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Sweden's Fourth National Energy Efficiency Action Plan

Summary

This Fourth National Energy Efficiency Action Plan is a follow-up to the third action plan from 2014. The calculations in accordance with the reporting requirements set out in the Energy Services Directive (2006/32/EC) show that Sweden meets the target of an increase in energy efficiency corresponding to 9 per cent by 2016 by a very comfortable margin. This action plan shows that the target has been met by 157 per cent, which is slightly more than in the previous action plan. Data and calculation methods for these calculations are presented both in the body of the text and in separate annexes. However, the results of this and previous action plans are not fully comparable because, *inter alia*, some statistical methods have been changed over the years.

From the detailed description of measures in the context of the individual Articles of the Energy Efficiency Directive (2012/27/EU), it is clear that the requirements of the Directive have been met in all essential respects.

This action plan also describes a number of other Swedish energy efficiency instruments that did not come about as a result of the Energy Efficiency Directive or any other Directive at EU level. This action plan thus helps create a comprehensive view of the energy efficiency work being carried out in Sweden.

Particular attention has been paid to compliance with Article 7 of the Energy Efficiency Directive. Instead of introducing so-called "white certificates", Sweden instead chose to calculate the total effect of all instruments by estimating the impact of the difference between the EU's minimum level of tax in respect of energy and value added tax and the higher Swedish taxes on energy and carbon dioxide, as well as the differences between the EU's minimum levels of value added tax and the higher Swedish value added tax on energy. In the detailed calculations presented in this action plan, the model that Sweden reported to the European Commission in December 2013 has been simplified somewhat for the sake of transparency and has undergone certain other changes. The procedure for this is described in the body of the text as well as in Annex 3. The calculations show that Sweden will achieve energy efficiency improvements of 111 TWh (cumulative) as opposed to the target of 106 TWh (cumulative) by 2020.

Contents

1 Introduction

1.1 Background

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency (henceforth referred to as the "Energy Efficiency Directive" and abbreviated to "EED") was implemented in Sweden in 2014. This Directive largely replaces Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services (hereinafter referred to as the "Energy Services Directive" and abbreviated to "ESD"). In accordance with Article 24(2), each Member State must submit a National Energy Efficiency Action Plan[1] in April 2014 and every three years thereafter.

This action plan will include substantial measures to improve energy efficiency and expected and/or achieved energy savings, including the transformation, transmission and distribution sectors, as well as end-use in order to meet the national energy efficiency targets established under Article 3(1) EED. The action plan will also include estimated total use of primary energy by 2020 as well as the level of use of primary energy in the industrial, transport, household and services sectors.

This action plan also presents in detail the development of the effects of energy and carbon taxes on energy efficiency. This is because Sweden complies with the requirements of Article 7 EED through calculations of the effects of the taxes.

Sweden's first preliminary national action plan[2] was submitted to the European Commission in March 2008. In that plan, the energy savings targets were calculated as 23.3 TWh for 2010 and 32.2 TWh for 2016. It was considered that completed or ongoing efficiency initiatives would contribute to an increase in efficiency of 21.5 TWh by 2010 and 27.0 TWh by 2016. In the Energy Efficiency Study,[3] the results were also calculated in terms of primary energy consumption and the conclusion (using that calculation method) showed that Sweden met the targets set out in the Energy Services Directive.[4] However,

[1] This action plan is referred to in the Energy Efficiency Directive as the first action plan, since it is the first action plan to be produced pursuant to the said Directive. However, in the investigation/report, this action plan will be referred to as the fourth plan in order to avoid confusion with the very first Energy Efficiency Action Plan that was submitted to the European Commission in 2008.

[2] The first action plan corresponds to Chapter 11 of Government Bill 2008/09: 163*En sammanhållen energi- och klimatpolitik: Energi [A Coherent Energy and Climate Policy]: Energy* with supporting data from the Energy Efficiency Study.

[3] On 14 June 2006, the Government appointed a special investigator with the task of proposing how the Energy Services Directive should be **implemented** in Sweden. The task also included developing weighting factors and a proposal for Sweden's first action plan. The Energy Efficiency Study consisted of a special investigator and experts to assist the special investigator.

[4] 2006/32/EC

it was pointed out in the study that there was reason to continue the work to increase efficiency and be more ambitious.

In the second national action plan (2011), the targets were recalculated and then amounted to 24 TWh by 2010 and 33.2 TWh by 2016. The values differ because more initiatives were included, other calculation methods were used, and the calculations included other time periods and lifespans for measures. It is therefore inappropriate to directly compare the results of the two action plans. The second action plan showed that Sweden meets the targets for savings by a comfortable margin. Mainly by applying the calculation methods recommended by the European Commission at that time, the savings were calculated at 33.1 TWh end-use energy by 2010 and 53.8 TWh by 2016.

In the third action plan from April 2014, the savings were calculated at 34.3 by 2011 and 48.7 TWh by 2016 as opposed to the target of 33.2 TWh by 2016. The reason for the difference in the final result for 2016 between the second and third action plans is essentially a question of changes in the calculation methods that followed the European Commission template from 2013. The template in question has also been applied to the calculations in this report.

1.2 Method

The EU Commission produced a template[5] and accompanying guidance for the national energy efficiency action plans, whose structure the report follows, in 2013. The requirements of the template are set out at the beginning of each section in a text box. In addition, the text also corresponds to points contained in the guidance.

The methods applied in the third action plan, which the EU Commission recommended at the time of the reports for the ***second*** Energy Efficiency Action Plan (2011) are mainly used for monitoring the ESD target (see section 2.1). However, the bottom-up methods the Commission recommended for housing and services and which are used in the second action plan are designed so as to be based on statistics at building level. Because there are no statistics at that level, existing statistics are supplemented with estimates and assumptions. For that reason, the third action plan and, consequently, this fourth action plan contain deviations from this method. When calculations are carried out top-down it means that the effect of all actions on the market are included, even those that do not derive from any instrument. Structural effects and cyclical effects, for example, are also included. That is one of the reasons why the results of the calculations will only be used for the purpose of monitoring the ESD target and not, for example, for monitoring individual instruments.

[5] Commission Staff Working Document, Guidance for National Energy Efficiency Action Plans, SWD (2013) 180, final

2 Energy efficiency targets

2.1 National energy efficiency targets

(1) State the national energy efficiency guide target for 2020 as required by Article 3(1) in the Energy Efficiency Directive *(Directive 2012/27/EU Article 3(1) and Annex XIV, part 2, section* 1).

(2) Please indicate the expected impact of the target on overall primary and final energy consumption in 2020 and explain how, and on the basis of which data, this has been calculated *(EED Article 3(1)).*

(3) Please provide an estimate of primary energy consumption in 2020, overall and by sectors *(EED Article 24(2), Annex XIV Part 2.*2).

In 2009, the Riksdag adopted a target of 20 per cent energy efficiency by 2020. The target is expressed as a sector-wide target for reducing energy intensity by 20 per cent between 2008 and 2020, i.e. the energy supplied per unit of GDP in fixed prices must be reduced by 20 per cent.

The Swedish target was expressed in Wh/SEK at 2009 monetary values. Since the European Commission changed its instructions as to how to report GDP, the time series for calculating this target must be backwards adjusted to enable a uniform series to be obtained. This means that Sweden adjusted its value for the base year of 2008 from 164 to 156 Wh/SEK, so the target becomes 125 Wh/SEK instead of the previously specified 131Wh/SEK by 2020. In 2014, the energy intensity had decreased by 9.6 per cent compared to 2008. [6] In 2015, the energy intensity is considered to have decreased by almost 18 per cent compared to 2008. It is expected that the target for 2020 will be achieved by some margin, largely due to decisions by the nuclear industry to close four nuclear power reactors by 2020.

In November 2016, the governing parties (*Socialdemokraterna* [the Social Democrats], *Miljöpartiet de Gröna* [the Green Party]) and *Moderaterna* [the Moderate Party], *Centerpartiet* [the Centre Party] and *Kristdemokraterna* [the Christian Democrats] entered into an agreement that, by 2030, Sweden would reduce energy intensity (i.e., primary energy consumption per unit of GDP) by 50 per cent compared to 2005.

In addition to this, the target in Directive 2006/32/EC on energy end-use efficiency and energy services (hereinafter referred to as the "Energy Services Directive" or "ESD") continues to apply.[7] In accordance with the requirements, the Member States must set an indicative target of savings of at least 9 per cent of average annual end-use of energy in 2001–2005 by 2016. The average final energy consumption does not include consumption for foreign transports or fossil fuels included in the EU emissions trading system (EU ETS). Use of electricity, heating and biofuels in facilities covered by the ETS is nevertheless

[6] Energy Indicators ER 2016:10
[7] Article 4 (paragraphs 1–4) and Annexes I, III and IV.

included. It is clear from this report that the target is expected to be met by 157 per cent, i.e. the target is met by a very comfortable margin.

The difference between energy supplied and end-use energy consists of transformation and distribution losses and use for foreign transports and non-energy related purposes (which in this case is already deducted). There is no constant connection between end-use and energy supplied (primary energy consumption). However, there is a link between final energy consumption and energy supplied adjusted for losses in nuclear power. The relationship between them is as good as constant[8], see connection (1). Nuclear power production and, subsequently, its losses, are considered to be independent of growth rates and final energy consumption.

$$(1) \quad \frac{\textit{Final energy consumption}}{\textit{Primary energy consumption} - \textit{nuclear power losses}} = 0.90$$

The mean value[9] for losses in nuclear power has been 131 TWh in recent decades.

Table 1 shows estimated energy consumption by 2020 according to the *Energimyndigheten* [Swedish Energy Agency] long-term scenarios in 2014.[10] Table 2 shows how large the energy consumption theoretically becomes in the user sectors (industry, transport, housing and services) if the energy supplied for electricity and district heating production is distributed proportionally. The total for the sectors will not be as large as the total domestic energy consumption in the table. The reason is that losses due to electricity exports and various transformations (e.g. in refineries) cannot be distributed to the end-users since there is no direct link to them.

[8] Standard deviation = 0.0086
[9] Mean value for the 1986–2011 period.
[10] The Swedish Energy Agency, Scenarios relating to the Swedish energy system - 2014 long-term scenarios, supporting data for the climate reports, ER2014:19

Table 1. Supply and consumption of energy in 2020 according to the Swedish Energy Agency's scenarios relating to the Swedish energy system in 2014, reference case [TWh][11]

Estimated energy consumption in 2020	*Unit (TWh)*
Total domestic energy consumption (excluding non-energy related) 2020	554
Input for conversion to electricity generation (thermal)	0 (214*)
Electricity generation (thermal)	0 (73*)
Input for transformation in cogeneration plants	61
Combined power and heat production (district heating)	38
Combined power and heat production (electricity)	23
Distribution losses (all energy carriers)	16
Total final energy consumption	376
Final energy consumption – industry	147
Final energy consumption – transport	82
Final energy consumption – housing and services	147

* Excluding cogeneration of heat and electricity. Figures in brackets refer to the supplied fuel and production for nuclear power. Note that this data derives from the Swedish Energy Agency's long-term scenarios from 2014. Since then, decisions have been made to close reactors by 2020. Nuclear power production, nuclear fuel supplied and total energy input is therefore presumed to be lower.

Table 2. Energy consumption in 2020 according to long-term scenarios in 2014 [TWh] where energy supplied for electricity and district heating production is allocated to the end-users [TWh]

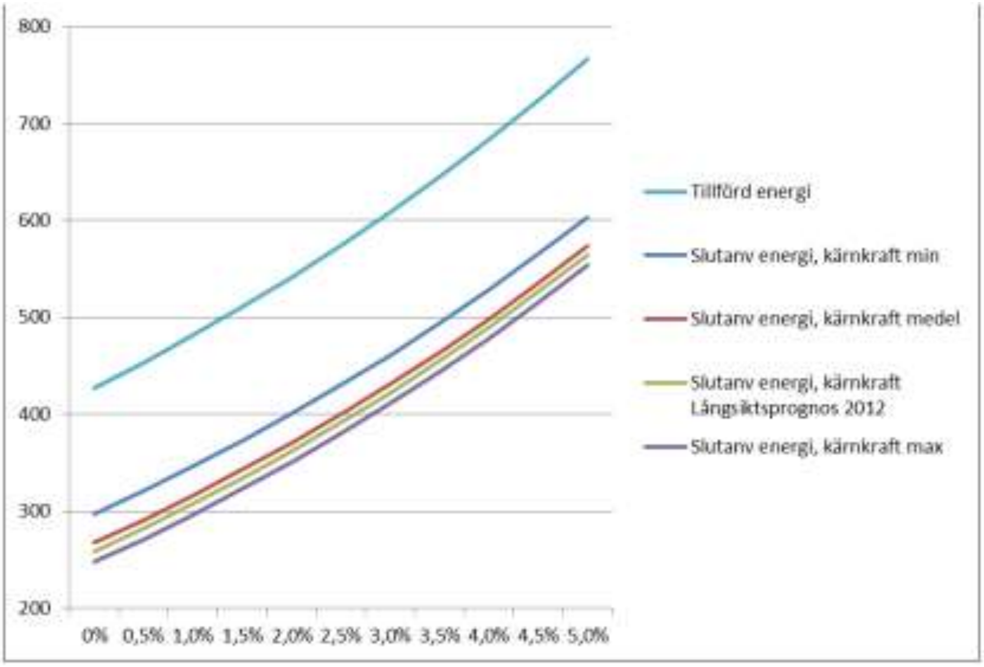
Total domestic energy consumption (excluding non-energy related)	**554**
Industry	192
Transport	85
Housing and services	212
Total industry, transport, housing and services	489*

* Note that the total domestic energy consumption will not be as great as the total "primary energy consumption". The reason is electricity exports and various transformations (e.g. in refineries) that cannot be distributed to the end-users since there is no direct link to them.

Figure 1 shows the amount of energy supplied and end-use energy by 2020 in the case of fulfilment of the intensity target at different growth rates.

[11] ER 2014:19

Figure 1. Energy supplied and end-use energy by 2020 in the case of fulfilment of the intensity target [TWh]



Key:
Tillförd energi = Added energy
Slutanv energi, kärnkraft min = End-use energy, nuclear power min.
Slutan energi, kärnkraft medel = End-use energy, nuclear power average
Slutanv energi, kärnkraft Långsiktsprognos = End-use energy, nuclear power Long-term forecast
Slutanv energi, kärnkraft max = End-use energy, nuclear power max.

2.2 Other energy efficiency targets

Please list any additional national targets related to energy efficiency, whether addressing the whole economy or specific sectors *(EED Annex XIV Part 2.1).*

Sweden has a vision that by 2030 it will replace its entire fleet of vehicles – all cars, buses, goods vehicles and work machinery – so that the fleet of vehicles is independent of fossil fuels. In 2015, 14.7 per cent of the fuels used were renewable.[12] Exactly how the concept of "vision of a fossil-free vehicle fleet" is to be understood is not unequivocally defined. For the present (November 2016), the Swedish Energy Agency is coordinating cross-authority cooperation for conversion to a fossil-free vehicle fleet.

[12] ES 2016:03

3 Results of calculations

3.1 Savings in end-use energy in accordance with the ESD

(1) For the purposes of Directive 2006/32/EC of the European Parliament and of the Council (1), in the first and the second NEEAP, please provide information on the achieved final energy savings and forecast savings in energy end-use by 2016 *(Article 4(1) and (2) of Directive 2006/32/EC; EED Annex XIV Part 2.2(b))*.

(2) For the purposes of Directive 2006/32/EC, in the first and the second NEEAP, please provide the measurement and/or calculation methodology used for calculating final energy savings *(EED Annex XIV Part 2.2(b), second paragraph).*

The methods recommended by the EU Commission at the time of reporting the second NEEAP (2011), which were also applied in the third NEEAP (2014), were mainly used to monitor the ESD target (see section 2.1). However, for the housing and services sector, the Swedish Energy Agency, just as in the third action plan, chose to change from bottom-up to top-down methods, in line with the other sectors. This enables better sector comparability while facilitating comparison with the overall EU target. The use of top-down methods means that calculations are carried out from a top-down perspective and that savings are calculated at sector or sub-sector level. Bottom-up methods mean that efficiency measures have been calculated from a bottom-up perspective. That means that savings due to measures are calculated separately and the total saving corresponds to the sum of all the calculations. The effect of all measures in the market is included in top-down, including measures that do not derive from any particular instrument. Structural effects[13] and cyclical effects, for example, are also included.

Because of this and the fact that the results are highly dependent on the assumptions and methods used, the figures should only be used for monitoring the 9 per cent target in accordance with the ESD.

The Directive distinguishes between so-called early and late efficiency initiatives. Early efficiency initiatives means initiatives implemented in 1995–2007, whereas late

[13] For these purposes, structural effects include, in industry for example, changes that do not involve modifications of the production process or similar, but which involve an improvement in efficiency according to the calculation method. This can, for example, consist of a change in product composition within an industry or a low energy intensity sector growing faster than a high energy intensity sector.

initiatives means initiatives implemented after 2007. Calculations have therefore been carried out with that division into early and late initiatives.

The results of the calculations and achievement of targets are shown in Table 3.

Table 3. Results of calculations for all sectors and achievement of targets.

	2014 (TWh)	**2016 (TWh)**
Housing and services - early initiatives	9.8	9.8
Housing and services - late initiatives	15.8	16.7
Industry - early initiatives		
Industry - late initiatives	5.8	11.7
Transport - early initiatives	1.4	1.4
Transport - late initiatives	10.4	12.6
Total	43.2	52.2
Targets	**-**	**33.2**
Achievement of targets		**157.2%**

Deficiencies in the methods
The top-down methods recommended by the Commission are designed in such a way that the activity in the end year – 2016 – is of great significance for the final saving. If use becomes more efficient during the period, the savings will be greater the higher the level of activity in 2016. For example, assuming that the vehicles of the future consume less than current vehicles, the savings for the period will be higher, the higher the level of transport activity in the future. The same applies to industry, where the savings are partly dependent on the size of the added value in the end year. It may therefore be more interesting to monitor the progress of the indicators than to study only the final savings. It is also difficult to exclude effects that are due to structural effects, trends and possible changes of fuel, which means that such effects are also included in the results.

The forecasts for 2016 depend on the assumptions made regarding economic developments, taxes and prices, etc. This means that the uncertainty and the likelihood that the actual outcome will differ from the forecast is relatively high.

The Swedish Energy Agency's scenarios relating to Sweden's energy system (a development of the previous *Långsiktsprognoserna* [Long-Term Forecasts]) are scenario analyses with a time perspective of 10–20 years that aim to describe the future development of the energy system, given a number of assumptions. Part of the difference compared to the 2014 action plan is thus due to the fact that it is now based on a scenario rather than a forecast. One further aspect is that there is less scope for major changes up to 2016 for each action plan because the target is closer in time.

3.1.1 Results of calculations for housing and services

The housing and services sectors include housing, holiday homes, private and public premises (excluding industrial premises), land-based industries and other services. No calculations have been carried out in this action plan for other parts of the housing and services sector, for example land-based industries. The lack of reliable and sufficiently detailed data makes it difficult to carry out calculations that meet the Commission's requirements. The sub-sectors that are not covered only account for around 10 per cent of total energy consumption in the sector.

In the first two action plans it was not possible to carry out *top down* calculations for housing and services. However, that possibility did exist for the third action plan and continues in this fourth action plan. Different calculation methods mean that the results differ slightly from those of previous action plans.

