvements and low energy demands in new buildings, lower volumes on the heating market are expected. By 2050 the total heating demand in dwellings and premises is estimated to be in the interval 60 – 90 TWh (65 – 90 TWh by 2030). Today the demand in dwellings and premises is approximately 90 TWh/year.

District heating, heat pumps, electric heating, and biofuels will continue to dominate the heating market in the future, and the competition between them will be tougher. Heat pumps are challenging electric heating, but also district heating, more and more. The strategic advantages of district heating (cogeneration, residual heat, waste incineration and unrefined fuels) together with a high heat density, give it a strong competitive position in urban areas.



The project has analysed the development of the heating market based on four scenarios:

- Slow development
- More energy efficient houses
- More individualised heating
- Combined solutions

The scenarios describe different possible development paths. To get distinct results we have streamlined the development scenarios. None of the scenarios are more probable than the others. Rather they are forming a "result space" within which the real development probably will be found. Below is a description of the four scenarios:

The scenario ***"Slow development"***: Things will go on as they are, or the development might even slow down compared to today. The heating market will have roughly the same size and position as today during the studied periods, up to 2030 and up to 2050. No larger changes.

Market shares on the "supplier market" will stay relatively unchanged. No significant conversion from district heating to heat pumps in multi-family houses and premises. Heat pumps will continue to win market shares from electric heating and oil in single family houses. Biofuels (firewood and pellets) and district heating will maintain their market shares.

The heating demand in buildings will slowly decline as energy efficiency improvement measures are taken (often in connection with renovation). The rate at which energy efficiency improvements are implemented is low though, somewhat lower than historic figures. New

buildings become more energy efficient, but building standards will be only slightly stricter than today.

The scenario ***"More energy-efficient houses"***: The buildings' demand for heating is significantly reduced. The demand is diminished at a high rate as efficiency improvement measures are implemented. There are several driving forces behind this, e.g. EU directives, taxes and national regulations. Future building standards are supposed to be strict and focusing on a reduction of the energy use and the houses' energy performance (thick insulation, energy conserving windows, efficient and careful maintenance etc.). This will be applied not only to new buildings, but also to rebuilding standards. There will be stronger requirements for environmental classification and the energy grading in these certifications will be seen as important. A majority of the new buildings will be passive houses. Property owners and tenants will show a markedly increased interest in heating, focusing at reducing the energy consumption. Energy prices will be relatively high, leading to a reduced heating demand since the profitability of energy efficiency investments will be improved. The interest in heating among end users will result in a more energy saving behaviour.

The market shares on the supplier market will also in this scenario remain broadly the same. There will be no significant conversion from district heating to heat pumps in multi-family houses or premises. In single-family houses, the heat pumps will take market shares from electric heating and oil. The share of biofuels (firewood and pellets) will stay stable, the same can be said about district heating.

The scenario ***"More individualised heating"***: A shift of the heating technologies´ market shares towards more individualised supply and small-scale solutions. The heating market will become more "individualised" and the heat consumer (the end user) will play a more important role in the heating supply. There will be a more pronounced conversion from district heating to heat pumps in multi-family houses and premises. Heat pumps will also continue to win market shares from electric heating and oil in single-family houses. The share of biofuels (wood and pellets) grows slightly. The district heating expansion to single-family houses will stop and some conversion from district heating to heat pumps can be seen. There will be no major technical break-troughs, but the performance of e.g. heat pumps will be gradually improved.

Heat use will have a stronger focus also in this scenario, as a consequence of the increased investment in individualised solutions.
A prerequisite is that the end users (the property owner and the heat consumer) step up to a higher responsibility. The buildings' heating demand will diminish as efficiency improvement measures are implemented.
The efficiency improvement efforts are of a relatively large scale and implemented widely, but they are not as large as in the scenario "More energy-efficient houses". The future building standards are supposed to be focusing at reducing final energy. As today, there will be a differentiation in the standards between electrically heated houses and other houses, but this differentiation is smaller than what is needed to make the properties of the houses independent on how they are heated, e.g. heat pumps are favoured. The standards will be stricter compared with today not only for new buildings, but also for rebuilding. There will be stronger requirements for environmental classification and the energy grading in these certifications will be seen as important. In this scenario the trend is that buildings with a small amount of final energy will be graded high in the certification system, regardless of the type of energy.

The scenario ***"Combined solutions"***: A development towards ever more of combined heat supply solutions, more of cooperation between supplier and customer and more of collaboration with other infrastructure actors. New actors will enter the heating market. District heating will have a new role in periodically acting as a heat receiver from its customers. These customers will act both as customers and as producers (so-called prosumers).

In this scenario the market is characterised by the supply, by the increase of combined solutions, technical as well as organisational/ actor related. These combined solutions also contribute to a broadening of the heating market towards other infrastructure markets (electricity, waste, measurement, etc.), which enlarges the market.

The buildings' heating demand will decline at a relatively low rate. But new as well as existing buildings are improved regarding energy performance, and they will have a lower energy demand than today. Building standards will promote a lowering of final energy. Own local energy production, partly covering but occasionally exceeding own demand, is becoming increasingly common. This is the only scenario where plus-energy buildings are becoming widespread and in a distinct way are influencing the heating market and the role of the building stock as a producer in the energy supply.

The scenario is, as said, characterised by combinations of different energy supply alternatives, e.g. combinations of district heating, solar power, own peak-load boiler and/or complementary heat pumps. Heat storage will become more important in this scenario. More solar cells for own electricity generation will be introduced, and this will happen on a large scale. The buildings' own energy demand will not be a limit for the energy production. Local energy production and combinations of supply alternatives will be supported by state subsidies. Another manifestation of the combined solutions is that more buildings, even dwellings, are equipped with cooling for a better indoor climate.

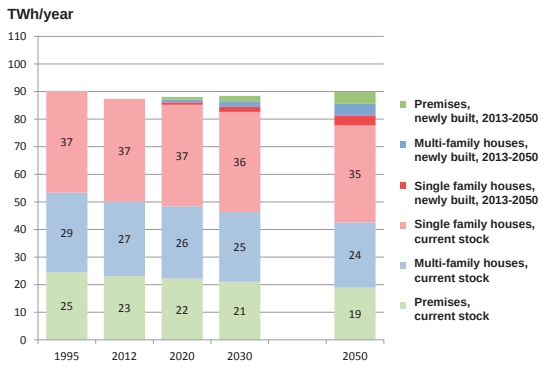
Result

After this summary of the different scenarios' characteristics, we will below describe two of the most important results from the scenario calculations, heat use and final energy. Some of the results from the scenario analysis are discussed in other chapters. A more complete scenario description, where also the different scenario-specific calculation assumptions are included, can be found in the main report (in Swedish).

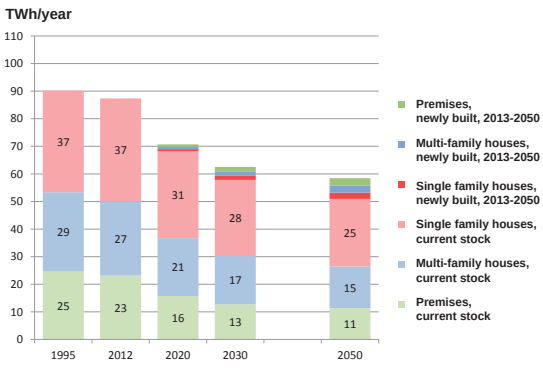
Heat use

Heat use (heat demand) develops, as described above, very differently in the four scenarios. In the figures below, the large variation is clearly illustrated.

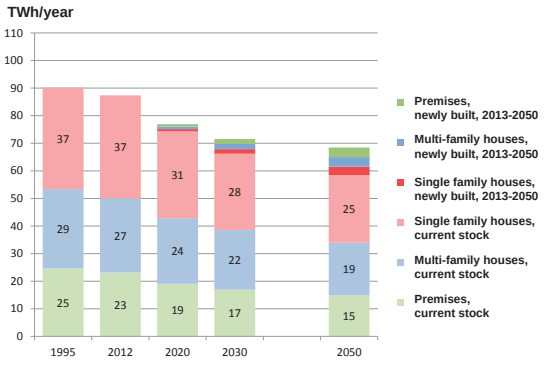
The scenario with the lowest heat demand, "More energy-efficient houses", will by 2050 use only a bit more than 60 % of the energy required the same year in the scenario "Slow development". This is explained mainly by different assumptions regarding energy efficiency improvements in existing buildings, but also by the assumed energy performance in new buildings.