The total savings for housing and services amount to 25.6 TWh by 2014 and 26.6 TWh by 2016. In the previous action plan, the savings by 2016 amounted to 22.8 and in the action plan before that, the savings amounted to 24.5 TWh. The difference of 2.8 TWh between this and the previous action plan is mainly due to the fact that the statistics for the total area for non-residential premises and housing vary to some extent, which is reflected in the savings, particularly for the service sector. Early initiatives amount to a total of 9.8 TWh by both 2014 and 2016. Late initiatives are expected to give a saving of 15.8 by 2014 and 16.7 TWh by 2016.

There are two main explanations for why savings in temperature-adjusted energy consumption have occurred for heating and hot water in households. The first is that the purchased energy reported in the statistics decreased because the use of heat pumps increased. The second is that rising energy prices during the 1990s was a contributory factor in the adoption of measures to reduce energy consumption by a large number of households.

Table 4. Results of calculations for housing and services.

	2014 (TWh)	2016 (TWh)
Early initiatives		
Energy consumption for heating in households per square metre (P1)	5.5	5.5
Energy consumption for hot water in households per inhabitant (P1)	4.3	4.3
Total early initiatives	**9.8**	**9.8**
Late initiatives		
Energy consumption for heating in households per square metre (P1)	5.4	5.4
Energy consumption for hot water in households per inhabitant (P1)	1.1	1.1
Electricity consumption per type of appliance (kWh/year) (P4)	1.5	2.1
Electricity consumption for lighting per household (P5)	1.0	1.3
Energy consumption in the service sector (not electricity) in each sub-sector per square metre (P6)	2.5	2.5
Energy consumption in the service sector (only electricity) in each sub-sector per square metre (P7)	4.4	4.4
Total late initiatives	**15.8**	**16.7**
Total early and late initiatives	**25.6**	**26.6**

Uncertainties

In some cases it is difficult to disaggregate statistics in the manner requested. This may mean that some sub-calculations may be unreliable. The statistics forming the basis for the calculations are based on sample surveys, which means that there will be some variations between years. For more information on the calculations, see Annex 1

3.1.2. Results of calculations for industry

The calculated saving for the industrial sector from 2007 is 5.8 TWh by 2014 and 11.7 TWh by 2016, see table 5.

Table 5. Results of calculations for the industrial sector.

	2014 (TWh)	2016 (TWh)
Late initiatives		
Energy consumption per value added (M8)	5.8	11.7
Total	**5.8**	**11.7**

Note: The number of the method used is given in brackets, see Annex 2 for more information.

The calculation up to 2014 is based on statistics. The calculation up to 2016 is based on the Swedish Energy Agency's Long-Term Scenarios, 2014.

The result of 11.7 TWh gives a higher saving up to 2016, compared to the result of 9.3 TWh in the previous action plan. The main reason for this is the differences in assumptions and methodological change in the Long-Term Forecasts in 2012 and Long-Term Scenarios in 2014.

A saving of 11.7 TWh is equivalent to approximately 7 per cent[14] of industry's energy consumption in 2007. Estimated between 2007 and 2016, this corresponds to an efficiency rate of approximately 1 per cent per year. The increase in the expected savings rate between 2007–2014 and 2014–2016 may be due, *inter alia*, to how the development in the 2011–2014 period is reflected in the scenario[15] because the largest economic growth in the scenario occurs in less energy-intensive sectors or the fact that the effects of recovery and stabilisation after the economic downturn in the form of, for example, higher investment are increasingly noticeable in 2015–2016 and the fact that 2014 saw the lowest energy consumption in industry since 2009.

The calculation includes both "technical" efficiency and structural effects.

Early initiatives

Early initiatives have not been calculated separately. Instead, initiatives that still have an effect after 2007 are included in top-down calculations for late initiatives.

[14] 9 per cent of the energy consumption covered by the ESD.

[15] The baseline year for the scenario is 2011.

Late initiatives

Late initiatives are expected to give rise to a saving of 11.7 TWh by 2016. The calculation is based largely on the Swedish Energy Agency's Long-Term Scenarios, 2014[1616] which include initiatives adopted up to 1 January 2014.

Uncertainties

Assumptions in Long-Term Scenarios, 2014 regarding aspects such as economic development, price development at energy carriers and emission allowances are uncertainties.

3.1.3. Results of calculations for transport

The calculated saving for the transport sector is 11.8 TWh by 2014 and 14.0 TWh by 2016. Of the 14.0 TWh by 2016, 1.4 TWh corresponds to early initiatives. Some calculations in the transport sector show negative savings, which means a decrease in efficiency. For example, it means that light goods vehicles[17] use more energy per tonne-kilometre in 2007 than in 1994. For more information, see Annex 1.

[16] The Swedish Energy Agency, Scenarios relating to Sweden's energy system, ER 2014:19

[17] Method P9 A2, for more information see

Table 6. Results of calculations for the transport sector.

	2014 (TWh)	2016 (TWh)
Early initiatives		
Passenger cars (P8)	1.67	1.67
Heavy goods vehicles (P9)	0.06	0.06
Light goods vehicles (P9 A2)	-0.21	-0.21
Rail (M6)	0.19	0.19
Maritime transport (M7)	-0.31	-0.31
Total early initiatives	**1.4**	**1.4**
Late initiatives		
Passenger cars (P8)	7.19	9.66
Heavy goods vehicles (P9)	3.03	2.61
Light goods vehicles (P9 A2)	0.04	0.14
Rail, passenger (P10)	-0.13	-0.10
Rail, freight (P11)	0.14	0.15
Maritime transport (M7)	0.09	0.08
Transfer of passenger transport from cars to public transport (P12)	0.16	0.10
Total late initiatives	**10.5**	**12.6**
Total early and late initiatives	**11.9**	**14.0**

Note: The number of the method used is given in brackets, see Annex 2 for more information.

Early initiatives

The saving from early initiatives has been calculated using the Commission's top-down methods. In the absence of statistics for certain modes of transport, the simpler variant of methods has been used for the sub-sectors of rail and maritime transport. The calculation for the early initiatives was carried out using an average of three years. The calculation methodology is described in more detail in Annex 1.

Late initiatives

Late initiatives are expected to give rise to a saving of 12.6 TWh by 2016.
The calculation is based mainly on the *Trafikverket* [Swedish Transport Administration] statistics for transport activity.

Uncertainties

Since energy consumption by maritime transport is irregular and highly variable, it is difficult to make reliable forecasts in this area. Similarly, the figures for road vehicle transport activity have been revised downwards, which has increased the energy efficiency of road transport by 2 TWh over the 2007–2011 period compared with the previous action plan.

The forecast results depend on assumptions regarding economic development, taxes, prices, etc. This means that the actual outcome will differ from the forecast. A number of sensitivity analyses have been carried out to illustrate how the calculated savings in 2016 are affected by changes in assumptions. These are shown in Annex 1.

3.2 Savings in primary energy

Please provide an overview of the primary energy savings achieved by the time of reporting and estimations of expected savings for 2020 *(EED Article 3(1), Article 24(2), Annex XIV Part 2.2(a))*.

Since the savings in end-use energy according to the ESD target have been calculated using top-down methods and the types of energy are not distinguishable from one another in this calculation, no savings in primary energy can be established.

3.3 Comparison with previous National Energy Efficiency Action Plans

In terms of methodology, this action plan conforms to the third action plan and the results are thus comparable. It should be emphasised, however, that the underlying statistics have been developed and changed over the past three years and, also, that the Swedish Energy Agency's forecasts have become scenarios, so a direct comparison at a detailed level is not to be recommended.

The top-down methods recommended by the Commission are designed in such a way that the activity in the end year – 2016 – is of great significance for the final saving. If consumption becomes more efficient during the period, the saving will be greater, the higher the level of activity in 2016. Assuming, for example, that the vehicles of the future consume less than current vehicles, the saving for the period will be higher, the higher the level of transport activity in the future.

The target for 2016 is 33.2 TWh. According to the second action plan, savings of 55 TWh by 2016 were forecast.

According to the third action plan, the margin was not as big in 2016, but was nevertheless significant. The saving was adjusted downwards from 55 TWh to 48.7 TWh for 2016, which means that the margin for meeting the target was adjusted from 166 per cent to 147 per cent. These differences are primarily due to revised bases for calculation, new forecasts and statistics. In this fourth action plan, savings are forecast at 52.2 TWh and the margin for meeting targets is 157 per cent.

There is therefore some variation between the forecasts for 2016 in the various action plans. However, the variations are not of any appreciable size, which indicates a certain robustness in the basis for the forecasts, not least because the data, once collected, broadly confirmed the forecasts.

The variation in the housing sector between the previous action plan and this action plan is mainly due to variations in the area statistics. A reduction in the area was obtained for 2011 and an increase was obtained in 2014 compared to 2007. This is reflected in the calculations.

In the industrial sector, savings calculated by statistics for 2007–2014 differ sharply from the scenario-based statistics for 2007–2016. According to the calculation, the saving will have almost doubled in two years. There may be several reasons for this. The base year for the scenario is 2011, so the progress in the 2011–2014 period is not fully reflected, whereas the highest growth in the scenario occurs in less energy-intensive sectors, which can mean that efficiency is overestimated in 2011–2014 compared to the actual progress. It can also be due to the fact that a higher efficiency rate can be expected at the end of the period when industry recovers and stabilises after the economic downturn and more investment takes place, etc. Also, 2014 saw the lowest energy consumption (and added value) since 2009.

In the transport sector, both the early and late savings were downgraded in the fourth action plan. This is due to the use of a new calculation method. One uncertainty factor in previous action plans consisted of the fact that the individual start and end years for the saving interval had a disproportionate impact on the end result. One illustration of this is energy consumption in goods vehicle transport in 1994, when the start year for calculation of early savings was considerably higher than in surrounding years. Both passenger and freight transport saw record high energy consumption and transport activity during the interval year of 2007, whereas 2008 was a record low year. A moving average of three years is used in all calculations in order to reduce the impact of these fluctuations. This means that all statistics in, for example, the start year of 1994 are calculated on an average of the corresponding statistics for 1993, 1994 and 1995.

Table 7. Comparison between results of calculations in the second and third action plans.

	The third action plan (2014)		The fourth action plan (2017)	
	2011 (TWh)	**2016 (TWh)**	**2014 (TWh)**	**2016 (TWh)**
Housing and services - early initiatives	10.4	10.4	9.8	9.8
Housing and services - late initiatives	6.4	12.4	15.8	16.7
Industry - early initiatives				
Industry - late initiatives	13.7	9.3	5.8	11.7
Transport - early initiatives	3.1	3.1	1.4	1.4
Transport - late initiatives	4.8	13.5	10.5	12.6
Total	**34.3**	**48.7**	**34.3**	**52.2**
Targets		**33.2**	**-**	**33.2**
Percentage achievement of targets		**147%**	**-**	**157%**

4 Instruments for implementing the Energy Efficiency Directive

4.1 Horizontal instruments

4.1.1 Article 7: Compulsory quota system or alternative instruments

Sweden informed the European Commission on 5 December 2013 that it intended to comply with the energy efficiency requirement in Article 7 by including the effect of energy and carbon taxes. These calculations are based, in the technical sense, only on taxes, but they indirectly include all other instruments for energy efficiency measures because their effect is by no means always distinguishable from that of taxes. In order to avoid double counting, Sweden has chosen not to include the estimated effects of these other instruments.

For general information on energy and carbon taxes in Sweden, see section 4.1.8.

Previously published estimates of elasticities of demand for the household and service sectors, industry, land-based industries and transport were used as a basis to enable the calculations to be carried out. These elasticities were then multiplied by the price change that followed the higher Swedish tax levels compared to the levels set out in the EU Energy Tax Directive (2003/96/EC). The saving is therefore calculated counterfactually.

The target for Sweden to be achieved by 2020 was set at 106 TWh (accumulated), which was divided into two intermediary periods (a 35 TWh improvement in efficiency achieved in 2014–2016, with the remaining 71 TWh improvement being achieved in the 2017–2020 period). The Swedish target was calculated on the basis of 1 per cent of sold energy in 2014 and 2015 and 1.25 per cent in 2016 and 2017, to amount to 1.5 per cent for the remainder of the period. This still conforms to the Directive.

Table 8 shows the calculations reported in connection with Sweden's communication the European Commission in December 2013.

Table 8. Sectoral annual efficiency improvements (cumulative) reported by Sweden in 2013.

	2014	2015	2016	2017	2018	2019	2020
Housing and services	2.2	3.4	4.5	5.5	6.5	7.3	8.1
Land-based industries	0.08	0.15	0.23	0.31	0.38	0.46	0.54
Transport	8.8	10.2	11.4	12.1	12.5	12.8	12.9
Industry	0.48	0.95	1.43	1.91	2.39	2.86	3.34
Total, cumulative in accordance with Article 7	11.6	26.2	43.9	63.7	85.6	108.8	133.9

The calculations forming the basis for the results presented above may be simplified, for the sake of clarity, into a model that shows the operators' ability to adapt. This model is based on the same econometric results described above and interprets them in terms of a long-term percentage saving and also as a short-term inertia function. These two parameters are then multiplied by the Swedish Energy Agency's forecast for energy consumption to enable the effect of the taxes to be calculated. The annual energy saving is therefore calculated as follows:

*AE (year) = long-term AE% * E (year) * inertia function (year)*

Where *long-term AE%* is the long-term percentage energy saving due to the fact that Sweden does not have the same level of taxation as the EU, *E* is the Swedish Energy Agency's forecast for Sweden's energy consumption and *the inertia function* shows a short-term inertia in the percentage by which the operators have adapted to the Swedish tax level.

The calculation method is explained in detail in Annex 3.

The total savings per year and the accumulated values up to 2020 are summarised in table 9. The effects of energy and carbon tax for industry are not taken into account in this model because there are several exceptions and the effects are considered to be very small and can therefore only be determined on a facility-by-facility basis. Instead, these calculations are replaced by an estimated annual effect of a 0.95 TWh fuel, steam and heating saving[18] from the *Programmet för Energieffektivisering* PFE [Energy Efficiency Programme][19], around two thirds of which is considered to be additional[20]. The other differences between the results from this model and the results reported previously are partly due to the fact that:

- differences in the calculation of the amount of energy sold and delivered.
- differences in the long-term percentage energy saving since petrol and diesel taxes were increased by approximately 14 per cent between 2014 and 2016 and electricity tax is increasing by 11.5 per cent from 2017
- small differences in the short-term model between the Swedish Energy Agency's simplified mathematical formula and the results from Sweden's previous reports

[18] Electricity savings are not included since they are in return for the removal of the EU minimum tax level
[19] Stenkvist och Nilsson (2009) - Process and impact evaluation of PFE - a Swedish tax rebate program for industrial energy efficiency
[20] According to survey responses from the companies

- differences between the energy consumption in the Swedish Energy Agency's forecast[21] and the energy consumption forecast previously

According to this new model, the energy saving in 2014–2020 is calculated at 111.3 TWh, which means that the target of 106 TWh is expected to be achieved (see table 9).

Table 9. Annual and cumulative energy savings based on a simplified model of the bases for calculation reported by Sweden to the EU Commission in December 2013

	Industrial - PFE fuels		Land-based industries - fuels		Housing and services - electricity		Transport - petrol and diesel		Total	
	TWh/ year	**TWh acc.**	**TWh/ year**	**TWh acc.**	**TWh/ year**	**TWh acc.**	**TWh/ year**	**TWh acc.**	**TWh year**	**TWh acc.**
2014	0.6	0.6	0.12	0.12	1.6	1.6	7.1	7.1	9.4	9.4
2015	0.6	1.3	0.23	0.35	3.0	4.6	8.1	15.3	11.8	21.2
2016	0.6	1.9	0.35	0.70	4.2	8.8	10.3	25.5	15.1	36.3
2017	0.6	2.5	0.45	1.15	5.9	14.1	10.7	36.3	17.2	53.5
2018	0.6	3.2	0.56	1.71	6.8	20.2	10.9	47.2	18.4	71.9
2019	0.6	3.8	0.66	2.37	7.7	27.0	11.0	58.2	19.4	91.3
2020	0.6	4.4	0.76	3.13	8.4	34.6	11.0	69.3	20.1	**111.3**

4.1.2 Article 8: Energy audits and energy management systems

Please provide an overview of measures planned or already undertaken to promote energy audits and energy management systems, including information on the numbers of energy audits carried out, specifying those carried out in large enterprises, with an indication of the total number of large companies in the Member State territory and the number of companies to which Article 8(5) is applicable *(EED Annex XIV Part 2.3.3).*

Lag (2014:266) om energikartläggning i stora företag (EKL) [the Act on energy audits of large companies] entered into force on 1 June 2014. The Act aims to promote improved energy efficiency at large companies. The Swedish Energy Agency is responsible for regulations and oversight of the Act. All large companies covered by the Act, around 1,100 in number, must have registered with the Swedish Energy Agency by 29 January 2016.

[21] It should be noted, in addition, that the Swedish Energy Agency's forecast tends to overestimate future energy consumption, which means that the energy saving could be lower when the real figures for Sweden's energy consumption are used

Under the Act, large companies are required to carry out a quality-assured energy audit at least every four years. The energy audit must provide answers as to how much energy is supplied and used to run the business each year. The energy audit must also put forward proposals for cost-effective measures that the company can adopt in order to reduce costs, reduce energy consumption and thereby increase energy efficiency. The energy audit can be divided into stages over a maximum of four years, starting in 2016. The detailed energy audit must be evenly divided over the four years. The results of the energy audit must be reported to the Swedish Energy Agency in the first quarter of 2017.

During the introduction of the Act, the Swedish Energy Agency devised a specific process whereby companies would be given the opportunity to conduct an energy audit of their business that results in a satisfactory basis for decisions on measures. The companies concerned must report this to the Swedish Energy Agency.

Activities in both the private and public sectors are affected by the Act because the Act adopts the size criteria set up by the EU for large companies as well as the economic criteria that specify that activities carried out on a non-profit basis are also included. The companies themselves are responsible for determining whether they are included within the scope of the Act.

The energy audit must be conducted by persons with specific expertise and must provide a representative view of the company's energy consumption. An overall analysis of the target group shows that just under 30 per cent of the large companies belong to the manufacturing industry and that other large companies dominate in terms of numbers. The companies that participated in PFE should be regarded as having conducted an audit of the kind contemplated in Articles 8(4)–8(7). These companies make up less than 10 per cent of the total number of large companies that are included within the scope of the requirement.

After consultation with the certification body and SWEDAC and in cooperation with the trade association *Energieffektiviseringsföretagen* (EEF) [Energy Efficiency Companies], the Swedish Energy Agency has produced guidance for certification of energy auditors in accordance with the Act. The guidance clarifies the skills requirements in the regulations and how energy auditors can be certified. The skills requirements, in addition to the requirement regarding independence, can be used for both personal certification and for energy auditors within energy management or environmental management systems. It also describes how renewed certification can be achieved and the criteria for revoking certification.

The purpose of the guidance is to allow certification bodies to apply for accreditation in order to certify energy auditors, but also to assist aspiring certified energy auditors who wish to prepare for an application for certification.

SWEDAC has also produced guidance for accreditation of certification bodies that intend to certify persons or management systems. The guidance also contains information on what large companies must take into consideration when choosing to conduct the energy audit with the support of a certified energy auditor or within a certified management system.