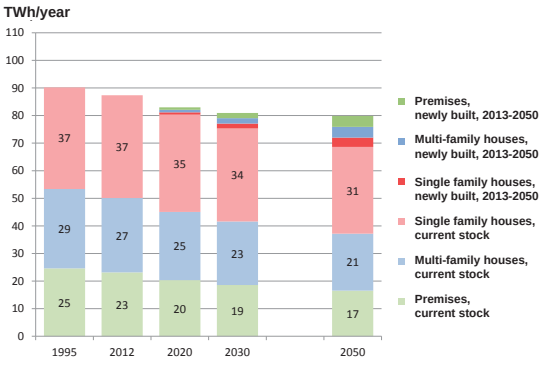
Slow development



More energy efficient houses



More individualised heating



Combined solutions

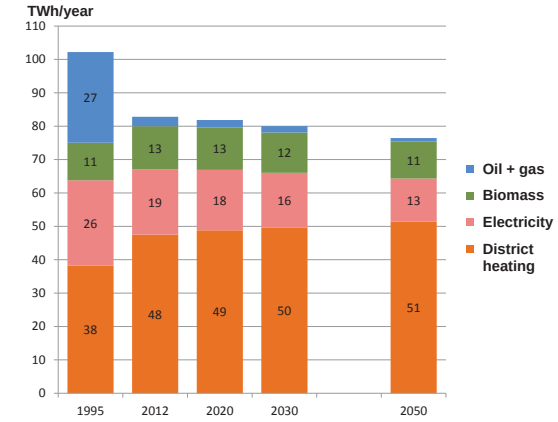
The development of heat use in the four scenarios

In the figures it is also obvious that the new buildings' heating demand will have a small effect on the total heating demand. This is explained by the moderate increase in building area needed to cover for population growth and demolition. Also, the new buildings are relatively much more energy-efficient than existing buildings.

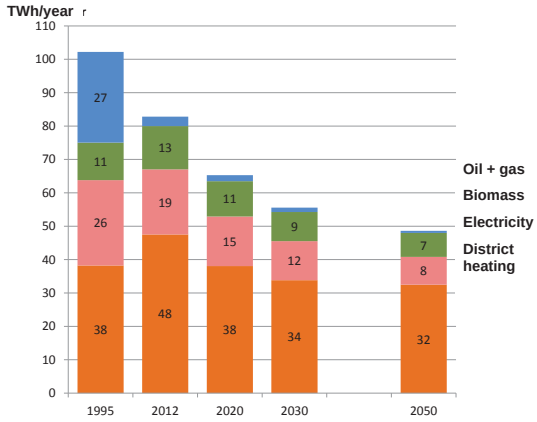
The single-family houses' share of the total heating demand will grow in all of the scenarios as a result of the assumption we have made about a lower relative degree of efficiency improvement in single-family houses compared to multi-family houses and premises.

Final energy

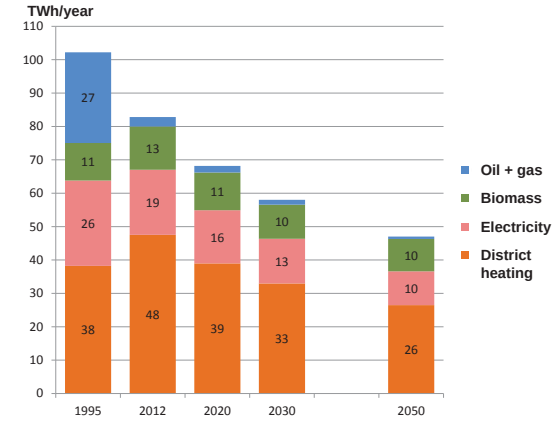
Also the development for final energy differs between the scenarios, which is illustrated in the pictures below. But they all have in common a decline in the amount of final energy for heating as a result of improved efficiency in the energy transformation, combined with a lowered or constant demand for energy for heating.



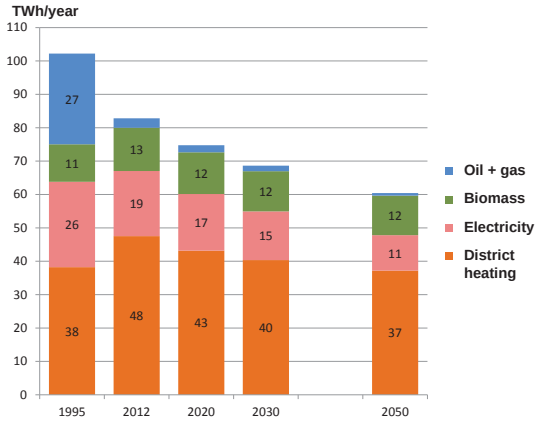
Slow development



More energy efficient houses



More individualised heating



Combined solutions

The development of final energy in the four scenarios

The improvement of efficiency is most pronounced for heat pumps, for which a significant improvement of the coefficient of performance is expected. An even greater effect on the total efficiency will come from the conversion from electric and oil-based heating to heat pumps, where a degree of efficiency of below 1 is replaced by the heat pump's coefficient of performance (degree of efficiency) of about 3 or, in the long run, even higher.

As discussed above, the scenario "more individualised heating" is above all characterised by heat pumps growing their share on the heating market from the current just over 20 %, to 30 % by 2030, and to 40 % by 2050. But still, electricity demand for heating will diminish from the reasons mentioned above. So, there are reasons to believe that delivery of electric energy for heating will be lower in the future, even if the demand for electric capacity will not decline at the same rate.

For the other large energy carrier, district heating, the picture is less clean-cut. The delivery of district heating by 2050 varies in the scenarios from a reduction by 45 % to an increase by almost 10 %. For specific district heating systems the outcome might be even more extreme. In areas with a declining population the decrease might be very massive, while the increase in some areas of urbanisation might reach higher levels than in our scenario analysis. This illustrates how complicated long term planning for district heating companies can be.

Development trends for the turnover on the heating market

Based on the scenarios, several possible development trends regarding the heating market's costs and turnover can be outlined. In all scenarios the heated area will grow, due to an increased population and a constant area standard (m^2 per person). This would indicate *increased costs*. At the same time, it is obvious that delivered energy ("final energy") is reduced in all scenarios. This is an effect of a lowered specific heating demand as a consequence of energy efficiency improvements and improved efficiency in the energy transformation. This would mean *decreased costs*. But there are also new costs for the assumed efficiency improvements and higher costs for the more sophisticated energy conversion equipment that enables the higher degrees of efficiency.

Moreover, the future prices of energy will impact the outcome. Our investigation, presented in the project's in-depth report about changes in the surrounding world, indicates relatively small changes in price of the different fuels. Changes in policy instruments might affect end user prices though. Our guess is that the development of the policy instruments and the energy prices altogether will influence the *costs* on the heating market *to rise*.

Sensivity analysis – alternative development of the population and the area standard

The future development of the population and the area standard (m^2 per person) are two essential factors determining the heating demand in the future. In the scenario analysis described above, the population grows to 2050 as in the basic case in SCB's population prognosis and the area standard is the same as today (case BASE in the table below). In a sensitivity analysis for the scenario "Slow development" we have combined alternative population developments and area standards to a case HIGH and a case LOW.

The higher and the lower population developments trends are taken from SCB's alternative calculations, where, most of all, different assumptions regarding migration give different results.

Case	Population 2050	Area Standard, m^2 heated area in dwellings per capita
BASE	11 228 000	Today 52, the same by 2050
HIGH	12 181 000	Today 52, increases to 65 by 2050
LOW	10 362 000	Today 52, declines to 45 by 2050

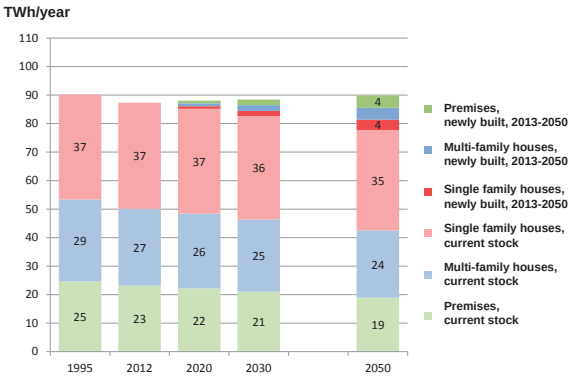
different results. The area standard is influenced by many different factors, political or others. The GDP development is one example.

The estimations take the continued urbanisation into account. The migration from the countryside and small villages to ever larger cities has gone on since the 19th century and is supposed to continue. This is in consistency with case BASE and case HIGH. In case LOW, the assumed low area standard and the slow population development means that the theoretical demand for living area will fall below that of the remaining building stock. But a zero-demand for new buildings cannot be seen as realistic. In this case we have therefore added new building volumes at the same low level as we saw in the late 90s, located to areas of urbanisation. Demolition rates will at the same time be higher than in scenarios BASE and HIGH.

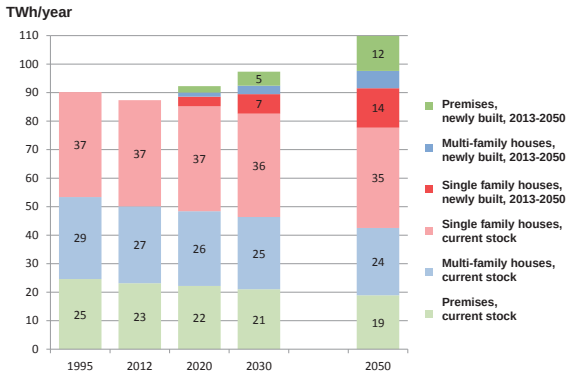
The development of premises has consistently been calculated with the same trends as the development of dwelling areas.

The figures to the right show the results for the development of heating demand as seen in the sensitivity analyses for the scenario ”Slow development”.

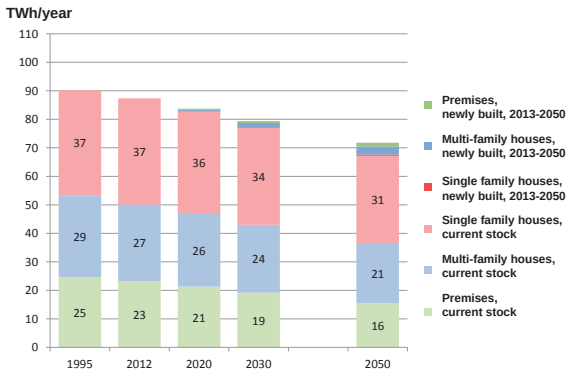
Case BASE in ”Slow development” shows, also illustrated on page 24, an almost unchanged total heating demand by 2050 compared with today. The relatively extreme assumptions in



Case BASE



Case HIGH



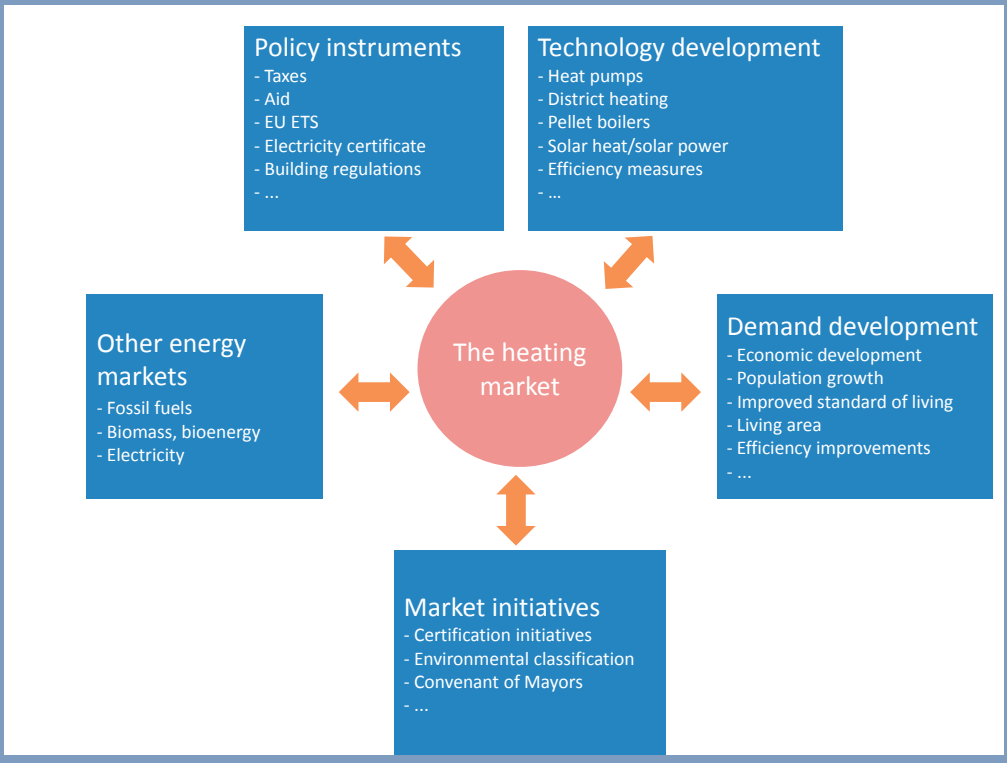
Case LOW

the sensitivity analysis regarding population development and area standard results in a heating demand that is 26 % higher in the case HIGH, and 18 % lower in the case LOW, by 2050, compared with today.

The world around us

The development of the heating market is influenced by the development in the surrounding world. When developing our four scenarios for the heating market, we have made different assumptions regarding the development of the world around. We have chosen to subdivide the surrounding-world factors into five groups; policy instruments (e.g. climate and environment), development of technology, other energy markets (mainly fuel and electricity markets), development of demand (use of heat and hot tap water) and market initiatives. The surrounding-world factors are influencing the total heat demand as well as the composition of the different heating categories.

The figure below presents a schematic picture of the heating market and the five groups of surrounding-world factors.



The actors

The heating market engages an increasing number of actors, offering a growing variety of products and services. Already today there are many actors on the market; heat suppliers, heat buyers, tenants, end users, consultants, equipment suppliers, financial partners, operation managers, etc. New actors are introduced, e.g. IT and security companies, and those already on the market expand their service portfolios. For example heat suppliers offer energy services, measured value management and statistics, energy performance contracting, facility management, etc.

More proactive customers

An increasing number of heat customers are today demanding a distinct product, with the right pricing and with favourable environmental characteristics. Customers are generally becoming more active on the market. Customer influence, local production, net billing, control / load balancing and smart grids, form a whole that makes the supplier–customer relation even more important. District heating companies have up to now failed in managing their customer relations, which to some extent has been beneficial for the heat pump expansion. Today, all suppliers have a clear focus on the customer dialogue, and the improved cooperation serves the interest of the parties themselves, as well as the development towards a sustainable energy system. Voluntary environmental classification of buildings is also becoming more important.

Today, larger heat customers ask for more of integrated solutions that really support their businesses. It is not any longer sufficient to produce and deliver energy. As a supplier you are now more often challenged to also understand the customers' driving forces and ambitions. This can only be accomplished through customer-intimate cooperations.

New cooperations on the market

With the heating market becoming more mature, it will most probably mean that we will see new cooperations among the actors on the market, also between parties today regarded as competitors. At the same time we can see a new energy landscape emerge. An increasing number of actors, renewables, small-scale electricity generation, demands for new solutions for energy efficiency improvements and proactive customers are all trends that rapidly are changing the conditions on the heating market. Altogether this calls for a new way of thinking from the actors on the market, if they want to stay competitive and maintain a profitable business.

In the publication 17 perspektiv på värmemarknaden ("17 perspectives on the heating market", only available in Swedish) we have summarised the heating market's actors' own perspective on the market and its development. Together they give a very clear picture of the diverse heating market and the directions of development to expect. The publication can be downloaded from www.varmemarknad.se

Sustainable development

The Swedish heating market has contributed significantly to improved sustainability with respect to energy and environment. As benchmarked using an energy and environmental sustainability index developed in the project, the heating market is the sector that has developed most positively in Sweden since 1970. This positive development goes for climate and environmental impact as well as for energy and resource efficiency. Also the industry has had a positive trend, measured with the project's index, while the development in the transport sector has been negative.

Our scenario analysis indicates that the heating market will continue developing towards improved sustainability regarding energy and environment, even though a large part of the transformation is already done. All our scenarios show a positive trend and every sign indicates that the heating market will continue to contribute to Sweden's ambition for a sustainable development.

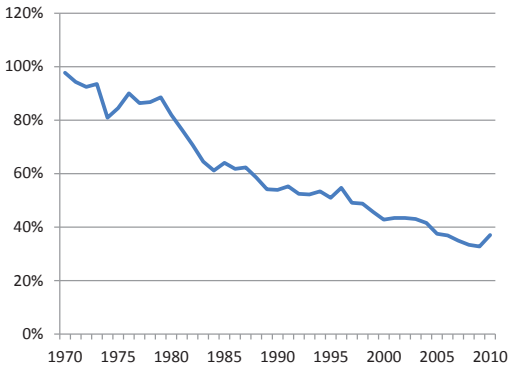
The heating market has gone through a massive development towards reduced emissions, improved efficiency, and better resource management. As mentioned earlier, the use of fossil fuels such as oil and natural gas has more or less ceased, only 3 TWh/year remain (compared to 30 TWh/year 20 years ago). As a consequence, the emission of carbon dioxide of fossil origin has been dramatically reduced. Total efficiency has also been improved by a better degree of efficiency in the energy conversion chain and by a lowered specific heating demand (kWh/m^2). Also the indirect emission related to electricity and district heating production have been significantly reduced.

To illustrate this complex development in a more straight-forward way, we have, in the project, developed a sustainability index related to energy and environment. The purpose with this sustainability index is both to be able to

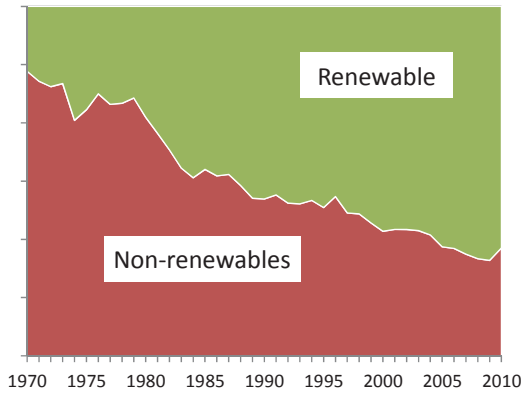
analyse and illustrate the heating market's development towards a more sustainable market, and to be able to compare the development of the heating market with other sectors. The index is based on the combination of six different indicators:

- Carbon dioxide emission
- Renewables (measured as "none-renewables")
- Energy efficiency improvement (specific energy use per area)
- Sulphur (dioxide) emission
- "Natural resource index" reflecting the "scarcity" of a resource from an availability view as well as from a durability view, i.e. how robust a lasting exploitation of the resource is.
- Primary energy

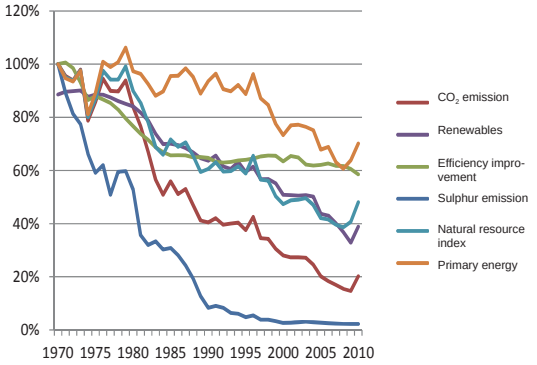
The figures below show the "energy and environmental sustainability development" for the heating market and on the next page to the right, for comparison, the same for the industry and the transport sector.