Access to high-quality, cost-effective energy audits conducted independently by qualified and/or accredited experts (Article 8(1)) is guaranteed by means of the information provided on the Swedish Energy Agency website.

A**rticle 8.2.** With support from the European Regional Development Fund, the Swedish Government launched a programme for small- and medium-sized enterprises to make their energy consumption more efficient. The programme involves a total of SEK 560 million spread over seven years, half of which is paid by Swedish Government and half by the European Regional Development Fund through *Tillväxtverket* [the Swedish Agency for Economic and Regional Growth].

The aim is to enable small- and medium-sized enterprises to carry out work on energy-efficiency in a systematic, structured way. The individual projects are tailored to companies' needs and are implemented in collaboration with county administrative boards, municipalities, regional energy offices and the Swedish Energy Agency. So-called "energy coaches" were introduced in 2016 within the framework of the national regional fund programme. The target group consists of small- and medium-sized enterprises whose energy consumption is below 300 MWh. The coaching will help achieve greater energy efficiency in the target group. The subsidy, for which the municipalities may apply, covers the costs of a 50 per cent FTE post for a coach employed by the municipality and applies until 2019. This replaces the energy audit checks that were applied until 2014.

Jordbruksverket [the Swedish Board of Agriculture] also offers advice on energy efficiency free of charge to agricultural units in its support programme *Greppa Näringen* [Focus on Nutrients].

Implementation of **Article 8(3)** is based on the existing municipal energy and climate advisors, which form a well-established instrument for information and advisory services for households and smaller businesses. It is likely that most of the measures that may need to be implemented to raise awareness can be carried out through a targeted repeated initiative involving the advisers and reinforced through press releases and information via established channels.

There are various forms of professional training programme for energy experts in both the public and the private sectors. There may be reasons to survey and analyse the availability of such programmes, as well as the number of persons trained and the application rates for these programmes. Furthermore, in a report from 2010, *Teknikdelegationen* [The Swedish Technology Delegation] stated that there is a gap between what society needs and what society supplies through the education system. Too few students focus on scientific and technical subjects which means, according to the Delegation, that the recruitment base for leading-edge skills becomes too small. In the longer term, there are therefore reasons to link the initiatives aimed at responding to the requirements of Article 8 to the other initiatives for increasing children's and young people's interest in science, technology, energy and climate issues. The Swedish Energy Agency has been entrusted with such an assignment since 2008.

4.1.3 Articles 9-11: Metering and billing

Please provide a description of the implemented and planned measures adopted or planned to be adopted in metering and billing *(EED Article 9, Article 10, Article 11, Annex XIV Part 2.2, first sentence).*

In two reports, *Boverket* [the Swedish National Board of Housing, Building and Planning] has examined the feasibility of establishing individual metering and billing in Sweden, in connection with new construction and conversion and for existing buildings. In all cases, the conclusion has been drawn that this would not be cost-effective and would result in unnecessary investment for property developers and property owners. Consequently, the Swedish National Board of Housing, Building and Planning has issued a recommendation to the Government that individual metering of tap water, heating and cooling should be introduced. At present, therefore, no requirements on individual metering are established, but the Government has entrusted the Swedish National Board of Housing, Building and Planning with the task of monitoring the question at the level of apartments with annual progress reports for 2017–2019.

Sweden generally applies a principle for establishing rents that include heating, which is probably unique in the EU. This provides incentives for property owners to implement measures to increase energy efficiency for the building's entire energy consumption, including its need for heating. Tenants, on the other hand, have no incentive to save energy when rents include heating. Implementation of individual metering and billing would mean that the shared incentive would be changed. The property owner would still be responsible for the costs of measures to increase energy efficiency, but would lose the income (i.e. the value of future energy savings), which would instead accrue to the tenant. As a result, the property owner will no longer have any incentive to implement measures to increase energy efficiency. The tenant, on the other hand, has an incentive to save energy because it can lead to lower energy expenses. However, the size of the energy saving is likely to be relatively small.

The Electricity Act (SFS [*Svensk Författningssamling* – The Swedish Code of Statutes] 2014:70) was amended at the time of the introduction of the Energy Efficiency Directive. According to the new provisions, electricity suppliers or network companies may not charge end-users for billing or billing information on energy consumption. The electricity suppliers' charges must apply to metered amounts and if metering data is not available, charging must take place according to estimated use. The bill should be clear and should provide information on consumption and current prices.

Similarly, natural gas suppliers (SF 2014:27) are also required to provide their customers with clear bills free of charge, based on metered amounts. Both natural gas suppliers and electricity suppliers are required to provide their customers with information on energy efficiency, among other things, on their websites.

Network concession holders and companies engaged in the transfer of natural gas must report metering results and estimates to the authority responsible for the system, users, producers, those with balance responsibility and suppliers, among others.

4.1.4 Articles 12 and 17: Consumer information and education

Please provide information on measures adopted or planned to be adopted to promote and facilitate efficient use of energy by SMEs and household customers *(EED Article 12, Article 17, Annex XIV Part 2.2, first sentence).*

The municipal climate and energy advice complies with the provisions set out in Article 12(1) and Article 17(4) on the promotion of use of energy in an efficient manner by small energy users, including household customers. Among the types of initiatives that the Member States may choose to implement 12(1), the municipal energy and climate advice is seen as a form of information dissemination. In addition, the Swedish Energy Agency carries out work to disseminate information and build up knowledge.

It is also important to note that energy taxes have existed in Sweden for a long time and constitute an important economic incentive for households and others to use energy efficiently. Sweden therefore also applies the instrument of tax incentives to comply with the requirements set out in 12(1). According to a new ordinance from 2016, in addition to the former municipal energy and climate advice, municipalities may also apply for extended advice aimed at local priority areas.[22]

In addition, on the initiative of the Swedish Energy Agency and other public operators, various forms of conferences and meeting places are being arranged where operators, including market operators, are given the opportunity to provide information. One example of this is the Swedish Energy Agency conference Energiutblick, which has a large number of participants from all sectors of society. The regional energy offices, etc. arrange similar events.

Furthermore, information on energy efficiency measures in addition to the above activities is already available for relevant operators, for example through the Swedish Energy Agency's websites, the Agency's various networks of market operators (BELOK, BEBO, BELIVS, etc.), public operators (energy efficient authorities) and the municipal energy and climate advisors, etc.

However, no information or other initiatives are currently targeted specifically at the banks and financial institutions. Since the Member States should encourage banks and other financial institutions to obtain information on opportunities to participate in the financing of energy efficiency measures, the Swedish Energy Agency has proposed the introduction of credit guarantees for energy efficiency.

4.1.5 Article 16: Certification

Please provide information on existing or planned certification or accreditation schemes or equivalent qualification schemes (including, if applicable, training programmes) for providers of energy services, energy audits, energy managers and installers of energy-related building elements as defined in Article 2(9) of Directive 2010/31/EU of the European Parliament and of the Council (1) *(EED Article 16, Annex XIV Part 2.3.7).*

[22] Ordinance 2016:385

In accordance with the Act on energy audits of large companies (2014:266), the energy audit must be conducted by persons with specific expertise and must provide a representative view of the company's energy consumption.

If a company affected by the Act has no certified energy or environmental management system, an energy auditor who has been certified in Sweden or who is authorised to conduct energy audits in other EU countries must be engaged to conduct the energy audit.

After consultation with the certification body and SWEDAC and in cooperation with the trade association *Energieffektiviseringsföretagen* (EEF) [Energy Efficiency Companies], the Swedish Energy Agency has produced guidance for certification of energy auditors in accordance with the Act. The guidance clarifies the skills requirements in the regulations and how energy auditors can be certified. The skills requirements, in addition to the requirement regarding independence, can be used for both personal certification and for energy auditors within energy management or environmental management systems. It also describes how renewed certification can be achieved and the criteria for revoking certification.

Compliance with Article 16.3 is achieved by having easily accessible information on the possibilities for certification of these energy services available on the Swedish Energy Agency's website, were there should also be references to the current regulatory framework in which the requirements are set out.

4.1.6 Article 18: Energy services

(1) Please provide information on measures adopted or planned to be adopted for the promotion of energy services. The description must include an internet link to the list of available energy service providers and their qualifications *(EED Annex XIV Part 2.2 first sentence, Annex XIV Part 2.3.8).*

(2) Please provide a qualitative review of the national market for energy services describing its current status and outlining future developments *(EED Article 18 1(e)).*

Article 18 is considered to have been fulfilled by means of the work currently being carried out by the Swedish Energy Agency, such as the dissemination of information.

A trade organisation, Energy Efficiency Companies (EEF), is currently available for energy service companies.[23] One of its tasks may be to ensure in practical terms that lists are compiled and published for all energy service areas in order to comply with article 18(1)(c).

[23] www.eef.se

The Member State must also support the public sector with regard to the procurement of energy services. This is also fulfilled by means of the Swedish Energy Agency's existing work, which will be further developed. In 2012, the Swedish Energy Agency investigated the possible existence of barriers to competition in the energy services market in Sweden.[24] Around one third of the companies surveyed considered that barriers existed, whereas the majority did not consider that to be the case. The main barriers are the rules for the procurement procedure, which are seen as cumbersome, and legislation on municipal energy companies' activities. This barrier is criticised mainly by municipally-owned companies. Nevertheless, the barriers are not considered to be such that any further action is considered justified. The overall assessment based on the requirements of the Directive is therefore that there are no legislative barriers and that the market is considered to work well. However, there are reasons to monitor developments in future, not least in view of the fact that the market is expanding. The Swedish Energy Agency has been entrusted with an assignment aimed at this.

An independent ombudsman to deal with complaints (18(2)(c)) and extra-judicial disputes concerning energy service agreements is not considered appropriate. No problems regarding energy services have emerged that would justify introducing dispute resolution mechanisms of an extra-judicial nature. No measures in addition to the existing consumer legislation, along with the regulations in the area of contract law, are considered necessary. Nevertheless, work is being done to develop general regulations. This is being done by suppliers and clients in consultation.

When it comes to giving independent intermediaries the opportunity to cooperate to stimulate market development on the demand and supply side (Article 18. 2(d)), such operators already currently have considerable opportunities to promote the development of the market for energy services. As an example of this, several of the regional energy offices have worked on this matter in cooperation with the Swedish Energy Agency. No further measures in addition to the activities already being carried out by the Swedish Energy Agency are necessary. A specific initiative to increase small and medium-sized enterprises' expertise as clients of energy services is being carried out within the framework of the EU regional fund programme.

The Member States must ensure that energy distributors, distribution system operators and retail energy sales companies refrain from activities that could impede demand for and supply of energy services. It may be verified that *Konkurrensverket* [the Swedish Competition Authority] has already been entrusted with the task of identifying to barriers to effective competition in the public and private sectors. This is specified in Ordinance 2007:1117 with instructions for the Swedish Competition Authority.

The Directive stipulates that the Member States must support the energy services market so that it works well. In this regard, the Swedish Energy Agency is acting as a point of contact for end-users and the relevant information is available on the Authority's website. The provisions regarding monitoring the development of the energy services market are currently being fulfilled through existing activities carried out by

[24] The Swedish Energy Agency, "*Finns det konkurrenshinder på marknaden för energitjänster?*" [Are there barriers to competition in the market for energy services?] ER 2012:26

the Swedish Energy Agency. There is, however, scope to develop this activity, for example with regard to how collection and compilation takes place. One important aspect for the development of the energy services market is greater client knowledge, where the Swedish Energy Agency has helped with training and information.

Detailed information is available at www.energimyndigheten.se

There is currently a lack of knowledge concerning how large the market actually is. The size of the market is difficult to determine, but previous studies show that the volume of energy services procured in the public sector more than tripled in the 2006–2011 period. On average, procurement of energy services amounts to SEK 40 million a year. However, that volume is likely to be a substantial underestimate of the reality. Energy services in the public sector most commonly related to properties. Three out of every four procurements of energy services included properties; 15 per cent of procurements were in transport and 8 per cent were in organisation.

Several operators consider that low demand is a large barrier in the market. There is a direct threat to the development and future of the market if leading operators choose to reduce their activities. Other perceived problems from the supplier side are lack of expertise and project management at clients. The basis for several of the problems is the fact that clients and suppliers do not have the same goals and vision in the project[25]

4.1.7 Article 20: Funds

(2) Please provide information about the Energy Efficiency National Fund *(EED Article 20, Annex XIV Part 2.2., first sentence).*

Funds have traditionally not been used to finance Swedish energy efficiency policy. Instead, the State contributes support in various ways that makes it easier for the different operators to implement energy efficiency measures. One example of this is the State aid granted for procurement of technology and market introduction of new energy-efficient technologies in homes and non-residential premises, grocery stores, manufacturing industry and the transport sector. What is referred to as the ROT [*Renovering, Ombyggnad, Tillbyggnad* – Repair, Conversion, Extension] tax deduction provides an opportunity for private individuals to receive a tax reduction of 30 per cent of the cost of the work on repair, maintenance, conversion and extension of housing (houses, tenant owner accommodation and private apartments). The State also provides support for installation of network-connected solar cell systems and solar electricity/solar heating hybrid systems.

A system of credit guarantees for energy efficiency is currently being studied.

There is reason to note that energy efficiency initiatives are prioritised within the framework of the structural funds.

[25] The Swedish Energy Agency – "*Energitjänster i Sverige. Statusrapport för tjänster för energieffektivisering*" [Energy Services in Sweden. A status report for energy efficiency services] ER 2013:22

There is currently no information or other initiatives aimed specifically at banks and financial institutions (however, see section 5.2.3.) Because this target group is important and specifically designated, the Swedish Energy Agency will design information initiatives to induce banks and other financial institutions to increase their commitment to greater energy efficiency.

4.1.8 Other horizontal instruments

Energy and carbon taxes

The energy tax that was introduced as early as the 1950s had previously been aimed primarily at contributing to the financing of public activities. Since the beginning of the 1990s, the environmental profile of energy taxation has been strengthened, particularly with the introduction of the carbon tax.[26] Though energy and carbon taxes originally functioned mainly as fiscal instruments, they are now used more as steering instruments.

The existing energy taxation must:

- contribute to more efficient energy consumption
- promote the use of biofuels
- create incentives to reduce companies' environmental impact
- bring about conditions for domestic production of electricity

The approach has been adapted to the Community's provisions since Sweden's entry into the EU. The frameworks are established mainly by the Energy Tax Directive[27] and their structure is complex. However, overall, it may be asserted that Swedish tax rates tend to be significantly higher than the minimum levels stipulated in the Energy Tax Directive.

There are taxes on electricity and fuels, on emissions of carbon dioxide and sulphur and charges for emissions of nitric oxide. The taxes vary depending on whether the fuel is used for heating or as a fuel for transport. There are also variations depending on whether it is used by households, industry or in the energy transformation sector. Energy tax is based on energy content, whereas carbon tax is based on the quantity of carbon dioxide emissions. The taxes on electricity vary depending on what the electricity is used for and whether that use takes place in the north of Sweden or the rest of Sweden.

Energy and carbon taxes have been subjected to several changes. Certain changes were made to the tax system in Government Bill 2009/10:41, which included a number of increases in both energy and carbon tax. A further increase of around 14 per cent in the energy and carbon taxes on petrol and diesel was carried out between 2014 and 2016 and an increase in electricity tax of just over 11 per cent has been announced for 2017. These changes in tax are part of a systematic

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[26] *Skatteverket* [The Swedish Tax Agency] refers to energy tax, carbon tax and sulphur tax as a single unit. Se www. skatteverket. se.

[27] Council Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity.

effort to reduce the number of exceptions in the energy tax system. At present, it is mainly trade and industry that receives reductions in carbon tax, whereas households typically pay the full tax. For that reason, only around half the revenue from the tax derives from trade and industry, which generate approximately 80% of emissions.[28]

Cogeneration plants that participate in the EU emissions trading scheme are exempt from carbon tax, as are some supplies of heat to industry that take part in the trading system.

The Swedish Tax Agency is the authority responsible for energy taxes.

The following tax rates on fuels apply in 2016:

Table 10. Tax rates for certain fuels – 2016.

Type of fuel	Energy tax	Carbon tax	Total tax
Petrol that meets the requirements for a) environmental category 1 – motor spirit	SEK 3.72 per litre	SEK 2.59 per litre	SEK 6.31 per litre
alkylate petrol	SEK 1.93 per litre	SEK 2.59 per litre	SEK 4.52 per litre
b) environmental category 2	SEK 3.75 per litre	SEK 2.59 per litre	SEK 6.34 per
Fuel oil, gas oil, kerosene etc., which a) has been provided with marking and colourant or gives less than 85 per cent by volume distillate at 350 degrees C.	SEK 846 per m3	SEK 3,204 per m3	SEK 4,050 per m
a) has been provided with marking and colourant and gives at least 85 per cent by volume distillate at 350 degrees C, belonging to	SEK 2,355 per m3	SEK 3,204 per m3	SEK 5,559 per m3

[28] *Riksrevisionen* [National Audit Office], *Klimatrelaterade skatter – vem betalar?* [Climate-related taxes – who pays?] RIR 2012:1

environmental category 1			
environmental category 2	SEK 2,634 per m3	SEK 3,204 per m3	SEK 5,838 per m3
environmental category 3, or belongs to no environmental category	SEK 2,779 per m3	SEK 3,204 per m3	SEK 5,983 per m3
Liquefied petroleum gas, etc. used for a) operation of motor vehicles, vessels or aircraft	SEK 0 per 1,000 kg	SEK 3,370 per 1,000 kg	SEK 3,370 per 1,000 kg
b) purposes other than those referred to in a)	SEK 1,087 per 1,000 kg	SEK 3,370 per 1,000 kg	SEK 4,457 per 1,000 kg
Natural gas used for a) for operation of motor vehicles, vessels or aircraft	SEK 0 per 1,000 m3	SEK 2,399 per 1,000 m3	SEK 2,399 per 1,000 m3
b) other than those referred to in a)	SEK 935 per 1,000 m3	SEK 2,399 per 1,000 m3	SEK 3,334 per 1,000 m3
Coal, coke	SEK 643 per 1,000 kg	SEK 2,788 per 1,000 kg	SEK 3,431 per 1,000 kg
Aviation petrol with a lead content of a maximum of 0.005 grams per litre	SEK 3.75 per litre	SEK 2.59 per litre	SEK 6.34 per litre
Crude tall oil	SEK 4,050 per m3		SEK 4,050 per m3

Source: Swedish Tax Agency

Sulphur tax for solid and gaseous fuels is SEK 30 per kilogram of sulphur in the fuel. For liquid fuels, the sulphur tax is SEK 27 per cubic metre for each tenth part weight percentage of sulphur in the fuel.

The tax rate for electricity is SEK 0.005 per kilowatt-hour for electricity consumed in industrial activities in the manufacturing process or in professional greenhouse cultivation.

The tax rate is SEK 0.193 per kilowatt-hour for electricity other than that referred to above consumed in a number of municipalities in northern Sweden. In other cases, it is SEK 0.292 per kilowatt-hour.

The Swedish Environmental Code

Miljöbalken (1998:808) [MB – The Swedish Environmental Code] is a mandatory, comprehensive instrument in the environmental sphere that covers all environmental activities and initiatives. The basic provisions of the Swedish Environmental Code (Chapter 1) aim to promote sustainable development and must be applied in such a way as to promote conservation of energy and raw materials, among other things.

The general rules of consideration in the Swedish Environmental Code state that anyone who engages in an activity or who takes an action must conserve raw materials and energy and primarily use renewable fuels (MB Chapter 2, section 5). Under the Swedish Environmental Code, activities must be carried out in such a way as to conserve energy and raw materials and use primarily renewable energy.

Naturvårdsverket [the Swedish Environmental Protection Agency] has overall responsibility for the implementation of the Swedish Environmental Code. However, the Swedish Energy Agency is a supervisory authority in matters relating to the operators' own checks when it comes to energy conservation and use of renewable energy sources.

The Energy Efficiency Council

Energieffektiviseringsrådet [the Energy efficiency Council] was established in 2010. Its task is to strengthen cooperation between authorities and facilitate coordination of implementation and monitoring of measures and instruments in order to fulfil the objectives adopted by the Riksdag on energy efficiency. The Council has an important role in the implementation of the Energy Efficiency Directive. The Council is an arena where strategically important issues are raised in order to strengthen cooperation between authorities and increase transparency within the sphere of energy efficiency, including within State authorities' purchasing and measures to increase energy efficiency. The Energy Efficiency Council provides advice and meets four times a year.

Supervision of the markets for electricity, natural gas and district heating

Energimarknadsinspektionen [the Energy Markets Inspectorate (EI)] is responsible for supervision of the energy markets and its task is to strengthen the position of energy customers and ensure that the markets for electricity, district heating and natural gas work as well as possible. This is aimed at making it easier for customers to make informed decisions. Its activities include verifying compliance with the regulations contained in the electricity, natural gas and district heating Acts, examining and issuing permits in accordance with these laws, monitoring energy markets and putting forward proposals for amendments to regulations or other initiatives to facilitate the functioning and development of the markets.

Ecodesign and energy labelling

Ecodesign aims to establish environmental performance requirements – normally energy efficiency – during the product life cycle. Energy-intensive products are being phased out of the market by means of these requirements on manufacturers. The requirements are governed by the

Eco-Design Directive 2009/125/EC.[29] The Directive can cover all energy-related products, with the exception of products for the transport sector. The product groups are normally regulated in the form of EU Regulations, but self-regulation can also exist.

The energy label supplements the eco-design requirements by providing the consumer with information on products' energy efficiency, performance, water usage or noise level. This allows consumers to make more informed decisions, including with regard to operating costs. The energy label provides an incentive for manufacturers to develop increasingly energy-efficient products. The product-specific labels are determined through EU regulations under the framework directive 2010/30/EC (the Energy Labelling Directive), which is incorporated in Swedish law by means of the Act on the labelling of energy-related products (2011:723). The Swedish Energy Agency is the responsible authority.

The implementation of the Energy Labelling Directive is regulated in Sweden by the Act on the labelling of energy-related products (2011:723).

Research

Studies and research programmes are an essential component of Swedish work on energy efficiency. The Swedish Energy Agency is involved at every stage of the chain, from research to development, demonstration and commercialisation. The Swedish Energy Agency is an important financier of research on energy efficiency, primarily in buildings, industry and transport, but also broader approaches to energy systems and energy consumption. In addition to the operators referred to above, a number of other operators are engaged in research and investigation activities concerning energy efficiency.

There are currently two main programmes within the thematic area of general energy system studies – *Strategisk energisystemforskning* [SEF – Strategy Energy System Research] and *Forskarskolan Energisystem.* [FoES – Graduate School in Energy Systems]. The aim is to ensure that the expertise will be useful in decision-making at different levels or for building up long-term capacity to meet any need for expertise in future.

The *Strategic Energy Systems Research* and *Graduate School in Energy Systems* programmes began their current programme rounds in 2014. The programme budget per year, up to 2018, is approximately SEK 47 million. Energy systems research is also conducted in other thematic areas via external operators such as IVA and Energiforsk.

The *Strategic Energy Systems Research* programme provides scientifically-based analyses and supporting data for decisions and also promotes development of expertise and skills in this field and in related disciplines.

[29] Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy-related products (recast) The Directive is implemented in Swedish law in its original form (2005/32/EC); Act on Eco-Design (SFS 2008:112) and amendment SFS 2011:395.

There have been two calls for proposals in the programme. Of the programme budget of SEK 130 million, approximately SEK 100 million had been distributed to 22 projects in autumn 2015. The projects were grouped into the categories of *International Climate Policy, General Energy Systems Studies, Electricity Market* and *Policy Instruments.* The projects link a variety of areas with different types of connections to the challenges associated with a sustainable energy system. Both newly-qualified PhDs and senior researchers are funded in the programme, often in larger constellations and involving national or international collaboration.

Graduate School in Energy Systems (FoES) contributes to the provision of skills in the field of energy research in general and interdisciplinary energy systems research in particular. The programme supports doctoral studies and its particular characteristic is that the doctoral projects are organised in interdisciplinary consortia in which two to three doctoral students with different backgrounds and usually from different higher education institutions cooperate in a project on the basis of questions deriving from their own discipline.

The Graduate School initially started in 1997 (as *Program Energisystem, PES)* [Energy Systems Programme] and funding was taken over by the Swedish Energy Agency in 2001. Since then, 66 doctoral and 3 licentiate's dissertations have been published. At most, 10 doctoral students are financed from several disciplines and higher education institutions and SEK 35 million has been set aside up to 2018.

Programmet Energi, IT och Design [The Energy, IT and Design Programme] began in 2009 and aims to influence people's habits, values and everyday behaviour with regard to energy efficiency, with the focus on making electricity consumption more efficient with the aid of both IT and design. The programme will result in a number of concrete prototypes and demonstrations. The third stage ends in 2017 and a fourth stage is being planned.

4.2 Instruments for increasing energy efficiency in buildings and premises

4.2.1 EPBD, the Energy Performance of Buildings Directive 2010/31/EU

Sweden has chosen alternative advice in accordance with Articles 14 and 15 of the EPBD. Work is currently in progress on how these Articles are to be reported. These Articles will be reported in a specific communication in spring 2017.

In accordance with Article 10(2) of the EPBD, Member States must draw up a list of existing and proposed measures and instruments including those of a financial nature, other than those required by the Directive, which promote the objectives of the Directive. The various instruments and initiatives used in Sweden to provide incentives for energy efficiency measures in buildings are described in this section and in sections 4.1.8 and 4.3.

4.2.2 Article 4: National building renovation strategy

Provide the national long-term building renovation strategy *(EED Article 4, final paragraph).*

Financial support was established in 2016 for renovation of rental accommodation in socio-economically vulnerable areas and to make that accommodation more energy-efficient. During the year, a multi-annual programme was also launched to enhance skills with regard to low-energy housing. In the 2016 Budget Bill, the Government announced funding for an information centre focusing on renovation to improve energy efficiency through the choice of sustainable materials. In spring 2017, the Government entrusted the Swedish National Board of Housing, Building and Planning with the task of procuring an operator with the ability to undertake this task. The procurement is expected to be carried out and an information centre completed in 2017.

Sweden's updated renovation strategy is presented in its entirety in Appendix 5.

4.2.3 Other instruments for energy efficiency measures in buildings

Please provide more information on significant measures to improve energy efficiency in buildings in order to meet the national energy efficiency objectives referred to in Article 3(1) *(EED Article 20(2), and Annex XIV Part 2(2), first sentence). 3.2.*

Boverkets byggregler (BBR) [Swedish National Board of Housing, Building and Planning building regulations] including amendments

The Swedish National Board of Housing, Building and Planning building regulations contain requirements for buildings in terms of residential design, accessibility and usability, load capacity, fire protection, hygiene, health, environment, water and waste management, noise protection, safety of use and energy conservation.

Section 9 of the building regulations[30] contains requirements for energy conservation that specify maximum permitted limits for energy consumption in buildings. The limits indicate how much energy, measured per square metre of floor area, a building may use per year. Energy consumption includes the energy consumed in one year for heating, comfort cooling, hot water and property energy. The rules relate to actual energy consumption when the building is in use.

Buildings must also meet requirements in addition to those relating to energy consumption. These consist of requirements relating to thermal insulation, heating, cooling and air-conditioning systems, efficient use of electricity and metering systems for energy consumption. For buildings heated by electricity, there is also a maximum installed electric power for heating.

When it comes to building modification, the basic premise is that, in principle, the requirements applying to construction of new buildings also apply to modification and renovation of buildings. In the case of modification, however, the requirements must be adapted and any departure from the requirements must take account of the extent of the modification, the conditions of the building, the precautionary requirement and the prohibition on distortion. In the case of modification, the requirements may be imposed on the modified part of the building.

If, after the building envelope has been changed, a building fails to meet the requirements imposed on new buildings, the rules specify the U values for ceilings, walls, floors, windows and exterior doors that the work must attempt to achieve. If a change is made in a ventilation system or a ventilation unit, the rules specify the SFP values[31] and SFPv[32] values that the work must attempt not to exceed.

[30] BFS 2011:6 with amendments up to BFS 2015:3
[31] Specific fan power (SFP), The sum of the power rating for all fans included in the ventilation system, divided by the maximum flow of supply air, kW/(m^3/s).
[32] SFPv, Specific fan power for a unit.

Energy declarations

Energy declarations contain information about the building's energy consumption and are aimed at prospective house buyers or tenants. Energy declarations, through the information they contain, will make buyers aware of the energy consumption so that it is taken into account at the time of purchase. An energy declaration must be drawn up for a building at the moment of sale, rental and new construction as well as for larger buildings frequently visited by the public. The energy declaration is issued by an independent expert commissioned by the owner and is valid for ten years.

Declarations have now existed for ten years and there are a total of approximately 632,000 buildings with energy declarations registered in the Swedish National Board of Housing, Building and Planning database. One of the most important changes to have been made in recent times has been the strengthening of the function of the declarations to enable them to provide consumer information. This has been done by making the declarations clearer. Previously, the focus was on proposed measures, but now the focus is more on the A–G rating. The rating looks the same as the energy label for products such as refrigerators and washing machines. To ensure that the buyer has received the declaration prior to the purchase, a requirement was introduced in 2014 that the label with the rating must be included in any advertisement for the property.

The Swedish National Board of Housing, Building and Planning issues rules on energy declarations and is responsible for supervising energy declarations and energy experts' independence.

Energilyftet and other training in low energy building

The Swedish Energy Agency, along with other operators, has several initiatives for enhancing skills in low-energy building that cater for different target groups. These initiatives are new from 2016.

Energilyftet is the Swedish Energy Agency's on-line training course to enhance basic skills in low-energy building among operators in the construction industry. The training is aimed at clients, architects, engineers, construction project managers, managers and technicians and will run until 2018 with the possibility of an extension.

Beställarkompetens [Client Skills] is a collaboration project involving *Byggherrarna* [Swedish Construction Clients], SABO [*Sveriges Allmännyttiga Bostadsföretag* – the Swedish Association of Public Housing Companies], *Fastighetsägarna Sverige* [the Swedish Property Federation], SKL [*Sveriges Kommuner och Landsting* – the Swedish Association of Local Authorities and Regions] and EMTF [*Energi- och Miljötekniska Föreningen* – the Society of Energy and Environmental Technology] that is financed by the Swedish Energy Agency. *Beställarkompetens* is aimed partly at providing more detail on the knowledge in the Swedish Energy Agency's Energilyften training initiative. *Beställarkompetens* is aimed at property developers, property owners and managers and the training provides more detailed knowledge of the tools available in Sveby [*Standardisera och verifiera energiprestanda i byggnader* – Standardise and verify the energy performance of buildings], BeBo [*Beställargruppen Bostäder* – Client Group Housing], BELOK [*Beställargruppen Lokaler* – Client Group Premises] and *Gröna Hyresavtal* [Green Leases].

Nya Glasögon [New Glasses] is a cross-industry project involving the Swedish Energy Agency and industries in the construction sector. *Nya Glasögon* is aimed at sixth-form teachers on construction programmes. They will in turn teach the labour force of the future how low-energy buildings are to be built and renovated.

Energibyggare [Energy Builders] is a skills-enhancing training programme intended for building workers, installation engineers, supervisors and site managers. The project forms part of the

EU BUILD UP Skills initiative and is financed by the European Commission and the Swedish Energy Agency.

Municipal energy and climate advice

Municipal energy and climate advice aims to provide impartial, locally-orientated information and advice on how to make energy consumption more efficient or increase the use of renewable energy. The advice is aimed at private individuals, small and medium-sized enterprises, tenant housing associations, private apartment building owners and associations and organisations. The energy and climate advisors play a central role, including in the fulfilment of Articles 14 and 15 of the Energy Performance Directive.

The National Regional Fund

The National Regional Fund Programme is part of the European Structural Fund Programme for Sweden and is implemented in the 2014–2020 period. The Swedish Energy Agency receives a total of SEK 80 million per year for investments to increase energy efficiency in small and medium-sized enterprises during the period. The purpose of the Swedish Energy Agency's work in the National Regional Fund Programme is to support the transition to a low-carbon economy and increase the share of renewable energy and promote energy efficiency in enterprises.

Energy efficiency in small and medium-sized enterprises should be promoted in all sectors. This takes place by means of financial support for enterprises and by forming networks and facilitating exchange of experience and dissemination of information. For most projects, the support goes through various partners such as *Energikontoren* [Energy Agencies of Sweden], the county administrative boards, the municipalities and *Energieffektiviseringsföretagen* [Energy Efficiency Companies]. For support for environmental studies and energy survey support, small and medium-sized enterprises can apply for money directly from the Swedish Energy Agency.

Innovation clusters

There are several so-called innovation clusters in the construction and property sector. These were formerly known as networks or client groups. The purpose of the clusters is to create a platform for close collaboration between industry operators, academia and the State. The clusters place the emphasis on innovation and on implementing and monitoring demonstration projects to develop energy-efficient methods, procure new technology and promote good practice.

Industry operators, along with the Swedish Energy Agency, run a series of innovation clusters: LÅGAN is for buildings with very low energy consumption; BELOK is a cluster for non-residential premises; BeBo is an innovation cluster for owners and managers of apartment buildings; BeLivs is an innovation cluster of grocery premises; and BeSmå groups together house builders. Two new innovation clusters began operating in 2016. They are *Innovationskluster för energieffektiv sjukvård* [Innovation Cluster for Energy-Efficient Medical Care] and *Innovationskluster Hållbart samhälle* [Innovation Cluster Sustainable Society].

The innovation clusters have mainly affected energy efficiency of the building stock by promoting the development of new solutions and applying and demonstrating new knowledge and technology. Experience and expertise is disseminated by bringing together industry operators in the clusters.

Research

As a public authority in the sector, the Swedish Energy Agency has a primary responsibility and coordinating responsibility for energy-related building research. In addition to the Swedish Energy Agency, Formas and Vinnova also finance projects in this sphere. *Konsumentverket* [the Swedish Consumer Agency], the Swedish National Board of Housing, Building and Planning and the Swedish Environmental Protection Agency also have energy-related commitments in the area of construction.

Energy-related research and innovation activities are characterised by a systemic vision. That vision is to achieve resource- and energy-efficient building. Cooperation is a keyword for the achievement of that vision. The Swedish Energy Agency's investment in research in the field of buildings in the energy system is divided into a number of programmes.

- Research and innovation for energy-efficient building and housing
- Heat pump research in the EFFSYS EXPAND collaboration programme
- District heating research in the Fjärrsyn cooperation programme
- The *Energieffektivt byggande och boende* (E2B2) [Energy-efficient building and housing] cooperation programme
- Energy, IT and Design
- Improvements in energy efficiency in buildings of cultural and historical value, *Spara och bevara* [Save and Preserve]
- The programme for energy efficiency in the area of lighting

These include a number of research projects carried on at universities, university colleges, institutes and companies. The Swedish Energy Agency has a project database[3333] in which all projects are recorded.

On-line portal

The on-line portal, *Energiaktiv* [Energy Active], on energy efficiency created jointly by the Swedish National Board of Housing, Building and Planning, the Swedish Energy Agency and the Swedish Board of Agriculture has been restructured by the Swedish Energy Agency. Information intended for house owners, other property owners and managers is available at www.energimyndigheten.se , where support is provided for energy efficiency applying to both buildings and organisations' transports. The support covers the entire chain from planning to follow-up of measures.

Credit guarantees

The Swedish National Board of Housing, Building and Planning credit guarantee is an insurance policy that a lender can take out for loans for new construction and conversion of housing. The credit guarantees aim to

[33] http://www.energimyndigheten.se/forskning-och-innovation/forskning/projektdatabas/

reduce the risk for the bank when granting loans and make it possible for property owners to obtain further mortgages on the property.

At present, the credit guarantees are clearly linked to the definitions for new building and conversion as specified in the Planning and Building Act. The Swedish National Board of Housing, Building and Planning and the Swedish Energy Agency have proposed use of the credit guarantees to stimulate renovation by expanding the area of use to also include specific renovation measures.[34]

Approximately 30 credit guarantees are issued per year, with the vast majority going to new production.[35] The Swedish National Board of Housing, Building and Planning has carried out information campaigns in 2016 to raise awareness of the possibilities of credit guarantees and the number of applications has also risen noticeably. Compared with the same period last year, on 30/9 agreements had risen by 56 per cent and advance notifications had risen by 124 per cent.

Aid for improvement and increases in energy efficiency of rental accommodation

Aid was introduced on 1 October 2016 with a view to stimulating renovation and greater energy efficiency for rental accommodation and improvements to outdoor environments in areas with socio-economic challenges. The Government has set aside SEK one billion per year for these purposes since 2016.

The aid is intended for buildings containing residential apartments that are let with a right of tenancy and that are located in residential areas where more than 50 per cent of households have low purchasing power.

The aid includes a renovation component and an energy-efficiency component. Renovation aid amounts to 20 per cent of the cost of renovation and that part of the aid goes directly to the tenants through a rent reduction over a seven-year period. Support for improvements in energy efficiency is calculated on the basis of the energy saving achieved after the renovation. That part of the aid goes to the property owner. To obtain that part of the aid, the renovation must lead to an improvement in the energy performance of at least 20 per cent.

Support for improvements to school premises and outdoor environments beside schools

The Government has introduced a subsidy for improving school premises for the 2015–2018 period. The initiative aims to give pupils a better learning and working environment and at the same time reduce the environmental impact of the premises, for example in the use of particularly hazardous substances, as well as reduce energy and water use. Grants for improvements to outdoor environments will be provided for up to 50 per cent of the total cost of the eligible measures.

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[34] Report by the Swedish National Board of Housing, Building and Planning and Swedish Energy Agency entitled "*Förslag till utvecklad nationell strategi för energieffektiviserande renovering - Utredning av två styrmedel 2015*" [Proposal for a developed national strategy for energy-efficient renovation – Investigation of two instruments 2015]

[35] This applies to all kinds of credit guarantees for new construction and conversion managed by the Swedish National Board of Housing, Building and Planning. Approximately 150 cases are handled per year in total.

Since 1 June 2016, a subsidy has also been granted for improvements to outdoor environments adjacent to schools, preschools and after-school recreation centres. The subsidy consists of a maximum of 25 per cent of the total cost of the eligible measures.