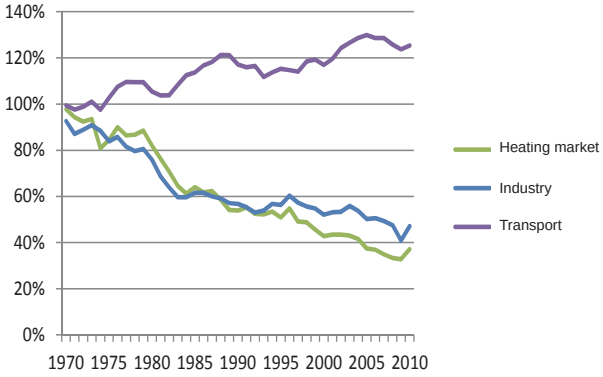
The development of our energy and environmental sustainability index for the heating market 1970 – 2010.



Schematic picture of the index's development for the heating market



The development of the index´s six input indicators for the heating market.



The index´s development for three different markets

The indicators carbon dioxide and renewables

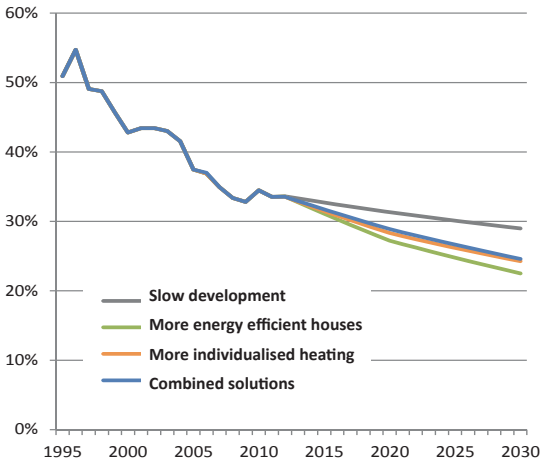
The individual indicators have developed very differently, which is illustrated in the figures above to the left.

Sulphur emissions have been reduced very drastically, and are today almost zero. Even emissions of carbon dioxide with fossil origin are markedly reduced, by more than 80 % since 1970. This is very positive, not the least from a climate perspective, but it also means that the remaining potential for carbon dioxide reduction on the heating market is limited.

The share of renewable energy has increased and is today approximately 60 % (the figure shows the non-renewable share, today about 40 %). Our scenarios predict a continued shift to renewable energy also in the future, but at a lower rate than the historical development. The reason is that we continue to use several other "acceptable" energy types in the heating supply system that are not renewable, e.g. recovered energy (industrial waste heat and waste incineration) and nuclear power.

The sustainable development goes on

The scenario analysis shows that the sustainability index will continue to have a positive development, i.e. an ongoing reduction, also in the future. We have calculated our energy and environmental sustainability index for the project's four scenarios. The estimations span over the period 2012 – 2030. The result can be found in the figure on the next page. In all of the scenarios, our sustainability index will fall all the way up to 2030. The future improvement varies somewhat between the scenarios and is a bit slower compared to historical figures. The reason for the latter is that the remaining potential for improvements is limited and that zero cannot be reached for all indicators. The largest reduction can be seen in the scenario "More energy-efficient houses" and the smallest in the scenario "Slow development". Altogether, we are prepared to draw the conclusion that the heating market will continue its sustainable development from an energy and environmental perspective also in the future, even if a large part of the transformation is already completed.



Future development of our energy and environmental sustainability index for the heating market in the four scenarios up to 2030, and the historical development from 1995 to today.

Technical development

All technologies on the heating market are under development, energy conversion technologies as well as efficiency measures. Most attention is drawn to the development of heat pumps, where the coefficient of performance is still improving. This results in a decline in electricity use for heating in spite of increased markets for electricity based heating. New technologies for district heating distribution in heat-sparse areas are being developed simultaneously with low temperature systems. Pellet boilers are becoming more reliable. The direct use of biofuels for heating is at the same time diminishing as a result of lower heating demands and improved boiler efficiency. The exploitation of solar power increases.

The technology development is thoroughly described in two in-depth reports (only available in Swedish) that can be found on the project's homepage. This chapter consists of extracts from these reports.

Heat pumps

Today, there are more than one million heat pump units installed in Sweden, mainly in single-family houses. These heat pumps have primarily replaced direct-acting electric heating, electric and oil-fired boilers, but also, to a certain extent, firewood, pellets and even district heating. In the recent years, the number of delivered heat pumps has decreased, and branch representatives think this is a result of the single-family house market being transformed to an exchange market, i.e. old existing heat pumps are exchanged for new ones. This market is smaller than the new-establishment market we have seen the last 20 years. Suggested areas for growth for heat-pumps are hot tap water heat pumps, e.g. for single-family houses heated by direct-acting electricity, and heat pumps for larger properties and industrial applications.

Recently adopted and coming directives will also influence the heat pump market. The Eco-design directive means that the poorest heat pumps will be taken from the market; they will not be allowed to be sold in the EU. This will result in a higher average efficiency, primarily for air-air and air-water heat pumps. The F-gas regulation is under revision, and a new regulation is supposed to come with a massive reduction of so-called HFC-refrigerants, because of their contribution to the greenhouse effect. This means that the heat pump industry will have to change to other refrigerants in a major part of their product portfolio the next 4 – 5 years. It is today hard to predict which solution that will be dominating, but the choice is between natural refrigerants (e.g. propane, ammonia and carbon dioxide) or new synthetic refrigerants with very little climate impact.

There are several technologies available for improving the efficiency of heat pumps, e.g. more efficient heat exchangers and compressors. But the largest potential can often be found outside the heat pump itself. If the heating system is tuned so that the heat pump can work using lower temperatures on the "warm side", the annual degree of efficiency will be greatly improved. This can be achieved by using larger radiators or by replacing radiators with underfloor heating. An annual efficiency of 6 is supposed to be fully achievable, but if this will be realised is depending not only on technology, but also on the development of energy prices. High energy prices will stimulate the development of advanced systems. Low energy prices would mean that efficiency improvement takes longer time.

District heating

The technology development of district heating is partly related to the production, partly to the distribution. Both these areas are subject to continuous improvements. For production there is also a potential for larger changes. One example could be increased electricity yield in cogeneration plants. If solid fuels are used, such improvement of performance will be associated with more radical changes of technology, for example gasification combined with utilisation of combined cycle. So far, costs and questionable operational reliability have stopped a wider implementation of such technologies.

In distribution, great efforts are made to lower the temperatures in the grids. This minimises losses, enhances the possibilities to utilise waste heat and solar power at low temperatures, increases the electricity yield for cogeneration and reduces the pump energy demand. An effect of these efforts is that more and more district heating companies are introducing a flow or return temperature component in the pricing of district heating. This to stimulate the customers to contribute to the reduction of temperatures.

In the long run, the development towards lower system temperatures will continue. This is often referred to as “Fourth generation district heating”. Delivery/return temperatures as low as 50/20°C has been suggested as targets. Such a development is desirable for several reasons, see discussion above. The advantages mentioned can be seen as opportunities for cost reductions. If the return temperatures could be lowered to what is technically feasible, the cost saving for the sector in total would add up to about 1 billion SEK / year.

Besides the focus on temperature, the following characteristics of district heating development are mentioned:

- Lower installation cost from using more standardised components.
- Higher demands for individual temperature comfort and more intelligent heat.
- Changed heat load profile in low-energy houses since hot tap-water use as well as the effect from heat generation from devices, sun and people will have a more pronounced penetration when the heating demand is reduced.
- The district heating system can absorb surplus electricity generation caused by intermittent production (primarily wind power) by producing heat in heat pumps and accumulating it.

Solar energy

The future role of solar energy on the Swedish heating market is hard to predict. Even if the solar influx in southern Sweden is almost equal to that in Germany, the technology has not reached the same volumes in Sweden as there (Germany has the highest amount of installed solar power / capita in the world). With the ambition to further improve the competitiveness for solar electricity as well as for solar heat, further price reductions and efficiency improvements are to expect. For example, there is a need to standardise the components, besides the solar panels, in the solar power installations to reduce costs.

An interesting possibility is that electricity from solar cells also might come to play an important role from a heating perspective. This primarily through the combination solution solar cells – heat pumps, which is emerging as an obvious competitor to small solar heat systems. The competitiveness for these systems might be even further improved by – besides a continued positive development of price and performance – higher prices of electricity and enhanced policy instruments.