Deduction for repair, conversion and extension work

The deduction for repair, conversion and extension work is a tax reduction on the cost of labour for repairs, maintenance or conversion and extension of residential accommodation. The deduction was introduced in 2008 in order to stimulate the supply of labour and reduce illegal labour.[36] A natural effect of the deduction for repair, conversion and extension work is that it provides an incentive for property owners to carry out more renovations. Some of the measures covered also contribute to more efficient use of energy.[37] The tax reduction was lowered from 50 per cent to 30 per cent of labour costs on 1 July 2016. The maximum amount of aid is still SEK 50,000 per year. The possibility is offered to owners of houses, apartments and second homes as well as holders of tenant owner apartments.

EU financial support for energy efficiency in buildings

The European Union has for many years promoted the improvement of the energy performance of buildings through a series of programmes for financial support.

A number of EU financing programmes are implemented in cooperation with international financial institutions (IFIs). There are three so-called intermediate financial instruments:

- the Energy Efficiency Finance Facility (EEFF)
- the Municipal Finance Facility (MFF) and
- the Small and Medium-sized Enterprise Finance Facility (SMEFF)

The European Energy Efficiency Fund (EEEF) was set up in 2011 with an amount of EUR 265 million. It provides instruments for loans, equity and guarantees and grants for technical assistance for project development support.

Requirements for investigation of alternative energy supply systems

Rules of application for the investigation of alternative energy supply systems were introduced on 12 July 2013.

4.3 Instruments in the public sector

4.3.1 Article 5: Central government buildings

Please provide information on the published inventory of heated and cooled central government buildings *(EED Article 5(5), Annex XIV Part 2.2, first sentence).*

[36] Government Bill 2006/07:94, p. 34 ff., and Government Bill 2008/09:97, p. 93

[37] House owners are granted a right to a tax reduction for work such as drilling and installation of geothermal heating as well as replacement of windows, doors and taps, additional insulation and assembly and replacement of ventilation. For a single holder of a tenant owner apartment, only repair, conversion and extension work carried out in the apartment confers a right to a tax reduction, for example replacement of taps but not replacement of windows.

The requirements in Article 5 cover the buildings in Sweden owned by Government administrative authorities and the courts. Sweden chose the alternative strategy for implementing Article 5. The ownership of properties of this kind is unevenly distributed. Two authorities own around 95 per cent of the buildings, whose total floor space amounts to 1.59 million square metres, with total energy consumption of 270 GWh. These authorities are *Statens fastighetsverk* [the National Property Board] and *Fortifikationsverket* [the National Fortifications Administration], see Table 12. Both authorities report directly to *Regeringskansliet* [the Government Offices] on the progress of efficiency work.

In order to promote cost-effective measures and reduce administrative costs, plans are being made to distribute the fulfilment of the energy savings target, which is calculated on all the authorities' buildings, between these two property owners, which are in a class of their own in terms of size. The same results will be achieved with the alternative strategy.

The annual savings target for state-owned buildings is calculated as 3 per cent of the difference between the total current energy consumption of the buildings and their total energy consumption if the minimum requirement set out in the Swedish National Board of Housing, Building and Planning building regulations (BBR) were fulfilled. The average energy performance for buildings owned by State authorities is 172 kWh/m^2/year. The average energy performance for these buildings had they met the requirement for new buildings in accordance with BBR is 108 kWh/m^2/year, which gives a difference of approximately 64 kWh/m^2/year.

This means that, by the end of 2020, the National Property Board and the National Fortifications Administration must have implemented measures to reduce energy consumption in the buildings by at least 21 GWh (see Table 13).

At the end of 2016, the two authorities had implemented measures that reduced the energy consumption by a total of 46 GWh.

Table 11. Central government buildings, area and energy consumption, forecast 2020

Authority	Number of buildings	Total floor area Atemp (m2)	Total energy consumption (kWh/year)
National Fortifications Administration	264	696,770	130,817,790
Luftfartsverket [Swedish Civil Aviation Authority]	11	68,067	15,195,047
Swedish Environmental Protection Agency	2	1,197	221,271
Swedish Maritime Administration	8	3,763	914,314
National Property Board	433	897,683	139,570,376
Swedish University of Agricultural Sciences	7	2,580	529,075
Swedish Transport Administration	6	8,619	1,555,361
Total National Fortifications Administration and National Property Board	697	1,594,453	270,388,166
Total all authorities	731	1,678,679	288,803,234

Table 12. Energy-saving target for buildings owned by public authorities

Year	Cumulative savings [MWh]
2014	3,219
2015	6,342
2016	9,371
2017	12,309
2018	15,160
2019	17,924
2020	20,606

4.3.2 Article 5: Buildings belonging to other public bodies

(1) Please provide information on measures undertaken or planned to encourage public bodies and social housing bodies governed by public law to adopt energy efficiency plans demonstrating the exemplary role of public bodies in buildings' energy efficiency *(EED Article 5(7)a), Annex XIV Part 2.2, first sentence).*

(2) Please provide a list of public bodies having developed an energy efficiency action plan *(EED Annex XIV Part 2.3.1).*

Since 2009, Ordinance (2009:893) on energy-efficiency measures for authorities has regulated the measures that State authorities (i.e., courts and administrative authorities under the Government) must take to increase their energy efficiency. That Ordinance was designed in the light of the provisions of the Energy Services Directive (2006/32/EC). A total of 180 State authorities are covered by the Ordinance.

The public sector in Sweden includes a total of 180 State authorities, 290 municipalities and 21 county councils. Under the Municipal Energy Planning Act (1977:439), each municipality must have a current plan for the supply, distribution and use of energy, which is considered to largely meet the requirements of the Directive concerning the obligation of Member States to encourage public bodies at a local and regional level to adopt an energy efficiency plan.

To enable the State authorities to play the role of forerunner, the authorities must develop a strategy including targets and an energy efficiency action plan and report annually on their progress. Purchase of goods, services and buildings with high energy performance must be included in the action plan. The authorities must adopt an energy efficiency plan that includes specific targets and measures for energy saving and energy efficiency. The Swedish Energy Agency, *Upphandlingsmyndigheten* [The National Agency for Public Procurement], and the Swedish Environmental Protection Agency cooperate to assist the authorities with this.

The authorities must introduce an energy management system, including energy audits, as part of the implementation of the plan. Where appropriate, the State authorities must also use energy service companies and agreements on energy performance to finance renovations and implement plans to maintain or improve energy efficiency in the long term.

The authorities that do not have an environmental management system in accordance with the Ordinance (2009:907) on environmental management in State authorities should introduce an energy management system.

The regulations that govern how energy efficiency in public buildings should be achieved also include requirements on other public procurement.

The main thrust is that the regulations that apply to State authorities must also apply to other public bodies. This presupposes instruments and initiatives by the State to stimulate energy efficiency.

The Government has put in place a State subsidy that applies to improvement of school premises. It applies for the 2015–2018 period and concerns improvement of school premises in order to improve the learning environment and the working environment and reduce the environmental impact.

The programmes *Uthållig kommun* [Sustainable Municipality] and Energy efficiency aid for municipalities and county councils ended in 2014. Nevertheless, the Swedish Energy Agency considers that these programmes created kinds of activities and networks that continue to exist.

4.3.3 Article 6: Purchasing by public bodies

Please provide information on steps taken or planned to ensure that central government purchase products, services and buildings with high-energy efficiency performance, (EED Article 6(1)), and on measures undertaken or planned to encourage other public bodies to do likewise *(EED Article 6(3), Annex XIV Part 2.2, first sentence).*

The Ordinance on authorities' purchases of energy-efficient products, services and buildings (2014:480) regulates State authorities' purchases with regard to energy efficiency. Exceptions are possible for reasons such as cost-effectiveness, economic feasibility, sustainability in a wider sense or sufficient competition

Municipalities' and county councils' procurements are not governed by the aforementioned Ordinance, but they are still expected to carry out energy-efficient procurements to achieve both their own objectives and Sweden's objectives.

The Act (2011:846) on the environmental requirements for the procurement of cars and some public transport services has been in force since 1 July 2011.

In order to comply with the Act, the procuring authority must impose environmental requirements, including energy consumption, for the procurement of vehicles (light and heavy) and certain public transport services.

Most State authorities are tenants. Energy performance requirements for State authorities' leases for premises are governed by the provisions contained in Article 6 EED. These take effect only when State authorities renegotiate leases.

4.4 Other instruments for increasing energy efficiency, including in industry and transport

(1) Please provide details on significant energy efficiency improvement measures in industry in view of achieving the national energy efficiency targets referred to in EED Article 3(1) *(EED Article 24(2), Annex XIV Part 2.2, first sentence).*

(2) Please provide details on significant energy efficiency improvement measures in passenger and freight transport in view of achieving the national energy efficiency targets referred to in EED Article 3(1) *(EED Article 24(2), Annex XIV Part 2.2, first sentence).*

(3) Please provide details of other significant end use energy efficiency measures which contribute towards national energy efficiency targets which are not reported on elsewhere in the NEEAP *(EED Article 24(2), Annex XIV Part 2.2, first sentence).*

4.4.1 Industry

With support from the European Regional Development Fund, the Swedish Government launched a programme for small- and medium-sized enterprises to make their energy consumption more efficient. The programme involves a total of SEK 560 million spread over seven years, half of which is paid by Swedish Government and half by the European Regional Development Fund through the Swedish Agency for Economic and Regional Growth.

The aim is to enable small- and medium-sized enterprises to carry out work on energy-efficiency in a systematic, structured way. The individual projects are tailored to companies' needs and are implemented in collaboration with county administrative boards, municipalities, regional energy offices and the Swedish Energy Agency.

The objective is for companies to develop enhanced skills as clients, see that energy efficiency is low-risk and make energy efficiency a strategic matter. In addition, efforts are made to ensure that energy-efficient products and energy services are available, well-known and that they meet requirements.

Projects currently exist within networks (for undertakings with energy consumption > 1 GWh), energy audit support (for undertakings with energy consumption > 300 MWh), coaches for energy and climate matters (for undertakings with energy consumption < 300 MWh), incentives for energy efficiency (undertakings subject to supervision under the Swedish Environmental Code), regional nodes at Energy Agencies of Sweden for supporting undertakings that seek energy audit support and environmental studies for investment and energy services.

Program för energieffektivisering inom energiintensiv industri**,** PFE [Programme for energy efficiency in energy-intensive industries], introduced in 2004, this was a voluntary agreement between individual companies and the Swedish Energy Agency. The agreement meant that a company, if it met the requirements in the PFE programme, obtained a tax exemption from energy tax on electricity (SEK 0.005/kWh)[38], which was introduced on 1 July 2004 after adaptation to the EU Energy Tax Directive[39]. Companies developed greater knowledge of their energy consumption through PFE.

Companies that participated in PFE would conduct an energy audit and introduce an energy management system[40] and procedures for energy considerations when purchasing equipment with high electricity consumption and when carrying out new project planning, changes or renovations of activities. Energy audits and analyses must be carried out from the perspective of a system and must be both long- and short-term. They must also result in initiatives to increase energy efficiency. Companies should implement initiatives with a repayment period of less than three years during the programme period.

However, the European Commission noted that the tax reduction was contrary to the State aid rules and for that reason PFE is gradually being phased out by 2017, though in such a way that participating companies have time to complete their commitments.[4141]. Because PFE is still in progress for the companies that joined in 2012, the programme is described here.

Networks

Several industry-specific networks for energy efficiency have existed in Sweden. These networks, which usually also received public support, have generally functioned according to a template in which the participating companies together built up expertise on energy efficiency through auditing, implementation and evaluation over a period of four years.

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[38] Companies that participate and meet the programme requirements can obtain a tax reduction on energy tax from SEK 0.005/kWh to SEK 0/kWh.

[39] The requirements to be met in PFE and which therefore form the basis for a tax reduction are governed in laws and ordinances on energy efficiency programmes. The condition for the tax reduction, i.e. that the company must participate in an energy efficiency programme, is regulated in the Energy Tax Act.

[40] Energy management systems are a tool for dealing with energy matters in an organisation in a consistent and systematic manner. The management system allows companies to plan, implement, monitor and improve their energy consumption.

[41] The PFE Act was repealed in 2012

Although some networks have formally ended, their effects must still be seen as important components for energy efficiency in industry, because the purpose of the network was to create lasting expertise at the companies.

The aim of the network in the mining and steel industry[42] is to increase expertise and provide tools to improve energy efficiency at all levels within the companies in the industry by means of three sub-projects. The sub-projects relate to education, an online-based energy manual and a network.

The network for energy efficiency, ENIG, consists of a network of experts, industries, energy agencies, energy and climate advisers for increasing energy efficiency in small and medium-sized enterprises in manufacturing. The focus is on casting, surface treatment, heat treatment, sheet metal forming and plastic processing. The original main objectives of the project were to reduce companies' energy consumption by 5 per cent per year – a total of 30 per cent by 2015. The Swedish Energy Agency's aid ended on schedule in 2015 and the network is now endeavouring to market its expertise. The network was launched in June 2009. Energy efficient sawmills, EESI, endeavoured to demonstrate that it is possible to reduce the specific use of energy in the sawmill industry by at least 20 per cent by 2020. These results are achieved through a programme for energy efficiency containing everything from energy consumption audits to modelling of energy efficiency opportunities and a plan for demonstration at selected sawmills. The network was launched in January 2010 and the second phase was completed in 2014.

Projektet GeniAL stands for "*Gemensamma energinätverk inom aluminiumbranschen*" [Joint energy network in the aluminium industry]. The aim of the project is to increase expertise, identify and implement measures and provide tools for long-term improvements in energy efficiency in the aluminium industry through cooperation on industry advice and networks. Public financing has ceased, but the network continues to exist.

Jernkontoret (the Swedish steel producers' association) carries on networking with its member companies in the field of energy but without financial support from the Swedish Energy Agency. *Jernkontoret* conducted the research programme *Jernkontorets Energiprogram* [the Jernkontoret Energy Programme] with support from the Swedish Energy Agency between 2006 and 2011. The research initiatives carried out in the programme are estimated to have led to efficiencies equivalent to 894 GWh per year over a ten-year period. Most of the potential for efficiency is estimated to have already been fulfilled. In certain projects, parts of the results have already been implemented in production. Energy efficiency naturally means a major significant benefit to the industry in the form of reduced costs for energy and raw materials.

[42] The network is an initiative that involves exchange of information and expertise. For example, there are different groups and networks within the industry.

4.4.2 Transport

Greater energy efficiency is about solving accessibility for persons and goods in society while reducing energy consumption for transport. This can be achieved by vehicles and infrastructure becoming more energy efficient but also by reducing the need for travel and transportation.

Requirements for vehicles and tyres within the EU

Provisions[43] on carbon dioxide emissions from new passenger cars were adopted in 2009. The Regulation will lead to average carbon dioxide emissions for new passenger cars being reduced to 130 grams per kilometre by 2015. The EU adopted Regulation 661/2009, containing rules for vehicles and tyres, in 2009. The Regulation introduced requirements on systems for monitoring tyre pressure, traction, maximum rolling resistance and rolling noise from 1 November 2012. Requirements on tyre markings were also adopted later in the year[44]. Tyres must be marked according to their rolling resistance, rolling noise and wet grip.

Vehicle tax

Sweden introduced carbon dioxide differentiated vehicle tax for passenger cars in 2006 through the Road Traffic Tax Act[45]. Vehicle tax for light goods vehicles, light buses and motor homes is also CO^2-differentiated for vehicles registered after 2010. From 1 July 2009, green vehicles are exempt from vehicle tax for the first five years. This tax exemption was broadened in 2013 to cover mobile homes, light goods vehicles and light buses.

The tax for passenger cars, motor homes, light goods vehicles and light buses was increased on 1 January 2015. For cars registered in 2006 or later and cars that meet the requirements for environmental category 2005, electricity and hybrid, the increase is greater the more carbon dioxide the vehicle emits. The same is true of motor homes, light goods vehicles and light buses, which became subject to tax for the first time after 2010. The emissions level has been reduced from 120 grams of carbon dioxide per kilometre to 111 grams of carbon dioxide per kilometre (2015). Carbon dioxide-based tax is therefore paid for each gram exceeding 111 grams of carbon dioxide per kilometre.[46]

Ordinance on authorities' purchases and leasing of green cars

Environmental requirements have been imposed on State authorities' purchasing and leasing of cars since 2005 (SFS 2004:1364). These have since been supplemented with road safety requirements

[43] EC Regulation 443/2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles
[44] Ordinance (1222/2009).
[45] SFS 2006:227, Road Traffic Tax Act.
[46] Vehicle tax in the carbon dioxide-based system is payable at a basic amount of SEK 360 and a carbon dioxide amount that, since 2011, has been SEK 20 per gram of carbon dioxide over 117 grams emitted by the vehicle per kilometre in mixed driving. For vehicles that can be run on alcohol or gas (other than LPG) the carbon dioxide amount is SEK 10 per gram of carbon dioxide.

and the proportion for environmental cars was raised from 85 to 100 per cent by Ordinance SFS 2009:1 (amendment to SFS 2011:351).[4747]

Other authorities' (municipalities, county councils, publicly-owned companies, etc.) bulk purchases are governed by the EU Directive on the promotion of clean and energy-efficient road transport vehicles. The Directive has been implemented in Sweden by the Act on the environmental requirements for the procurement of cars and some public transport services (Government Bill 2010/11:118).

Supermiljöbilspremie [Super Green Car Premium]

In December 2011, the Government decided to introduce a super green car premium. The aim is to attempt to increase sales and use of new cars with a low impact on the climate. (Ordinance 2011:1590). The premium covers passenger cars with very low emissions of greenhouse gases, a maximum of 50 grams of carbon dioxide per km, which mostly consist of plug-in hybrids and pure electric cars. Since 2016, the premium amounts to SEK 40,000 per pure electric car and SEK 20,000 for plug-in hybrids for private individuals and 35 per cent of the difference in the new car price and the price of the closest comparable car (though up to a maximum of SEK 20,000 or SEK 40,000, as above) for companies, the public sector and associations.

Taxation of company cars

Tax on fringe benefits is permanently reduced for green cars. Since 1 January 2012, only rechargeable electric cars and gas cars (not LPG) are covered by an additional time-limited reduction in the value of the benefit. Electric and plug-in hybrids cars, which can be recharged from the electricity network, and gas cars (not LPG) are first adjusted to a comparable car without environmental technology. The tax on fringe benefits is then reduced by 40 per cent, a maximum of SEK 16,000. This applies only if the car has a new car price that is higher than the price of the closest comparable car. Ethanol cars, hybrid cars that cannot be recharged from the electricity network and cars that can run on LPG, rapeseed methyl ester and other types of environmentally acceptable fuels are only adjusted downwards to a comparable car.

Congestion charges and other local initiatives

The congestion charge was introduced permanently in Stockholm on 1 August 2007. The tax was also introduced in Gothenburg in 2013 and conforms to the same principle as in Stockholm. The congestion charges in Stockholm and Gothenburg primarily aim to increase accessibility and improve the local environment and finance infrastructure investments – but indirectly are also of significance for energy consumption and carbon dioxide emissions.

Locally, municipalities can also influence car use without using congestion charges through parking charges, parking rules and

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[47] "Green car" is considered to mean cars that can run on ethanol, CNG gas or electric and fossil-fuelled vehicles with maximum carbon dioxide emissions of 120 g/km. Energy requirements are also imposed on ethanol, gas and electric powered vehicles.

parking policy. Increases in parking charges make alternatives to the car more attractive.

Lower speed and economical driving

There are currently over 1,000 traffic safety cameras in the Swedish road network. Many municipalities in Sweden introduced new lower speed limits in 2010–2011, with 30 or 40 km per hour as the norm in densely populated areas. There is a strong link between speed and fuel consumption, with increased consumption from around 50 km per hour.

Since 2007, economical driving requirements have been included in driving instruction and driving tests for class B driving licences (passenger cars). Those requirements were subsequently extended to all classes. The requirements include both practical and theoretical elements. The concept of economical driving is also considered to have potential in rail services. Installing energy meters and the use of Drive Style Manager reduces energy consumption in both new and old vehicles.

Green corridors

Green corridors is a Swedish initiative launched by the European Commission in 2007. National and international freight transport will be concentrated on long journeys, abolishing bottlenecks and coordinating regulations. Modes of transport will be used optimally through logistical solutions and strategically placed transhipment terminals with customised support infrastructure. The green corridors will also be a platform for innovative logistical solutions and demonstration of good examples. The work is characterised by close interaction between society, business and academia.

Improved energy efficiency in infrastructure

In addition to the energy consumption to which road and rail traffic gives rise, energy is also used for construction, operation and maintenance of infrastructure. As a rough estimate, this represents around 10 per cent of the energy consumed by road transport, which is just over 80 TWh in total. The Swedish Transport Administration has introduced energy efficiency as an area of focus within its own operations.

Climate Calculator is the Swedish Transport Administration's model for effectively and consistently calculating the energy consumption and climate impact to which transport infrastructure gives rise from a life-cycle perspective. The governing guidelines entered into force in 2015. This means that a climate calculation must be drawn up for investments over SEK 50 million. The climate calculation is published on the Swedish Transport Administration's website.

The Swedish Transport Administration has been working to identify and calculate the one-time effects on the energy and climate area in its investment projects for several years. The work is summarised to enable the experience to be disseminated more easily in client organisations and to suppliers.

A handful of selected investment projects report on their energy efficiency measures in information sheets. The information sheets are updated on an annual basis until each activity has been carried out and evaluated according to the area of activity.

The Swedish Transport Administration has been working for several years on a lighting strategy involving a change to more energy efficient fittings, turning off unnecessary lighting and also moving lighting from roadways to cycle paths and pedestrian pathways.

Work on more energy-efficient lighting is also being carried on in the maritime sector. In order to reduce energy consumption and increase lifespans in navigable channel markings, LED technology is being used in more and more applications such as light buoys, which has also contributed to fewer purchases of batteries, even though the number of light buoys has risen. Fewer maintenance transports are also required. In addition, since 2012, *Sjöfartsverket* [the Swedish Maritime Administration] has been implementing an energy-efficiency project for its own vessels and has achieved savings of 1.6 per cent mainly in the use of fossil fuels.

Information initiatives

There are many different types of information activities that affect energy consumption in the transport sector.

The Climate Barometer provided by the Swedish Transport Administration shows the amount of carbon dioxide emitted from road traffic from all cars, goods vehicles, buses, motorcycles and work machinery in Sweden. The Barometer is updated each month.

The Climate Barometer specifies the sum of all carbon dioxide emissions for all fuels, petrol and diesel, and also ethanol, biodiesel (FAME and HVO), natural gas and biogas. The calculation includes all emissions, from manufacturing and distributing a fuel and from burning it in a motor. The Barometer provides a more complete picture and allows for closer follow-up than has previously been possible through, for example, a car index.

The Consumer Agency and the Swedish Energy Agency cooperate to develop and manage a portal for information and facts on cars for consumers, "Bilsvar.se". The work is carried on in collaboration with the Swedish Transport Administration, which contributes expertise on various matters whenever required. The purpose of Bilsvar.se is to provide consumers with easily accessible and reliable information on new and used car models, which allows them to be more knowledgeable and active in the market. Before every purchasing decision, consumers should have sufficient information to choose a model on the basis of their needs, financial conditions and from an environmental perspective.

The website www.miljofordon.se, which has been co-financed by the Swedish Energy Agency since 2011, is available for green vehicles.

Research

The Swedish Energy Agency and other authorities and organisations finance research in the transport sector. The Swedish Transport Administration finances research that covers all aspects of climate impact and energy consumption in road and rail. The Swedish Maritime Administration's research relates to the vessel, its physical design, power sources, fuel and emissions, as well as matters relating to increasing efficiency throughout the transport chain. The Swedish Energy Agency's research is carried on in the areas of alternative fuels and energy-efficient vehicles, among others.

Fordonsstrategisk Forskning och Innovation (FFI) [Strategic Vehicle Research and Innovation] is a partnership between the Swedish Government and the automotive industry for joint funding of research, innovation and development concentrating on Climate, Environment and Safety. The Swedish Energy Agency is responsible for the *Energi & Miljö* [Energy & Environment] cooperation programme. The programme is focused on vehicle-related research, innovation and development activities in energy efficiency, propulsion systems for renewable fuels, electrical power, local and/or regional environmental impact and other energy technologies with the potential to strengthen Sweden's and the Swedish automotive industry's competitiveness in a global perspective. The FFI initiative came about due to the fact that developments in road transport and the Swedish automotive industry are of great importance for growth.

The initiative involves research and development activities amounting to approximately SEK 1 billion per year, of which public funds account for approximately SEK 410 million per year.

The programme "*Energieffektivisering i transportsektorn*" [Energy efficiency improvements in the transport sector] has a budget of SEK 175 million for the 2014–2019 period. The programme will help ensure that the potential for energy efficiency improvements in the transport system is fulfilled through new methods, approaches and solutions for greater expertise on:

- transfer of freight and passenger transports to more energy-efficient modes of transport.
- energy efficiency improvements for freight or passenger transport solutions.
- social planning that brings about conditions for an energy-efficient transport system.
- behaviour of both individuals and organisations and their motivations and capacity for change.
- safeguarding the opportunities for digitalisation for the development of energy-efficient working methods and solutions in the passenger and freight transport sector.
- analysis of possible instruments for bringing about an energy-efficient transport system

Collaboration with the public sector and the business community

Broad-based work to limit the impact of transport on the climate has been going on since the late 1990s. Initiatives implemented with the public sector and the business community form an important part of this. It is a question of information, coordination and financial support for projects. Some of the initiatives included consist of social planning for reduced car use, choice of energy-efficient travel or transportation methods, choice of energy-efficient vehicles, car pools, improved logistics for passenger and freight transport, economical driving, greater observance of speed restrictions and reduced use of studded tires.

Sweden is cooperating with Finland to make ice-breaking more efficient. Ice-breaking is an energy-intensive service offered to maritime transport. Better coordination between the States' ice-breaking operations can result in lower energy consumption for the same level of service. A formal 20-year cooperation agreement was signed in 2012.

4.5 Instruments for efficient heating and cooling

4.5.1 Comprehensive assessment

(1) In the second and subsequent NEEAPs please provide an assessment of the progress achieved in implementing the comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling referred to in Article 14(1) *(EED Article 14(1), Annex XIV Part 2.3.4).*

(2) Please provide description of the procedure and the methodology used for carrying out a cost benefit analysis to satisfy the criteria of EED Annex IX *(EED Article 14(3), Annex IX Part 1, last paragraph, Annex XIV Part 2.2. first sentence).*

District heating is widespread in Sweden. District heating is the most common type of energy in apartment buildings. Around 90 per cent of the heating of these buildings takes place using district heating. Almost 80 per cent of non-residential premises are heated by district heating. The total use of district heating amounts to over 50 TWh. Because district heating is used extensively, the potential for further expansion is relatively small.

In a report (ER 2013:09), the Swedish Energy Agency points out the potential for the development of cogeneration, district heating and district cooling based on cost-benefit calculations from a range of different reports. That assessment of the potential assumes that, in principle, existing instruments internalise external costs. Given that assumption, the market will implement the projects that are profitable, taking any externalities into consideration. The operators can thus be said to be acting in a socio-economically efficient manner. The Swedish Energy Agency states that current instruments are sufficient inasmuch as no new or other instruments are necessary to develop the district heating market because in principle it is already fully developed.

Many of the sources have used estimates from the MARKAL and MAPvKAL-NORDIC[48] models. The target function is generally the discounted total system cost and must be minimised. The models use net present value as an evaluation criterion. The real imputed interest rate is set at 7 per cent.

The need for heating and cooling is classified by sector (apartment buildings and non-residential premises, houses, industry & others), but not geographically. However, the calculations are based on Sweden's geographical boundaries, but also take imports and exports into account.

55 TWh of district heating was produced in 2011. The analysis shows that there is remaining potential for expansion of district heating, district cooling, and cogeneration. That potential is limited by the fact that there has already been considerable expansion, except in district cooling. The potential for additional district heating has been calculated at 4 TWh by 2020 and 8

TWh by 2030. However, at the same time, 12 TWh of district heating is expected to disappear, which means a net reduction of 4 TWh.

District cooling production currently amounts to almost 1 TWh. For district cooling, the potential has been assessed at a further 1 TWh by 2020 and 2 TWh by 2030. In 2011, electricity from cogeneration amounted to 10.5 TWh in district heating networks and 6 TWh in industry. The potential for cogeneration consists of both cogeneration in the district heating system and cogeneration in industry, so-called industrial counter pressure. The additional potential for electricity production from cogeneration amounts to 5 TWh by 2020. Thereafter, it is considered that only marginal contributions will occur by 2030.

The overall primary energy savings from the potential expansion of cogeneration, district heating and district cooling are calculated at 9.75 TWh by 2015, 14 TWh by 2020, 15.5 TWh by 2015 and, at most, 16 TWh by 2030.

4.5.2 Other instruments for efficient heating and cooling

Please provide a description of measures and strategies, including programmes and plans, at national, regional and local levels to develop the economic potential of high-efficiency cogeneration and efficient district heating and cooling and other efficient heating and cooling systems as well as the use of heating and cooling from waste heat and renewable energy sources *(EED Article 14(2) and (4), Annex XIV Part 2.2, first sentence).*

to relate to. When an expansion is profitable, it is implemented through market forces. Because the district heating market is already largely developed in Sweden, there is little or no room for any State initiatives to expand further. Besides, it would most likely mean a distortion of competition in the heating market. Nevertheless, the district heating market can be improved. Some assignments and proposals are set out below.

- Implementation of Article 14(5) of the EED. Principle for reporting the residual heat potential when designing new district heating production. (ER 2013:09)

- Price change test and equal treatment principle for district heating (Ei R 2013 07)

- Regulated access to district heating networks (Ei R 2013 04)

- Overhaul of Swedish National Board of Housing, Building and Planning building regulations to obtain competition and technology neutrality

- Overhaul of distorting tax rules

However, the Swedish Energy Agency has objected to the proposal put forward by the EI [Energy Markets Inspectorate] for price change testing and regulated access to the district heating networks.

A research programme, Fjärrsyn, will develop new expertise for developing existing and new district heating systems and will also assess the effects of the changes in the surrounding environment that affect Swedish district heating systems. Fjärrsyn is being implemented in the 2013–2017 period and is a further development of earlier periods of the programme with the same name. It takes the form of a cooperation programme. The Swedish Energy Agency cooperates with Swedish Fjärrvärme, which also manages the programme.

4.6 Instruments in transformation, transmission and distribution of energy

4.6.1 Energy efficiency criteria for network tariffs and network regulations

(1) Please describe planned or adopted measures to ensure that incentives in tariffs that are detrimental to the overall efficiency of the generation, transmission, distribution and supply of energy, or might hamper participation of demand response in balancing markets and ancillary services procurement, are removed *(EED Article 15(4), Annex XIV Part 2.2, first sentence).*

(2) Please describe planned or adopted measures to incentivise network operators to improve efficiency through infrastructure design and operation *(EED Article 15(4) Annex XIV Part 2.2, first sentence).*

(3) Please describe planned or adopted measures to ensure that tariffs allow suppliers to improve consumer participation in system efficiency including demand response *(EED Article 15(4), Annex XIV Part 2.2, first sentence).*

The Electricity Act was amended from 1 June 2014[48][49] to meet the requirements of the Energy Efficiency Directive. An explicit ban on tariffs that would adversely affect overall efficiency was thereby stipulated. Furthermore, it enabled the network authority (*Energimarknadsinspektionen* – the Energy Markets Inspectorate) to take into account to what extent the network concession holder's way of operating promotes energy efficiency. The network authority may decide on a reduction in the revenue framework for a network company that operates in a way that is not compatible with the efficient use of the electricity network. A company that, on the one hand, contributes to energy efficiency can, on the other, be ascribed a higher return on the capital base.

The stipulation in the Electricity Act, after the amendment, that the network tariffs must be designed in a way that is compatible with efficient use of the electricity network ensures that the tariffs do not constitute barriers for such system services or contain incentives that can hamper participation of demand response in balancing markets and procurement of ancillary services.

[48]

[49] Ordinance 2014:1064

4.6.2 Facilitate and promote demand response

Please provide information on other measures adopted or planned to enable and develop demand response, including those addressing tariffs to support dynamic pricing *(EED Annex XI(3), Annex XIV Part 2.3.6).*

In 2014, the Swedish Energy Agency and the Energy Markets Inspectorate carried out a government assignment to investigate the overall potential for improvements in efficiency in the infrastructure for electricity and gas (see the following section).

In autumn 2016, the Energy Markets Inspectorate investigated how demand flexibility could be developed.

4.6.3 Energy efficiency in network design and regulation

Please report on progress achieved in the assessment of the energy efficiency potential of national gas and electricity infrastructure, as well as adopted and planned measures and investments for the introduction of cost effective energy efficiency improvements in network infrastructure and a timetable for their introduction *(EED Article 15(2), Annex XIV Part 2.3.5).*

In 2014, the Swedish Energy Agency and the Energy Markets Inspectorate studied the potential for improved efficiency in the electricity and gas networks.

The energy efficiency potential in the electricity network by 2020 was assessed at 472 GWh/year and 820 GWh/year by 2020. The greatest potential exists in modified production, which falls outside the network companies' area of responsibility.

In relation to total losses, the assessed technical energy efficiency potentials are relatively small: 4% by 2020 and 7% by 2030. There are many other factors that have a far greater effect on the losses, for example geographical distance or weather conditions.

The new regulatory model for the network companies' revenue frameworks may have led to greater incentives for the companies to invest. However, the model is still in its first period and consequently no conclusions can yet be drawn.

In the transformer area, there is relatively large potential for reducing losses, particularly no-load losses, using modern nuclear materials with low losses. This is particularly interesting in the area of distribution, where the transformers are subjected to a fairly low load over time.

The loss reduction potential as a result of changes in consumption and production patterns is considered to be very small for the period contemplated – up to 2020 and 2030. This is fully determined by factors other than electricity network losses. However, some new production is expected to be established within regional and local networks. The more closely consumption and additional production are linked in, the greater the effect on loss reduction in transfer.

5 List of sources

The Swedish National Board of Housing, Building and Planning, Proposal for Swedish application of near-zero energy buildings, Report 2015:26

Commission Staff Working Document, Guidance for National Energy Efficiency Action Plans, SWD (2013) 180, final

Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity

Directive 2005/32/EC establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council

Directive 2006/32/EC on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC

Directive 2009/125/EC establishing a framework for the setting of Ecodesign Requirements for Energy-related Products

EC Regulation 1222/2009 on the labelling of tyres with respect to fuel efficiency and other essential parameters

EC Regulation 443/2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles

The Energy Markets Inspectorate, Price change test and equal treatment principle for district heating (Ei R 2013 07)

The Energy Markets Inspectorate, Regulated access to the district heating networks, Ei R 2013 04 Swedish Energy Agency, Energy Indicators, ER 2016:10

The Swedish Energy Agency, Energy consumption in the transport sector 2015, ES 2016:03 Swedish Energy Agency, the Energy Situation in 2015, ET 2015:08 Swedish Energy Agency, Scenarios of Sweden's energy system ER 2014:19 Swedish Energy Agency, Basis for the national energy efficiency action plan 2013:31

The Swedish Energy Agency, Certification of energy service providers, ER 2013:11

The Swedish Energy Agency, Energy audit checks. A socio-economic assessment, ER 2013:13

The Swedish Energy Agency, the Swedish Energy Agency's annual report for 2012, ER 2013:01

The Swedish Energy Agency, Energy Services in Sweden. A status report for energy efficiency, ER 2013:22

The Swedish Energy Agency, Are there barriers to competition in the market for energy services? ER 2012:26

The Swedish Energy Agency, Comprehensive assessment of the potential for using high efficiency cogeneration, district heating and district cooling, ER 2013: 24

The Swedish Energy Agency, Long-term forecasts 2012, ER 2013:03

The Swedish Energy Agency, The second national energy efficiency action plan ER 2010:32

European Commission, Preliminary draft excerpt - Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end-use efficiency and energy services

Ordinance 2016:385

Ordinance 2014:1064 on revenue frameworks for electricity network companies

Ordinance on authorities' purchasing of energy efficient products, services and buildings 2014:480

Ordinance 2009:1577 on State aid for energy audits

Government Bill 2008/09:163, An integrated energy and climate policy: Energy

Government Bill 2009/10:41, Certain excise duty questions concerning the 2010 Budget Bill.

Riksrevisionen [National Audit Office], Climate-related taxes – who pays?, RIR 2012:1

SF 2014:70

SF 2014:27

SFS 2006:227, Road Traffic Tax Act.

SFS 2008:112 on Ecodesign

SOU 2008:110, The Energy Efficiency Study

Stenkvist & Nilsson (2009) - Process and impact evaluation of PFE - a Swedish tax rebate program for industrial energy efficiency. Paper presented at 9th eceee summer study Act! Innovate! Deliver! Reducing energy demand sustainably, France.

The Swedish Transport Administration, Proposal for a national plan for the transport system 2014–2015

The Swedish Transport Administration, Report on a national plan for the transport system 2014–2025, preliminary version

www.eef.se

www.energimyndigheten.se

www.jordbruksverket.se

www.skatteverket.se

Annex 1 Supporting data for calculations

Annex 1 describes the statistics and assumptions used in the calculations. The methods recommended by the Commission have been used as far as possible. Deviations from the methods are set out in Annex 2. The Commission's recommended methods[50] include what are known as P, A and M methods. The P methods (preferred methods) are the methods that the Commission considers more appropriate for use than the methods referred to as the A methods (alternative methods) and the M methods (minimum methods). The choice of method to use depends on the availability of statistics. The selected indicators can be seen below in

Housing and services

For housing, savings are calculated using five indicators.

1. P1 - Energy consumption for heating in households per square metre
2. P2 - Energy consumption for cooling in households per square metre
3. P3 - Energy consumption for hot water in households per inhabitant
4. P4 - Electricity consumption per type of appliance (kWh/year)
5. P5 - Electricity consumption for lighting per household (kWh/year)

The statistics forming the basis for the calculations consist of Energy Statistics in houses, apartment buildings and non-residential premises, Annual electricity and district heating supply and the Energy balances.

The official energy statistics report energy consumption for heating and hot water together since they often cannot be separated due to the fact that heating and hot water are not metered separately in most households. In this work, the Swedish Energy Agency has chosen to use a standard of 80 per cent heat and 20 per cent hot water. Cooling is not used a great deal in Sweden, though it is increasing. . Nevertheless, there are no reliable statistics in which energy consumption for cooling is disaggregated from energy consumption for heating and hot water and electricity. For that reason, the P2 indicator is not considered relevant for Sweden. Because no great changes in energy consumption generally take place in the short term in housing and services, the statistics used for 2014 are also used for 2016. Table 11 shows the supporting data used for the calculations.