Pellets

Delivery of pellets for warming of single-family houses has stagnated and even declined in the early 10s. How much that can be referred to changes in user behaviour and a massive reduction in new installations, or to a variety in average temperature in different winter seasons is hard to exactly tell. But it is tempting to believe that the single-family house market has stagnated. Partly due to a massive reduction in the number of new installations, partly due to the fact that some of the older boilers converted to pellets combustion through the installation of a pellet burners, have been phased out for reasons of age. Another factor that might have importance is that pellet boilers have been phased out for "burden reasons", i.e. the users are no longer prepared to put in the effort of handling the fuel and the pellet boiler. There are several areas where the technical potential for the pellet boilers is not fully exploited. As examples can be mentioned; advanced control systems, physical integration of the burner with the construction of the boiler and optimisation of the heat transmitting details, e.g. with regards to the risk for or the utilisation of flue gas condensation. The pellet boilers sold on some foreign markets, e.g. Germany and Austria, are on average more technically advanced than those that are common on the Swedish market. This has more to do with the willingness to pay among the customers than the ambition level of different manufacturers. In Sweden the average house owner is not willing to invest as much as those in the mentioned countries. Probably there is also some influence from national or regional investment grants.

The development for pellet stoves is more or less following that of pellet boilers. Better control systems, better efficiency, lower emissions are the key words also for them. But for pellets stoves there are a specific factor with a limiting effect on the technical development, the design and appearance issue. A pellets stove is usually placed in the central part of the building and often as an eye-catcher.

The global market for pellets is growing fast and pellets is developing towards becoming commoditised, just like coal and oil. The development is driven by large industries and power companies asking for biofuels that can easily replace or be fired together with oil or coal.

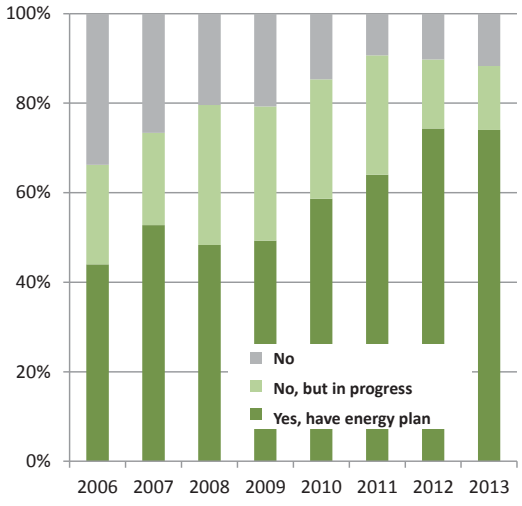
The heating market is many local markets

While, for example, the electricity market is a cohesive market, the actors on the local heating markets are competing with other local alternatives, which brings special conditions. Also, many municipalities have very high ambitions in improving the efficiency in their heat usage and in phasing out fossil fuels, while others have very low aspirations for influencing and driving the development.

The heating market is special, as it is ruled by local circumstances. This can be the size and density of the settlement, the conditions for district heating production e.g. waste heat and waste incineration, but also the average temperature in the area and the nature of the ground.

Municipalities

The municipalities have a strong influence on the local heating markets. They are often owners of the district heating companies and through their enterprises and administrations they are often the largest property owner at the site. This strong influence is underpinned by the municipalities' responsibility for planning and by the legislated obligation to develop and maintain comprehensive energy and climate strategies. Therefore most of the municipalities have an up-to-date energy plan.



The proportion of municipalities with an up-to-date energy plan (Source: www.miljomal.se).

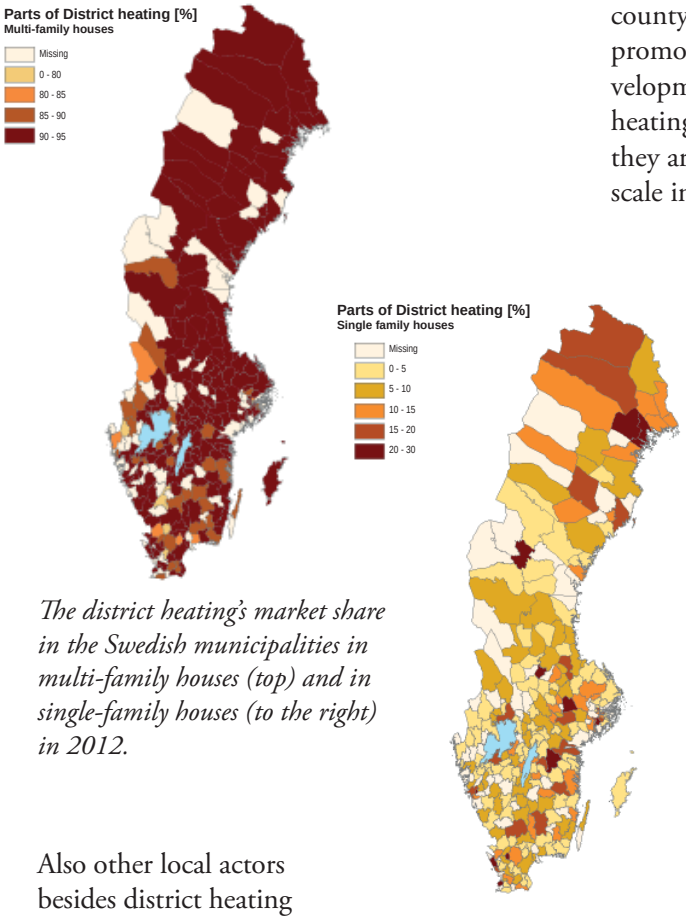
In the energy plan the municipalities define their objectives and strategies for the local development. But the ambition level in influencing the heating market and other parts of the energy system varies a lot between different municipalities. There are examples of municipalities that not to any larger extent want to influence and drive the development as well as of others that see themselves as forerunners with very high ambitions. The latter want to implement massive efficiency improvements, phase out fossil fuels and increase the share of renewable energy. The average energy efficiency improvement target from 2009 to 2020 among Swedish municipalities is 20 %, but the variation is large. Between 2009 - 2012 the real improvement has been 1 % per year, with a large variation even here.

Also heat buyers / heat consumers have defined targets in the same way. For example, a large number of SABO-companies (municipality-owned companies with mainly multi-family houses) have signed (in the Skåne initiative) for a reduction of final energy by 20 % during a period of 10 years.

The local heat supply

In all municipalities district heating is the predominant form of heating in multi-family houses and premises but the local variation is large. The market share for district heating

is more than 90 % in multi-family houses, approximately 70 % in premises and a little bit less than 20 % in single-family houses. In single-family houses electric heating and heat pumps are the predominant means of heating.



The district heating's market share in the Swedish municipalities in multi-family houses (top) and in single-family houses (to the right) in 2012.

Also other local actors besides district heating companies are dependent on local conditions, e.g. heat pump suppliers. They are impacted by the average temperature in the area, the quality of the bedrock, the price of electricity and district heating as well as by the structure, level and competence among local installation companies.

The counties and the regions

In Sweden, the counties (through the county administrative boards) have a less clearly defined role in the energy and climate work compared to the municipalities. Their mission is to "Promote the realisation in the county (or the region) of the national targets, while at the same time, considering regional conditions and circumstances". This wording is of general nature but one of the areas specifically mentioned is the energy and climate issues. Since the county administrative boards' duty is to follow, promote and coordinate the regional / local development, it means that their influence on the heating market is indirect and limited, even if they are responsible for the inspection of large scale installations.

Future challenges for some of the district heating companies

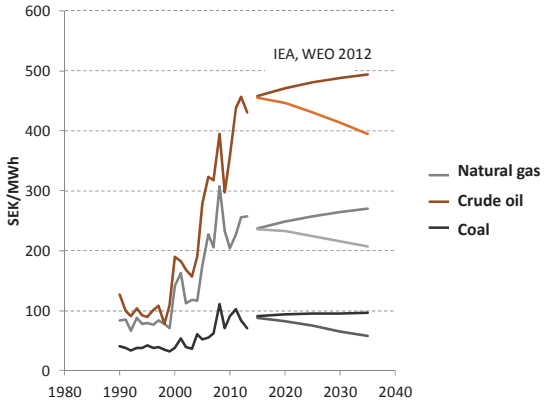
Even if the district heating is predominant on the heating market and is strengthening its position at many sites, it is challenged in other places. Declining delivery and a diminishing potential for new connections might result in difficulties for district heating companies to maintain profitability, since they, as heavy investors, have a large proportion of fixed costs. These companies are particularly exposed at large and fast falls in delivery, for instance if many property owners implement massive efficiency improvements or shift their means of heating, e.g. to heat pumps. As always when discussing the conditions for district heating, it is important to remember that these conditions vary a lot between different systems. Even if district heating is developing positively on average, there will be some district heating systems facing problems. The companies are aware of the challenges and they are making great efforts to adapt and develop their businesses. The very large variance in district heating delivery seen in our scenario analysis indicates how difficult the future is to predict.

The price of energy

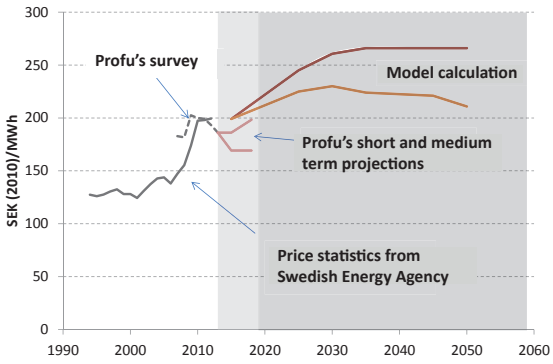
Slowly rising prices are expected for the energy carriers on the heating market. The fossil fuels are supposed to show a comparably moderate development of real prices. This will have only an indirect effect, since they are hardly existent on the heating market nowadays. The future prices of electricity are tightly linked to future European climate targets and can be expected to rise compared to today. Prices of district heating are harder to predict, since they vary from system to system. Even the price models are being developed, towards better reflecting the underlying costs. This is true particularly for district heating, but an increasing number of electricity distribution companies are also reviewing their price models.