[50] European Commission, Preliminary draft excerpt - Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end-use efficiency and energy services

The calculations for the indicators P4 and P5 are based on sales statistics.[51] Due to lack of statistical quality for previous years, only late measures are included.

P1 - Energy consumption for heating in households per square metre

Early savings (2007–1995) are calculated as follows:

$$Besp. = \left[\left(\frac{Eh_{2007}}{F_{2007}} \cdot \frac{MDD_{30}}{ADD_{2007}}\right) - \left(\frac{Eh_{1995}}{F_{1995}} \cdot \frac{MDD_{30}}{ADD_{1995}}\right)\right] \cdot F_{2007}$$

Later savings (2007–2011 and 2007–2016) are calculated in an equivalent manner. **Table 13.**

Statistical basis for indicator P1

	1995	2007	2011	2016
Heating use (TWh) (actual) [Eh]	**60.4**	**46.0**	**44.2**	**47.2**
Hot water use (TWh) [Ew]	**15.1**	**11.5**	**11.0**	**11.8**
Area in housing [F]	**446**	**426**	**450**	**456**
Inhabitants in Sweden [P]	**8.8**	**9.2**	**9.5**	**9.9**
Heating degree days [ADD]	**3782**	**3283**	**3241**	**3740**
Heating degree days (normal year, last 30 years) *[MDD_{30}]*	**3841**	**3740**	**3740**	**3740**

Table 14. Calculation result for indicator P1

Indicator P1	**2011**	**2016**
Early savings (TWh)	6.2	6.2
Late savings (TWh)	4.3	8.8
Total savings P1	10.5	15.0

Because the calculations are carried out on final purchased energy consumption, the large installation of heat pumps means that the final energy consumption has decreased significantly and has resulted in significant savings. This is because absorbed energy of heat pumps is not included.

P2 - Energy consumption for cooling in households per square metre

Not applicable to Sweden due to the small-scale use of cooling and difficulties in separating energy consumption from heating and hot water.

[51] The calculations are based on data from IT Energy ApS and Energistyrelsen, Denmark.

P3 - Energy consumption for hot water in households per inhabitant

Early savings (2007–1995) are calculated as follows

$$Besp. = \left[\frac{Ew_{2007}}{P_{2007}} - \frac{Ew_{1995}}{P_{1995}}\right] * P_{2007}$$

Later savings (2007–2011 and 2007–2016) are calculated in an equivalent manner.

Table 15. Calculation result for indicator P3

Indicator P3	2011	2016
Early savings (TWh)	4.2	4.2
Late savings (TWh)	0.8	0.6
Total savings P3	5.0	4.8

In the same way as for heating, the large-scale installation of heat pumps and conversion of oil means that the final energy consumption for hot water has decreased significantly and has resulted in significant savings.

P4 - Energy consumption for household appliances

$$(UEC^x_{2016} - UEC^x_{2007}) * stock^x_{2016}$$

Where UEC^x refers to electricity consumption per appliance type (x) and stock is the total number of appliances by type.

Table 16 Average energy consumption per appliance (kWh/year)

$[UEC^x]$	2007	2011	2016
Refrigerators	249	212	177
Fridge-freezers	322	275	225
Washing machines	233	218	204
Dishwashers	330	306	282
Clothes dryers	500	471	438
TV	398	364	230

Table 17 Number of appliances in the stock

[stock"]	2007	2011	2016
Refrigerators	3,669,985	4,094,359	4,501,883
Fridge-freezers	1,707,413	1,858,915	2,015,920
Washing machines	2,333,394	2,708,257	3,098,886
Dishwashers	2,117,525	2,537,268	2,978,001
Clothes dryers	932,004	1,095,787	1,324,612
TV	2,547,145	5,787,869	7,486,721

Late savings (2007–2016) are calculated by taking the difference between the key ratio (average energy consumption per year per appliance type) for 2016 and 2007 and multiplying it by the total number of appliances (per type) in 2016. The corresponding calculation is carried out for 2011.

Table 18 Savings for appliances (GWh)

Indicator P4	2011	2016
Refrigerators	150	322
Fridge-freezers	87	196
Washing machines	40	91
Dishwashers	61	143
Clothes dryers	31	82
TV	193	1,254
Total	**562**	**2,088**

P5 - Energy consumption for lighting:

$$Besp. = \left(\frac{E_{2016}^{H,li}}{D_{2016}} - \frac{E_{2007}^{H,li}}{D_{2007}}\right) * D_{2016}$$

Where $E^{H, li}$ refers to electricity consumption for lighting in households and D refers to the number of households.

Table 19 Estimated energy consumption for lighting in households

	2007	**2011**	**2016**
Energy consumption lighting (kWh/year and household), [(E)^{Hli}]	797	494	464
Number of households (in 1000s), [D]	4,477	4,656	4,656

Late savings (2007–2016) are calculated by taking the difference between the key ratio (electricity consumption for lighting per household) for 2016 and 2007 and multiplying it by the total number of households in 2016. The corresponding calculation is carried out for 2011.

Table 20 Savings for lighting (GWh)

Indicator P5	2011	2016
Lighting	1,407	1,550

Service sector

The following indicators are used for the service sector.

1. P6 - Energy consumption (not electricity) in each subsector per square metre

2. P7 - Energy consumption (only electricity) in each subsector per square metre

The subsectors that the Swedish Energy Agency chose to divide up are as follows:

- Public administration and government services
- Offices
- Hospitals
- Wholesale and retail trade services
- Hotels and restaurants
- Other

It is important to note that the statistic broken down at this level may in some cases be unreliable and vary somewhat between the years. This is because carrying out divisions of this kind is problematical. Other is calculated as a residual item and forms a large proportion of the total energy consumption in the sector. No early savings (1995–2007) are calculated since that is difficult with comparable statistics broken down into different sectors for 1995. For 2016, it is assumed that the normal year adjusted energy consumption and area will be the same as in 2011. This is because it is difficult to divide up these figures from the long term forecasts the Swedish Energy Agency carried out in 2012 and such a division is of limited value.

Below are three tables with statistics forming the basis for the calculations. The first table relates to energy consumption excluding electricity for various sectors. The second relates to electricity consumption and the third to area.

Table 21. Energy consumption (not electricity) divided into different subsectors [Enonel] (TWh)

	2007	2011	2016
Public administration and government services	0.38	0.64	0.74
Offices	2.36	2.07	2.39
Hospitals	2.26	1.92	2.21
Wholesale and retail trade services	1.04	1.12	1.29
Hotels and restaurants	0.55	0.69	0.79
Other	13.86	13.09	15.10
Heating degree days [ADD]	3283	3241	3740
Heating degree days (normal year) *[MDD_{30}]*	3740	3740	3740

Table 22. Electricity consumption in TWh divided into different subsectors [Eel].

	2007	2011	2016
Public administration and government services	1.56	1.41	1.41
Offices	3.82	3.75	3.75
Hospitals	3.27	2.69	2.69
Wholesale and retail trade services	5.89	5.80	5.80
Hotels and restaurants	1.48	1.64	1.64
Other	10.32	10.04	10.04

Table 23. Area in million square metres divided into various sub sectors [I].

	2007	2011	2016
Public administration and government services	4.6	6.9	6.9
Offices	28.6	22.4	22.4
Hospitals	22.5	18.6	18.6
Wholesale and retail trade services	16.3	15.8	15.8

	2007	2011	2016
Hotels and restaurants	7.3	7.3	7.3
Other	79.4	81.1	81.1

P6 - Energy consumption (not electricity) in each subsector per square metre

The formula for the savings for each subsector up to 2016 is as follows:

$$Besp. = \left[\left(\frac{E_{2016}^{non-el}}{IA_{2016}} * \frac{MDD_{30}}{ADD_{2016}}\right) - \left(\frac{E_{2007}^{non-el}}{IA_{2007}} * \frac{MDD_{30}}{ADD_{2007}}\right)\right]$$

Table 24. Energy consumption per subsector

Indicator P6 in TWh	2011	2016
Public administration and government services	0.09	0.09
Offices	0.29	0.29
Hospitals	0.09	0.09
Wholesale and retail trade services	0.14	0.14
Hotels and restaurants	0.16	0.16
Other	-1.02	-1.02
Total savings P6	-0.26	-0.26

Overall, there will be no savings, but rather a sharp increase for non-electricity consumption between 2007 and 2016 for the indicator.

P7 - Electricity consumption in each subsector per square metre

The formula for the savings for each subsector up to 2016 is as follows

$$Besp. = \left[\frac{Eel_{2016}}{I_{2016}} - \frac{Eel_{2007}}{I_{2007}}\right] * I_{2016}$$

Table 25. Electricity consumption per subsector

Indicator P7 in TWh	2011	2016
Public administration and government services	-0.93	-0.93
Offices	0.77	0.77
Hospitals	-0.01	-0.01
Wholesale and retail trade services	0.09	0.09
Hotels and restaurants	0.16	0.16
Other	-0.50	-0.50
Total savings P7	-0.42	-0.42

Overall, there will be no savings, but rather a sharp increase for electricity consumption between 2007 and 2016 for the indicator.

In total, there will be no savings in non-residential premises. Instead, there will be an increase of 0.68 TWh

Table 26. Total energy consumption per subsector

Indicators P6 and P7	2011	2016
Savings P6 (TWh)	-0.26	-0.26
Savings P7 (TWh)	-0.42	-0.42
Total savings	-0.68	-0.68

Industry

The Directive only includes energy consumption in industries outside the emissions trading scheme. For that reason, the energy consumption of the fossil fuels in the trading sector have been excluded. This has been done by calculating the trading sector's share of the energy consumption for each energy carrier in each industry. These shares have been used to exclude the energy consumption of different energy carriers that are included in the emissions trading scheme. The same share was used for both 2007 and 2016 in order to ensure comparability between the calculations.

Early initiatives

No early initiatives were calculated.

Late initiatives

The M8 method was used to calculate the saving for 2007–2016, see Annex 2. The Long-term scenarios 2014[52] were used.

The calculation is carried out per energy carrier and industry with the same distribution as in the Swedish Energy Agency scenario, i.e. on 14 energy carriers[53] and 11 industries[54]. The chosen industry and fuel classification affects the results of the calculations.

In order to reduce the impact of structural effects, the calculations were carried out using the most finely-divided distribution at industry level. However, due to the structure of the method (M8) and the scenario, it was not possible to fully exclude the effects of fuel substitution, for example, or all structural effects.

Transport

Early initiatives

The saving from early initiatives has been calculated using the Commission's top-down methods. In the absence of statistics from the mid-1990s, the minimum methods have been used to calculate rail and maritime transport. The following methods have been used to calculate the improvement in efficiency for early initiatives:[55]

- Passenger cars (P8)
- Heavy goods vehicles (P9)
- Light goods vehicles (P9 A2)
- Rail (M6)
- Maritime transport (M7)

Table 27 shows the calculated saving for the transport sector.

[52] The Swedish Energy Agency, Scenarios relating to Sweden's energy system, ER 2014:19
[53] The energy carriers are coal, coke, petroleum coke, biomass fuel, liquefied petroleum gas, petrol, diesel, fuel oil 1, fuel oil 2–6, natural gas, town gas, coke and blast furnace gas, district heating and electricity.
[54] The industries are the mining industry (05-09 in SNI 2007), the food industry (10-12), the textile industry (13-15), the wood products industry (16), the pulp and paper industry (17), the publishing industry (18), the chemical industry (20–21), plastic and rubber (22), the soil and stone industry (23), iron, steel and metal works (24) and the engineering industry (25-30)
[55] Some adjustments have been made to the Commission's indicators, as shown in Annex 2.

Table 27 Calculated saving from early initiatives in the transport sector.

	2011 (TWh)	2016 (TWh)
Early initiatives		
Passenger cars (P8)	3.33	3.33
Heavy goods vehicles (P9)	0.06	0.06
Light goods vehicles (P9 A2)	-0.21	-0.21
Rail (M6)	0.19	0.19
Maritime transport (M7)	-0.31	-0.31
Total improvement in efficiency, early initiatives	**3.1**	**3.1**

The Commission's calculation methods are presented in Annex 2. The calculated saving is simplified using the following method:

$$Besparing = \left(\frac{E_0}{A_0} - \frac{E_t}{A_t}\right) * A_t$$

E = energy consumption; A = activity; 0 = start year; t = end year.

The saving is the difference in energy consumption per activity between the start year and the end year, multiplied by the activity for the end year.

The saving therefore depends on the situation in the start year and the end year. To reduce the impact of individual years, the saving for early initiatives has been carried out using the average values over three years instead of only using the statistics for the start year and end year as a basis.

Late initiatives

Forecast for transport activity

"Forecasts for freight transport 2030" and "Forecasts for passenger travel" have been used as a basis for transport activity.[56] These forecasts were produced in 2012 as a basis for the Swedish Transport Administration's planning of measures[57]. Both the statistics and the forecasts for transport activity have been revised and lowered since the second action plan. . The rate of development according to the Swedish Transport Administration forecasts have been used for 2011 onwards. The Swedish Transport Administration forecasts apply up to 2030 and, apart from the fall in 2012, the progress during the forecast period is assumed to be essentially linear. Tables 28 and 29 show the forecast progress of freight and passenger transport activity.

[56] The Swedish Transport Administration, Report on a national plan for the transport system 2014–2025, preliminary version
[57] The reference scenario has been used in this work (in the Swedish Transport Administration forecasts, this scenario is referred to as *Basprognos* [Base Forecast] 2030).

Table 28 Statistics for freight transport activity in 2007 and forecast progress in 2011 and 2016 (million tonne-kilometres).

	2007	2011	2016
Road	40,525	38,333	44,301
Rail	23,250	22,864	23,585
Maritime transport	7,246	7,508	7,780

Table 29 Statistics for passenger transport activity in 2007 and forecast progress in 2011 and 2016 (million person-kilometres).

	2007	2011	2016
Car	99,315	103,194	112678
Rail	10,261	11,378	12,063
Tram services	2,204	2,340	2,592
Bus	8,655	8,766	8,786

Energy consumption for passenger cars and goods vehicles

The results from the Swedish Transport Administration supporting data for climate reports have been used for energy consumption, though they have been adjusted slightly to conform to the transport activity described in Tables 28 and 29. The results from the model are shown in Table 30. During the 2007–2013 period, an energy improvement of 0.4 per cent per year for heavy goods vehicles is included in the energy forecasts. Furthermore, it is assumed that passenger cars will achieve 120–130 g/km by 2020 at EU level, with gradual introduction in 2012–2015, and it is assumed that Sweden will achieve the same relative reduction as the EU average. An improvement in efficiency of 1 per cent per year is assumed after 2015. Light goods vehicles, however, are expected to decrease by 1 per cent after 2015.

Table 30 Energy consumption for passenger and freight transport by road. Statistics for 2007 and forecasts for 2011 and 2016.

	2007 (TWh)	2010 (TWh)	2016 (TWh)
Passenger cars	49.3	47.6	46.9
Light goods vehicles	7.5	7.9	8.0
Heavy goods vehicles	17.9	17.9	19.7

Source: Artemis/The Swedish Transport Administration.

Energy consumption for passenger and freight transport by rail

Energy consumption between 2012 and 2016 is forecast on the basis of the historical development of the "kWh/transport activity" quota between 2000 and 2011. This period of time is used as a basis because the energy consumption for passenger and freight services is not divided up for previous years. The calculation is based on statistics from Traffic analysis for transport activity and energy consumption and, because these are bundled together, the progress of energy consumption per transport activity is shown in Table 31.

Table 31 Energy consumption per transport activity (kWh/pkm and kWh/tonnekm).

	2000	2007	Prog.*
Passenger (railway)	0.12	0.11	0.99
Passenger (other track services)	0.14	0.12	0.98
Cargo	0.04	0.04	10.99

*This column shows the average annual progress of energy consumption per transport activity

The energy consumption per transport activity for freight transport has remained relatively constant in recent years, whereas that of passenger transport appears to have seen an improvement in efficiency of approximately 2 per cent per year. The same rate of progress is assumed for the 2007–2016 period (table 32).

Table 32 Energy consumption per transport activity.

	2007	2011	2016
kWh/pkm (rail)	0.12	0.11	0.10
kWh/pkm (other track services)	0.14	0.11	0.11
kWh/tonnekm	0.04	0.04	0.04

Transfer passenger transport

The saving for method P12 is calculated using the formula:

Saving = $(PT_t - PT_{2007}) * T_t * (UECA, - UEPT_t)$ where:

PT = share of public transport (calculated in pkm); T = total transport activity (pkm);

UECA = energy consumption for passenger cars (kWh/pkm);
UEPT = energy consumption for passenger cars (kWh/pkm);

The assumptions for the calculation of method P12 are shown in Table 33. Public transport includes buses, underground railways, trams and trains. The energy consumption for buses has been taken from Artemis. The energy consumption for rail and track services has been taken from calculations carried out for method P10, see Annex 2. The transport activity has been taken from the passenger transport activity forecasts described above.

Table 33 Assumptions for calculating the saving for indicator P12.

	2007	2011	2016
Public transport share	17.5%	17.9%	17.2%
Total transport activity (pkm)	120,435	125,678	136120
Energy consumption passenger car (kWh/pkm)	0.52	0.47	0.41
Energy consumption public transport (kWh/pkm)	0.19	0.18	0.17

The saving up to 2016 will be negative, -0.1 TWh, which means that the public transport share decreases.

Saving late initiatives

Methods P8, P9, A2, P10, P11 and P12 in Annex 2 have been used. The calculated saving for late initiatives in the transport sector are shown in Table 34.

Table 34 Calculated saving from late initiatives in the transport sector.

	2011 (TWh)	2016 (TWh)
Late initiatives		
Passenger cars (P8)	5.10	12.19
Heavy goods vehicles (P9)	-0.39	1.24
Light goods vehicles (P9 A2)	-0.04	0.04
Rail, passenger (P10)	-0.04	0.05
Rail, freight (P11)	0.07	0.11
Transfer of passenger transport from car to public transport (P12)	0.13	-0.10
Total late initiatives	**4.8**	**13.5**

Sensitivity analyses

The parameters used in the forecasts are energy consumption per transport activity carried out in the start year and end year and transport activity for the end year. Using the Commission's recommended methods for saving, that means that the amount of transport activity in the end year is of relatively large significance. One uncertainty factor is thus whether transport activity will increase as forecast. A lower rate of transport activity in 2016 would mean a lower saving, even if the energy consumption per transport activity progresses as forecast. To illustrate this uncertainty factor, a sensitivity analysis has been carried out in which transport activity is assumed to be constant throughout the forecasting period. With constant transport activity, the calculated saving for late initiatives in 2016 amounts to 12.3 TWh, i.e. a reduction of 1.2 TWh compared to the basic case, as is shown in Table 34.

Maritime transport is not included in the assessment of the saving in the transport sector, but should be included in later analyses when more statistics, and possibly even forecasts, are available. To include maritime transport at a later stage can affect the total saving, though maritime transport is expected to be of marginal significance for the national objective. This is because the saving in maritime transport is high, but transport activity is low. To illustrate the marginal effect of maritime transport, a sensitivity analysis has been carried out in which the energy consumption per tonne-kilometre is assumed to be halved between 2007 and 2016, whereas transport activity is assumed to be constant over the period. The saving from maritime transport in 2016 would then amount to 0.1 TWh. With this progress, the total saving for the transport sector would amount to 13.6 TWh, see Table 34.