The price development of the fossil fuels has little direct influence on the Swedish heating market. The indirect effect is more important, since the Northern European price of electricity is affected. The most cited prognosis for prices is the regularly issued one from IEA. In the figure below to the left can be found intervals for the future prices of oil, natural gas and coal respectively. The higher level represents a scenario with moderate climate ambitions, whereas the lower level is associated with very ambitious climate targets. The price development is a function of the demand for these fuels. The same tendency can be seen for the future prices of unrefined biofuels, see figure below, to the right. But, here, the ambitious climate targets are linked to the high prognosis for price development since ambitious climate targets increase the demand for biofuels. The future prices of electricity are closely related to the climate ambitions, e.g. manifested in the price of emission allowances, see figures on the next side.

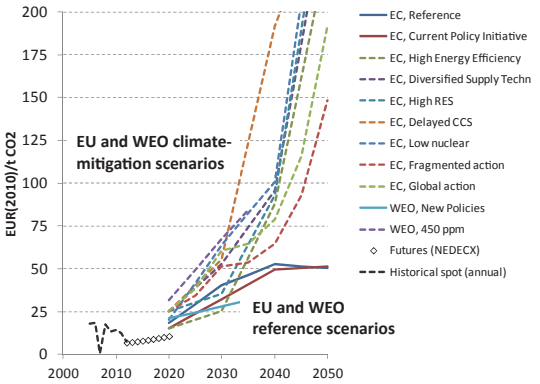
The price of district heating is influenced by the prices of the energy carriers used for production. As said above, a moderate increase is expected for the prices of fuels. This might lead to expected levels of the same magnitude for the price development of district heating. The assumed rising price of electricity has two effects. In case electricity is used in district heating production, mainly in heats pumps, it will increase the cost for production. For



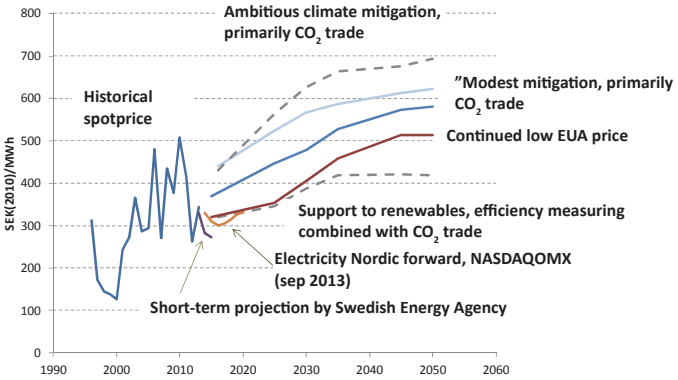
The price development of fossil fuels according to IEA's latest World Energy Outlook (2012), and the historical development. (1 EUR~9 SEK)



The price development of wood chips (Source: The Swedish Energy Agency's price list, Profu's biofuel market report and calculations from Elforsk's NEPP project) (1 EUR~9 SEK)



Price development of EU ETS based on the EU's Roadmap studies, OECD/IEA's World Energy Outlook (2012) and the prices of futures (Nov 2012)



The system price development on the Nordic electricity market (Source: Nordpool Spot, Nasdaq OMX, The Swedish Energy Agency and Elforsk's NEPP Project).

Policy instruments

The heating market is influenced by a large variety of different policy instruments. They have an impact on the quantity of energy demanded as well as how this quantity is distributed over different energy carriers and technologies for heating. Most of the policy instruments influence not only the heating market, but also other related markets.

The following policy instruments are used today and are influencing the heating market to varying degrees:

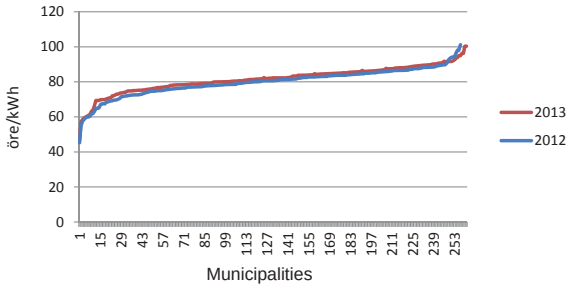
- **Energy tax**
- **Carbon dioxide tax**
- **Electricity tax**
- **Emission allowance trading**
- **Electricity certification systems**
- **NO_x fees**
- **Building standards**
- **ROT tax deduction**
- **Energy declarations**
- **Technology procurement**

Besides these policy instruments there are regulations that also influences the cost of different energy carriers. One example is the possibility to avoid electricity tax by using own electricity generation (e.g. from wind power) for own use (e.g. heating with heat pumps). There are also a variety of political targets and commitments that are likely to influence the future design of policy instruments. Examples are the EU's energy efficiency directive and the national environment targets, e.g. in the areas "good settlements" and "limited climate impact". Especially on EU level, large changes of policy instruments can be expected if the long term energy and climate political targets shall be reached.

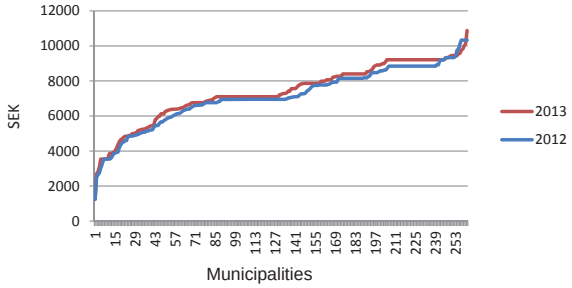
cogeneration, the rising prices of electricity have the opposite effect. The value of the electricity generation in the cogeneration plant is increased, which in turn improves the company's revenues, and thereby they can offer a lower price of heat. In most cases the latter of these two effects is dominating.

Meanwhile, there are other factors with an impact on the price of district heating, e.g. the fixed costs and how big the district heating delivery to distribute these fixed costs on, is. These factors vary considerably between the scenarios and this illustrates the uncertainty when it comes to future prices of district heating.

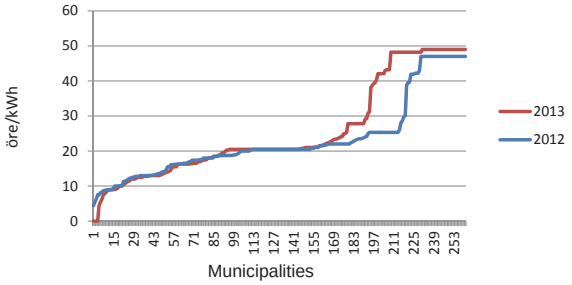
Moreover, for district heating and electricity there are also large local variations. For district heating these can be related to, for instance, production mix, the dimension of the system, heat density, age, and local opportunities for the utilisation of industrial waste heat. For electricity, it is mainly the price of the electricity grids that varies. Typically, the price of grids is lower in denser settlements and higher in sparsely populated areas. Variations in prices can also be seen between the four electricity price regions. Also, the electricity tax differs between Northern and Southern Sweden. The three figures to the right illustrates the variance among the Swedish municipalities of the price of district heating, fixed price for grid and variable cost for grid, for a multi-family house with a heating consumption of 193 MWh/year.



Prices of district heating in Swedish municipalities



Prices of electricity distribution, fixed costs, in Swedish municipalities



Prices of electricity distribution, variable costs, in Swedish municipalities

Several factors are influencing the competition

The competition on the heating market is also significantly influenced by different national policy instruments, for example, energy and carbon dioxide taxes, electricity tax, building standards, etc. Then, there are a large number of "market initiatives" with an impact on the heating market. Examples of these are building certification systems, *Nils Holgersson – en avgiftsstudie* (*"Nils Holgersson - a study in fees"*), the heating market committee, environmental classification of energy, The "Skåne" initiative, as well as real estate companies with their own energy efficiency objectives.

The heating market is linked to other markets

The heating market has strong and distinct connections to other markets - direct and indirect - which bring opportunities for development, but also restrictions. District heating in particular has many such connections to, for instance, electricity, waste, industrial waste heat and biomass resources.

The electricity market is, in many ways, influenced by the development on the heating market. Heating is in a large part of the building stock, particularly in single-family houses, based on electricity. This can be pure electric heating (waterborne and direct acting electrical heating) or different electricity-powered heat pumps. Generally, the electricity demands for heating of the building stock will peak simultaneously, resulting in challenges for the electricity supply during cold winter days.

The largest heating alternative, district heating, is impacting the electricity market in at least two ways. Electricity is used in the production of district heating and electricity is produced in the district heating systems' cogeneration plants. The electricity production in the cogeneration plants has its maximum when the load on the electricity system and the electricity prices peak.

The largest waste management alternative in Sweden is incineration. An important factor for *waste incineration* is the possibility to recover energy. This is primarily attained through heat delivery to the district heating systems but also through electricity generation.

Many *industrial processes* have a generation of waste heat as a by-product. District heating offers a means of exploiting this resource, which would otherwise be wasted.

Biomass has several links to the heating market. Firewood and pellets are used as fuels in heating boilers in the buildings. Biomass is also the predominant fuel in the Swedish district heating production. The forestry industry is competing for parts of the biomass used by the heating market, whereas other parts can be seen as residues with no other areas of application. In the future we might see competition for biomass from biofuel production and from the industry using biomass as raw material for other products than sawn timber and pulp.

The link between the heating and the *district cooling markets* is yet another example. In many premises there is a large demand for heating as well as for cooling. This is of importance to heat pumps and might strengthen their competitiveness, but district cooling can also be an alternative. The demand for comfort is increasing even in dwellings and cooling is becoming more common, especially in single-family houses.

The heating market is also linked to other markets that are not specifically energy related, e.g. *IT, property development and consultant markets*.

Thirteen challenges and future scenarios for the heating market

In this chapter are described a number of challenges facing the heating market. Some of these are rather expressed as future scenarios and for them the challenges are of a more indirect nature, i.e. how can these scenarios be realised as real development?

1

The heating market should have a more central role in politics and planning, in Sweden and in the EU. Today there is no consensus on the status or development of the heating market, neither in Swedish, nor in European politics. There is a lack of knowledge and interest in the heating market and, as a consequence, it is often neglected. Its development is to a large extent ruled by objectives and policy instruments with the focus on other markets, e.g. the electricity market, and in other EU countries also the gas market. Therefore it is a great and important challenge to place the heating market high on the political agenda, in Sweden as well as in the EU.

2

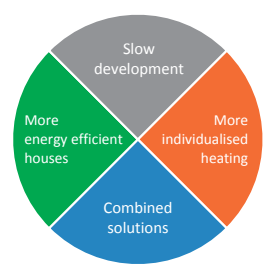
Taxes, fees, building standards, and other regulatory frameworks have a large impact on the choice of heating system, and on the trade-off between energy efficiency efforts and energy supply.

2 *(cont.)*

The market asks for stable conditions, but at the same time, regulations and instruments must be evaluated against the objectives of resource efficiency and environmental impact that are governing the development towards a sustainable energy system. Insight in the specific conditions for the heating market is crucial for an effective design of policy instruments. Analysis of how current and coming regulatory systems and instruments are influencing the future heating market is a constant challenge for the actors on the heating market. An example of a topical policy instrument is the building standard framework issued by Boverket (the Swedish National Board of Housing, Building and Planning), that stipulates the requirements on the buildings' energy performance. There can be found discussions about levels, principles (use or buy energy) and differentiation between electricity based energy and other means of heating.

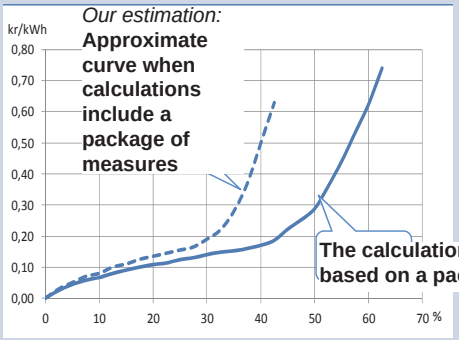
3

Which direction of development will become predominant? Energy efficient houses, more individualised heating technologies, or increasing exchange of energy in combined systems ? Our scenarios have these main directions as starting points and the outcome is widely different, especially in the long run. Which direction the development will take is far from obvious. Customer expectations, technology development, policy instrument design, and price development are examples of influencing factors. It is also apparent that different heating alternatives and technical solutions will have a dramatically different development in the different scenarios. As an example, the district heating's market share varies between 36 and 56 % by 2050, while total delivered energy (all types of energy) varies between 49 – 76 TWh the same year. The different main development paths will result in different consequences for the heating market, and depending on what is prioritised, the development will take different directions. If the government, and the EU, want to push for a development in a certain direction, there are several effective policy instruments at hand to support such a development. Since transformation of the heating market is a slow and costly process, long-sightedness is of uttermost importance. For the market it is essential to know where we collectively are aiming at.

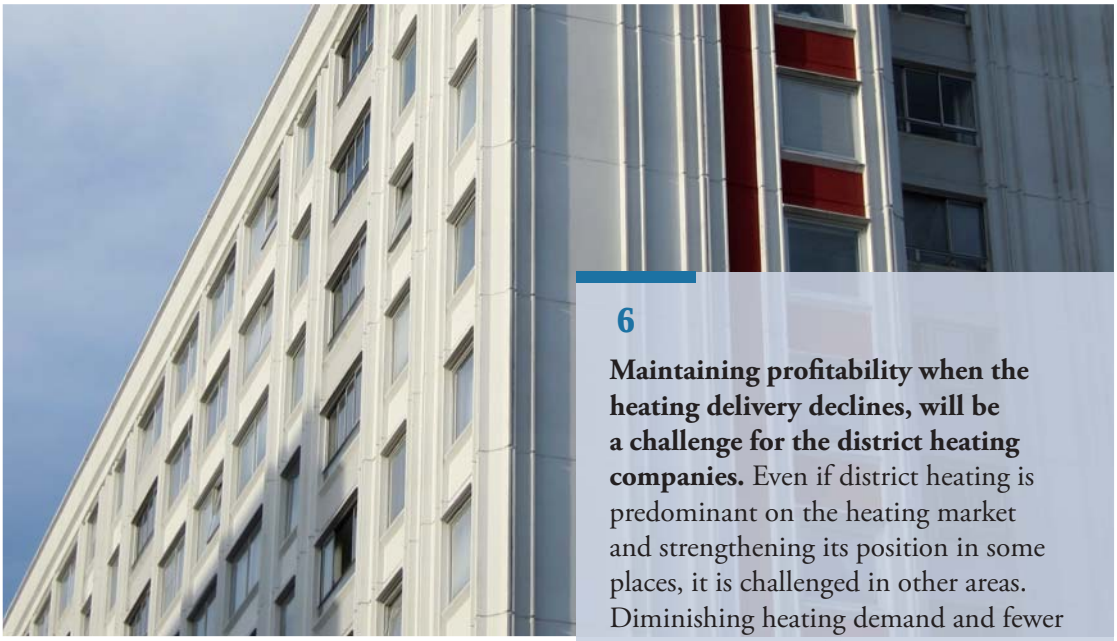


4

Efficient usage of energy – great opportunities, but difficult to implement. How much will the heating demand on the market decrease? Will it decrease at all? Will the improved energy efficiency of existing buildings really be realised? What are the real costs for the efficiency improvements, and which factors will influence the implementation? Many of the measures are simple and can be realised without heavy investments, but they are still only implemented at a limited scale. The more extensive actions are guided by the building's investment cycles, and are triggered when buildings are renovated or rebuilt. There are many questions regarding the development of energy efficiency. In summary, we can state that there is a huge potential but the implementation is challenging. The magnitude of the effort will have a very strong influence on the future heating demand.



Cost in SEK (excl. VAT) per saved kWh for all commercial and official buildings, as a function of the degree of energy efficiency improvement. (The diagram is taken from the background report "Framtida värmeanvändning i Sverige", only available in Swedish)



5

The renovation and the improvement of energy efficiency in "The Million Programme" is a huge challenge. Even if the houses from the million programme era (built 1965 -1974) do not show especially large energy demands, they are still in a great need for further actions. They are today 40 – 50 years old, and many of them have not been properly maintained. But, implementing major energy efficiency improvements in these areas with a limited solvency and high demand for return on investment is a very large challenge. (It should be said that about 30 % of the million programme have already been thoroughly renovated, and parts of it consist of single-family houses).

6

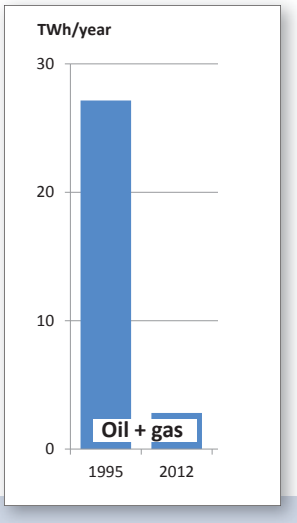
Maintaining profitability when the heating delivery declines, will be a challenge for the district heating companies. Even if district heating is predominant on the heating market and strengthening its position in some places, it is challenged in other areas. Diminishing heating demand and fewer opportunities to add new connections, might cause problems for some companies in keeping competitiveness, since they as investment-heavy actors have a large proportion of fixed costs. These companies are particularly exposed at large and rapid decrements in demand, e.g. when many property owners implement extensive energy efficiency measures, or are changing means of heating. As always when discussing the conditions for district heating, it is important to remember that these conditions vary a lot between different systems. Even if district heating is developing positively on average, there will be some district heating systems phasing problems, while others will develop perfectly well. The companies are aware of the challenges and they are making great efforts to adapt and develop their businesses. The very large variance in the long run in district heating delivery seen in our scenario analysis indicates how difficult the future is to predict.

7

The market for heat pumps is changing. At the same time as the market share of heat pumps in single-family houses increases, a shift from a conversion-market to an exchange-market can be observed. Large scale heat pump installations in multi-family houses might still be a growing market, but the magnitude of this is uncertain. The efficiency of heat pumps is increasing. How far it will reach is influenced by the price of energy, and the properties of the buildings, where the possibility to use lower system temperatures is important. Another factor of importance for the future competitiveness of heat pumps is the development of the cooling demand, especially if it in the long term will be called for even in dwellings. If the demand is raised, the competitiveness of heat pumps will likely be improved. A development path with consequences for heat pumps harder to predict is the one described in the scenario "Combined solutions". There, combinations of e.g. heat pumps, solar energy and district heating might become common. Then, heat pumps will work both as a local heat producer in the building and occasionally as a source of heat for the district heating system.

8

Large heating customers are asking for integrated solutions, supporting their businesses. Producing and delivering energy is no longer enough. Suppliers are now more often expected to understand the customers' driving forces and ambitions. This can only be achieved through customer-intimate collaborations. Single-family house owners are also becoming more interested in their energy consumption. Customer influence, local production, net billing, control/load balancing and smart grids create an environment with interesting possibilities. A weak interest for energy issues from some customers is working in the opposite direction.



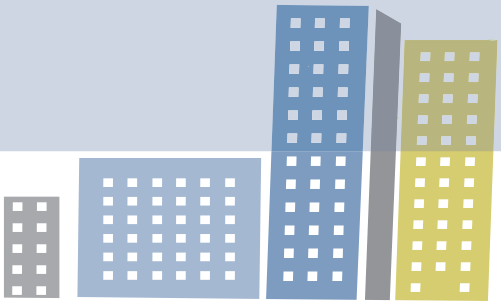
Direct use of fossil fuels on the Swedish heating market

9

When electricity and district heating production become free from fossil fuels, heating will be fully fossil fuel free - how can we get there? As already mentioned, the direct use of fossil fuels has more or less ceased. The indirect use in electricity and district heating production is also small and continues to decline. This is driven forward by cost reduction ambitions (fuel prices and policy instruments) and by customers' demand for environmentally friendly and resource efficient production. Electricity based heating is influenced partly by what is happening outside Sweden's borders. The ambition of the European electricity generation sector is to be carbon dioxide neutral by 2050.

10

The sustainable city.
The actors on the heating market expand their collaboration with municipalities and cities. Common infrastructure solutions and sustainability certifications of buildings and boroughs will influence the agenda for the heating and energy systems. But, it is important for the heating actors to safe-guard the resource efficiency on the market. Today we can see examples where certifications and sustainability ambitions have the desired effect – improved energy efficiency – but also cases where they have led to inadequate sub-optimisations.



11

In the long term, the heating market might turn into an energy market.
Combined systems and stagnating heating delivery shift focus from heat delivery to energy solutions. The heating market develops to becoming an important part of an integrated energy market. It might mean that the customers and the energy companies integrate their systems. "Open district heating" is a first step, where the heating market moves from a one-way buyer/supplier-relation to a marketplace with a bi-directional trade. It can also relate to load balancing that influences how the customers' equipment is run. New products are created. There is a shift from being product-oriented to a complex energy solution approach.

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The actors on the heating market can expect new collaborations.
The heating market is now a mature market, which indicates that we will see new collaborations, also between parties that are competitors today. At the same time, a new energy landscape is emerging. New actors, renewables and small scale electricity production, demands for new solutions for improved energy efficiency, and proactive customers, are all trends that rapidly are changing the conditions on the heating market. All this means that the actors on the market must change their thinking to stay one step ahead, and to create new business opportunities.

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The heating market will also be influenced by information and communication technologies (ICT), and by smart grids.
The heating market will also be influenced by information and communication technologies (ICT), and by smart grids. The development is fast, with new technologies for measurement, storage, visualisation and analysis of energy data, to help the customer in using the energy as smart as possible. Individual measurement of heat consumption is, if cost-effective, stipulated by EU directives. Eventually, it is likely to be a digital unit in every apartment, controlling the energy use, also heating. It will become more complex to be a heating or energy actor.

These thirteen challenges and future scenarios show that the opportunities as well as the uncertainties regarding the future development of the heating market are huge, and some of the development directions might bring large consequences for the actors on the market. Since new constructions and renovations, as well as the heating supply, are examples of inert and capital-intensive activities, it is important to try to reduce the uncertainty about the future. Uncertainties cannot, of course, be totally eliminated. But, by – as we have made in this first stage of the project – making an integrated description and analysis of the heating market, and by having a deep discussion with the actors on the market involved, it is possible to accomplish a higher level of understanding and consensus regarding the future development. It is therefore our hope that this analysis and discussion will go on, thereby contributing to *c*reating the conditions for a continued efficient and resource lean development.

Summary

The heating market in Sweden

- an overall view

The Swedish heating market is one of our largest energy markets. The turn-over is 100 billion SEK and 100 TWh per year. The demand for heating and hot tap-water represents a fourth of the total Swedish energy consumption.

The heating market has developed very positively the last 40 years. Today it is energy and resource efficient and characterised by a low emission of greenhouse gases and other substances with environmental or health-related hazardous effects. Since the 70s we have had a trend with a shift over to renewable and recovered energy. A major part of the heat produced for the Swedish heating market today is sustainable from an environmental and energy perspective, at the same time as the heating's share of the housing costs continues to be low. This is important for creating sustainability in the housing and the service sector, as well as for a sustainable and long term competitive industry.

Still, the heating market and its actors are facing several great challenges; demanding efficiency targets, increased competition between heating alternatives, internationalisation of politics and fuel markets and demands for new regulations, to mention a few. Sweden is lacking a cohesive strategy for meeting these challenges.

The project The heating market in Sweden is a multi-disciplinary research project, which in its first phase has been run 2013 – 2014. The aim of the project is to give a collected view of the Swedish heating market and its development. The project has engaged a large number of the actors on the heating market; heat users, heat producers, energy and installation suppliers, branch organisation and authorities.

This report summarises the project's analyses and results from the first phase.

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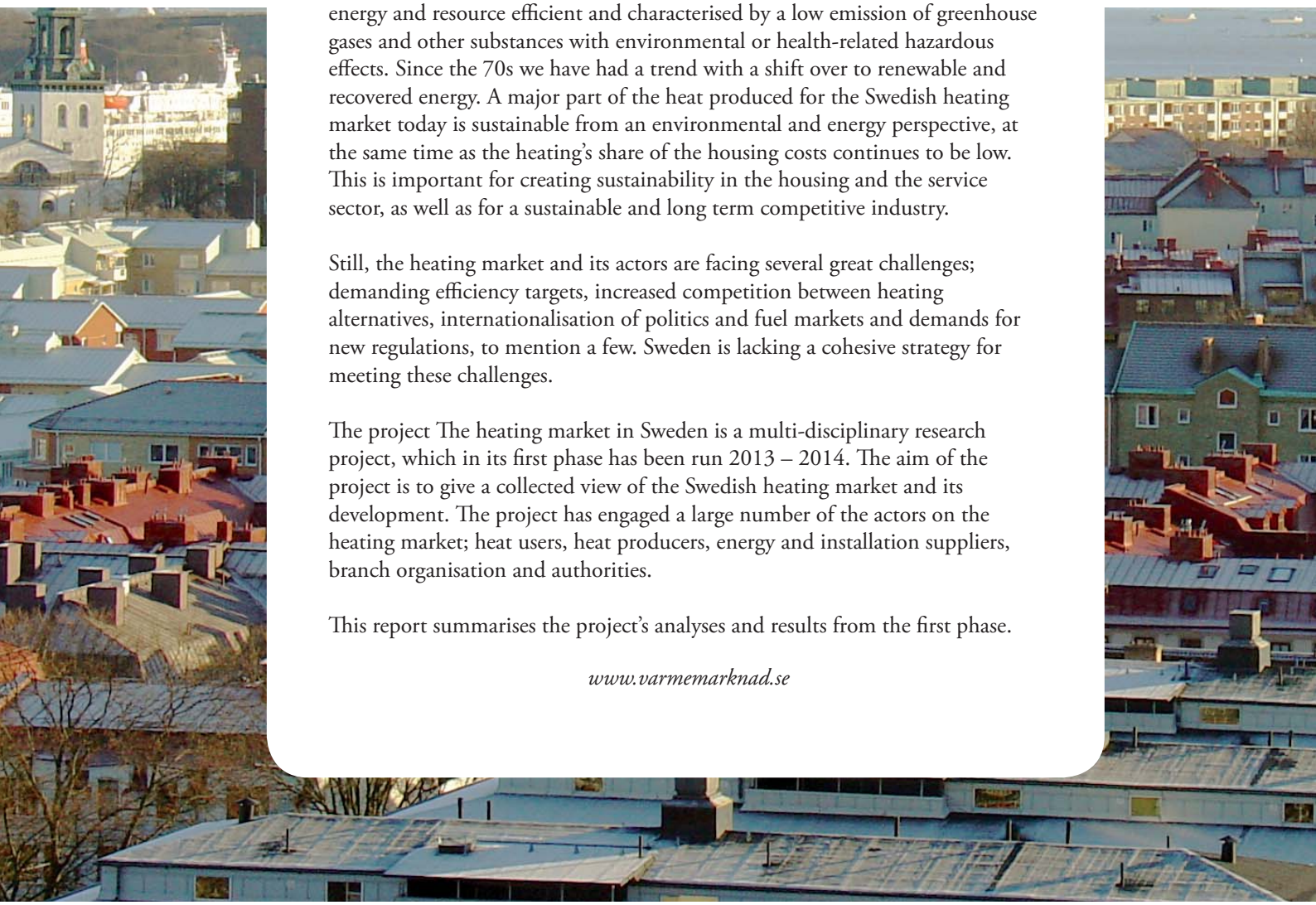

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