Annex 2 Calculation methods

Housing and services

P1 - Energy consumption for heating in households per square metre

$$Besp. = \left[\left(\frac{Eh_{2007}}{F_{2007}} * \frac{MDD_{30}}{ADD_{2007}}\right) - \left(\frac{Eh_{1995}}{F_{1995}} * \frac{MDD_{30}}{ADD_{1995}}\right)\right] * F_{2007}$$

Where Eh: use of heating, Ew: use of hot water, (F): area in housing, P: inhabitants in Sweden, ADD: heating degree days in Sweden and MDD30: heating degree days (normal year, last 30 years).

P3 - Energy consumption for hot water in households per inhabitant

$$Besp. = \left[\frac{Ew_{2007}}{P_{2007}} - \frac{Ew_{1995}}{P_{1995}}\right] * P_{2007}$$

Where Ew: hot water use, and P: inhabitants in Sweden.

P4 - Energy consumption for household appliances

$$Besp. = (UEC_{2016}^{x} - UEC_{2007}^{x}) * stock_{2016}^{x}$$

Where UEC^x refers to electricity consumption per appliance type (x) and stock is the total number of appliances by type.

P5 - Energy consumption for lighting

$$Besp. = \left(\frac{E_{2016}^{H,li}}{D_{2016}} - \frac{E_{2007}^{H,li}}{D_{2007}}\right) * D_{2016}$$

Where $E^{H, li}$ refers to electricity consumption for lighting in households and D refers to the number of households.

P6 - Energy consumption (not electricity) in each subsector per square metre

$$Besp. = \left[\left(\frac{E_{2016}^{non-el}}{IA_{2016}} * \frac{MDD_{30}}{ADD_{2016}}\right) - \left(\frac{E_{2007}^{non-el}}{IA_{2007}} * \frac{MDD_{30}}{ADD_{2007}}\right)\right]$$

Where $E^{non\text{-}el}$: energy consumption non-electricity, IA: area, MDD30: heating degree days (normal year, last 30 years) and ADD: heating degree days in Sweden.

P7 - Electricity consumption in each subsector per square metre

$$Besp. = \left[\frac{Eel_{2016}}{I_{2016}} - \frac{Eel_{2007}}{I_{2007}}\right] * I_{2016}$$

Where E^{el}: electricity consumption and I: area.

Industry

M8

$$Indikator\ \frac{E^{I^x}}{VA^{I^x}}; \qquad M8 = \left(\frac{E_{2007}{}^{I^x}}{VA_{2007}{}^{I^x}} - \frac{E_t{}^{I^x}}{VA_t{}^{I^x}}\right) \cdot VA_t^{I^x} \cdot K_{2007}^{I^x}$$

E^{Ix}_{2007}, E^{Ix}_{2007} = energy consumption in subsector x 2007 and year t; K^{Ix}_{2007} = proportion of energy consumption in subsector x included in the Directive; $V^{Ix}2007$, $V^{Ix}2007$ = added value in fixed costs in subsector x
2007 and year t.

Transport

All calculations in the transport sector have been carried out in kWh rather than in oil equivalents. To reduce the impact of individual years, the savings for both early initiatives and late initiatives have been established using the average values over three years instead of using only the statistics for the start year and end year as a basis.

P8 Passenger cars

$$Indikator\ \frac{E^{CA}}{T^{CA}}; \qquad P8 = \left(\frac{E_{2007}{}^{CA}}{T_{2007}^{TLV}} - \frac{E_t{}^{CA}}{T_t^{CA}}\right) \cdot T_t^{CA}$$

E^{CA} = energy consumption for cars (kWh); T^{CA} = passenger transport activity (passenger-kilometre) **P9**

P9 Heavy goods vehicles

$$Indikator\ \frac{E^{TLV}}{T^{TLV}}; \qquad P9 = \left(\frac{E_{2007}^{TLV}}{T_{2007}^{TLV}} - \frac{E_t{}^{TLV}}{T_t^{TLV}}\right) \cdot T_t^{TLV}$$

E^{TLV} = energy consumption for light goods vehicles (kWh); T^{TLV} = freight transport activity (tonne-kilometre)

P9 A2 Light goods vehicles

$$Indikator\ \frac{E^{TLV}}{S^{TLV}}; \qquad P9A2 = \left(\frac{E_{2007}^{TLV}}{S_{2007}^{TLV}} - \frac{E_t{}^{TLV}}{S_t{}^{TLV}}\right) \cdot S_t^{TLV}$$

E^{TLV} = energy consumption for light goods vehicles (kWh); S^{TLV} = vehicle fleet light goods vehicles.

Different indicators are used for heavy and light goods vehicles because statistics on freight transport activity are only available for heavy goods vehicles. In order to obtain the progress for light goods vehicles, another indicator is used for light goods vehicles – a modified version of the Commission's P9 A2. This method displays the actual energy consumption per goods vehicle, as in the above formula. However, Sweden has statistics on mileage for this group of vehicles. Using existing statistics for mileages and calculating the indicator as energy consumption per km should then be a more accurate way of calculating the saving for light goods vehicles than merely taking into account the number of vehicles.

P10 Rail passenger

$$Indikator\frac{E^{RPa}}{T^{RPA}};P10=\left(\frac{E_{2007}^{RPa}}{T_{2007}^{RPa}}-\frac{E_t^{RPa}}{T_t^{RPa}}\right)\cdot T_t^{RPa}$$

E^{RPa} = energy consumption (kWh); T^{RPa} = passenger transport activity (passenger-kilometre)

P11 Rail freight

$$Indikator\frac{E^{RFa}}{T^{RFr}};\qquad P11=\left(\frac{E_{2007}^{RFr}}{T_{2007}^{RFr}}-\frac{E_t^{RFr}}{T_t^{RFr}}\right)\cdot T_t^{RFr}$$

E^{RFr} = energy consumption (kWh); T^{RFr} = freight transport activity (tonne-kilometre).

P12 Transfer of passenger transport from car to public transport (P12)

$$Indikator\frac{T_{Public}^{Pa}}{T^{Pa}};\qquad P12=(PT_t-PT_{2007})\cdot T_t^{Pa}\cdot(UE_t^{CA}-UE_t^{PT})$$

PT = public transport share (calculated in passenger-kilometres); T = total transport activity (passenger-kilometres);
UECA = energy consumption for passenger cars (kWh/passenger-kilometre);
UEPT = energy consumption for public transport (kWh/passenger-kilometre);

M7 Maritime transport

$$Indikator\frac{E^{W}}{T^{W}};\qquad M7=\left(\frac{E_{2007}^{W}}{T_{2007}^{W}}-\frac{E_t^{W}}{T_t^{W}}\right)\cdot T_t^{W}$$

E^{W} = energy consumption for maritime transport (kWh); T^{R} = transport activity (tonne-kilometre).

Appendix 3 Method for calculating the effects of energy and carbon taxes within the framework of Article 7

In order to comply with Article 7 of the Energy Efficiency Directive, Sweden has chosen to report the effect of energy and carbon taxes and the value added tax on energy consumption instead of introducing white certificates. Sweden has since developed an econometric calculation that shows how much higher energy consumption would be in different sectors had Sweden applied the EU minimum tax rules from 2014. The difference between a scenario with EU minimum taxation levels and a scenario with Sweden's continued tax level is equivalent to the Swedish taxes' additional energy saving. The equation for energy-saving for each sector and each type of energy is shown in Figure 1 and the following formula.

Long-term energy saving AE (year)
= price elasticity s_p
** percentage difference in energy prices between the two scenarios AP*
** forecast of Sweden's energy consumption E(year)*
*= long-term AE% * E(year)*

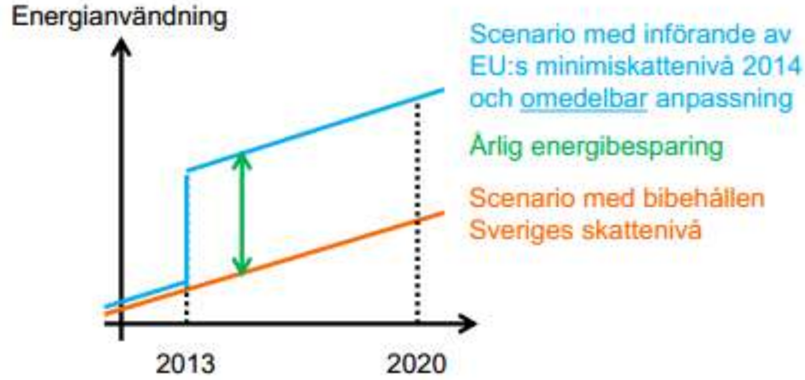

Figure 2 - Annual energy saving as a result of the introduction of EU minimum taxation levels in 2014, with immediate adaptation

Key:
Energianvändning = Energy consumption
Scenario med införande av EU:s minimiskattenivå 2014 och omedelbar anpassning = Scenario with introduction of EU minimum taxation levels in 2014 and immediate adaptation
Årlig energibesparing = Annual energy saving
Scenario maintaining Swedish taxation levels = Scenario maintaining Swedish taxation levels

Sweden's reports also include a short-term model that shows, for example, that it takes time to replace existing capital before the taxes achieve their full effect (Figure 3).

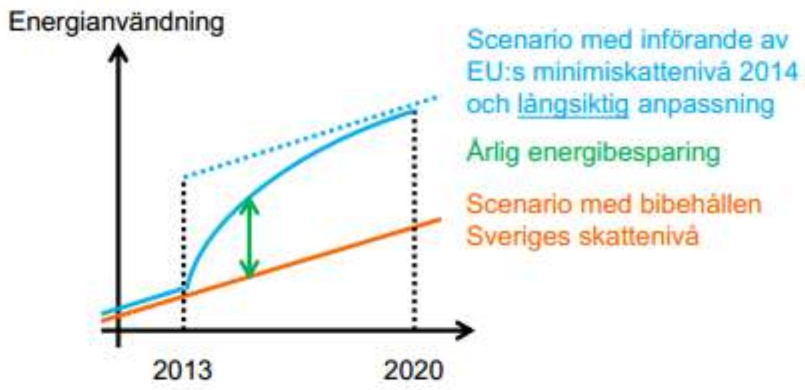

Figure 3 - Annual energy saving as a result of the introduction of EU minimum taxation levels in 2014, with long-term adaptation

Key:
Energianvändning = Energy consumption
Scenario med införande av EU:s minimiskattenivå 2014 och omedelbar anpassning = Scenario with introduction of EU minimum taxation levels in 2014 and long-term adaptation
Årlig energibesparing = Annual energy saving
Scenario maintaining Swedish taxation levels = Scenario maintaining Swedish taxation levels

The Swedish Energy Agency has developed a model that is based on Sweden's previous report on the long-term energy saving percentage per sector. The Swedish Energy Agency has since simplified the short-term model, which shows the inertia in the system, by creating a mathematical function that varies over time as much as the percentage difference between the actual percentage of energy savings and the long-term energy savings. The Swedish Energy Agency's forecast is then used as a reference scenario (Table 35). The annual energy saving is then calculated as follows:

*AE (year) = long-term AE% * E (year) * inertia function (year)*

Table 35 - The Swedish Energy Agency's forecast for amount of sold delivered energy, in TWh

	2014	2015	2016	2017	2018	2019	20
Industry and construction	74	73	72	71	70	69	68
Land-based industries	10	10	10	10	9	9	9
Housing and services (only electricity)	68	68	68	68	69	69	69
Transport (only petrol and diesel)	70	69	68	67	66	64	63

An example of how the model is applied is contained in Table 36.

Table 36 - Examples of the calculation method

Sector	Long-term percentage annual energy saving (according to the Swedish reported model)	Sold and delivered energy in 2017 (according to the Swedish Energy Agency's forecasts)	Short-term "inertia function" for the sectors' adaptation (according to the Swedish Energy Agency, based on Sweden's reporting data)	Energy saving in 2017 with inertia function (according to the Swedish Energy Agency's calculations)	Energy saving in 2017 (according to Sweden's reported model)
Industry according to PFE (fuels)				=2/3*0.95 =0.63 TWh[58]	1.91 TWh
Land-based industries (fuels)	8.3%	9.6 TWh	=1/7*year	=8.3%*9.6*4/7 =0.46 TWh	0.31 TWh
Housing and services (electricity)	18.5%[59]	68.4 TWh	≈1-exp(-0.156*year)	≈18.5%*68.4* (1-exp(-0.156*4)) ≈5.9 TWh	5.5 TWh
Transport (petrol and diesel)	18.1%[60]	66.9 TWh	≈1-0.35* exp(-0.34*(year-1))	≈18.1%*66.9* (1-0.35* exp (-0.34*3)) ≈10.7 TWh	12.1 TWh

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[58] It is estimated that the PFE companies (approximately 30 TWh) saved 1.0 TWh of electricity per year and 0.3–1.0% fuel per year. However, this is uncertain since the reporting was not obligatory in the case of the other fuels.

[59] In the previous reports, the price difference excluding VAT was AP=33%=(P_{Sv}-P_{EU})/P_{EU}=(29.3-1.0)/Psv, so Peu=SEK 0. 857/kWh and Psv=85.7+29.3-1.0=SEK 1.14/kWh. The long-term percentage of savings was then 16.5% = price elasticity 0.5 * price difference 33%. Since the electricity tax rises by 11.5 per cent from 2017, the price difference becomes AP=(29.3*m,5%-1.0)/85.7=37.0% instead, and the long-term percentage saving becomes 0.5*37%=18.5%.

[60] In the previous reports, the long-term percentage saving on petrol was 15.5% = price elasticity 0.37 * price difference 42%. The price difference including VAT was also such that AP=42%=(Psv-Peu)/Peu=(34.3+27.5+24-34.06)/Peu so Peu=SEK 1.232/kWh and P_{Sv}=123.2+34.3+27.5+24-34.06=SEK 1.7494/KWh. Since the petrol tax rises by 14 per cent from 2016, the price difference becomes AP=((34.3+27.5)*114%+24-34.06)/123.2=49.0% instead, and the long-term percentage saving becomes 0.37*49.0%=18.1%.

Annex 4, Annex XIV to the Energy Efficiency Directive

General framework for National Energy Efficiency Action Plans

National Energy Efficiency Action Plans referred to in Article 24(2) shall provide a framework for the development of national energy efficiency strategies.

The National Energy Efficiency Action Plans shall cover significant energy efficiency improvement measures and expected/achieved energy savings, including those in the supply, transmission and distribution of energy as well as energy end-use. Member States shall ensure that the National Energy Efficiency Action Plans include the following minimum information:

1. Targets and strategies

– The indicative national energy efficiency target for 2020 as required by Article 3(1),
– The national indicative energy savings target set in Article 4(1) of Directive 2006/32/EC,
– Other existing energy efficiency targets addressing the whole economy or specific sectors.

2. Measures and energy savings

The National Energy Efficiency Action Plans shall provide information on measures adopted or planned to be adopted in view of implementing the main elements of this Directive and on their related savings.

a) Primary energy savings

The National Energy Efficiency Action Plans shall list significant measures and actions taken towards primary energy saving in all sectors of the economy. For every measure or package of measures/actions estimations of expected savings for 2020 and savings achieved by the time of the reporting shall be provided.

Where available, information on other impacts/benefits of the measures (greenhouse gas emissions reduction, improved air quality, job creation, etc.) and the budget for the implementation should be provided.

b) Final energy savings

The first and second National Energy Efficiency Action Plans shall include the results with regard to the fulfilment of the final energy savings target set out in Article 4(1) and (2) of the Directive 2006/32/EC. If calculation/estimation of savings per measure is not available, sector level energy reduction shall be shown due to (the combination) of measures.

The first and second National Energy Efficiency Action Plans shall also include the measurement and/or calculation methodology used for calculating the energy savings. If the "recommended methodology" (1) is applied, the National Energy Efficiency Action Plan should provide references to this.

3. Specific information related to this Directive

3.1 Public bodies (Article 5)

National Energy Efficiency Action Plans shall include the list of public bodies having developed an energy efficiency plan in accordance with Article 5(7).

3.2 Energy efficiency quota obligations (Article 7)

National Energy Efficiency Action Plans shall include the national coefficients chosen in accordance with Annex IV.

The first National Energy Efficiency Action Plan shall include a short description of the national scheme referred to in Article 7(1) or the alternative measures adopted in application of Article 7(9).

3.3 Energy audits and management systems (Article 8)

National Energy Efficiency Action Plans shall include:

a) the number of energy audits carried out in the previous period;

b) the number of energy audits carried out in large enterprises in the previous period;

c) the number of large companies in their territory, with an indication of the number of those to which Article 8(5) is applicable.

3.4 Promotion of efficient heating and cooling (Article 14)

National Energy Efficiency Action Plans shall include an assessment of the progress achieved in implementing the comprehensive assessment referred to in Article 14(1).

3.5 Energy transmission and distribution (Article 15)

The first National Energy Efficiency Action Plan and the subsequent reports due every 10 years thereafter shall include the assessment made, the measures and investments identified to utilise the energy efficiency potentials of gas and electricity infrastructure referred to in Article 15(2).

3.6 Member States shall report, as part of their National Energy Efficiency Action Plans, on the measures undertaken to enable and develop demand response as referred to in Article 15.

3.7 Availability of qualification, accreditation and certification schemes (Article 16)

National Energy Efficiency Action Plans shall include information on the available qualification, accreditation and certification schemes or equivalent qualification schemes for the providers of energy services, energy audits and energy efficiency improvement measures.

3.8 Energy Services (Article 18)

National Energy Efficiency Action Plans shall include an internet link to the website where the list or the interface of energy services providers referred to in point (c) of Article 18(1) can be accessible.

3.9 Other measures to promote energy efficiency (Article 19)

The first National Energy Efficiency Action Plan shall include a list of the measures referred to in Article 19(1).

Annex 5 The second national strategy for renovations to increase energy efficiency

Contents

6 Introduction

Sweden reported its first renovation strategy to the European Commission in April 2014. At that time, it was noted that one prerequisite for increasing the scope of energy efficiency work was an increase in the number of renovations carried out. There is also a need to implement initiatives for energy-efficiency measures in connection with the renovations. Barriers to improvements in energy efficiency when renovating were identified in the supporting data. One of these was market failure associated with lack of knowledge. The supporting data therefore contained a proposal to set up an information centre for renovation to increase energy efficiency in order to remedy this market failure. The 2013 study also emphasised the need to increase expertise regarding measures to increase energy efficiency at banks and to continue development work on energy declarations.

The study carried out in 2015 contained an investigation of whether and how two financial instruments could increase the number of renovations. The conclusion reached was that the credit guarantee could be developed to cover measures other than new production and conversion.

Since the first strategy was developed, the proposal for a national information centre for renovation to improve energy efficiency has been further developed. This study contains further analysis of barriers to renovation and possible instruments to remove those barriers.

6.1 Constraints

This year's study is more clearly focused on investigating the barriers to increasing the number of renovations. When analysing this question, we have prioritised work involving the various building categories and we have chosen to begin with apartment buildings and non-residential premises.

The need for measures in apartment buildings has been identified in a number of studies. Some data also exists for non-residential premises, whereas identifying the need for renovation in houses requires greater efforts. The supporting data for apartment buildings and non-residential premises is supplemented in this study in order to gain a clearer view of the need for renovation. That means that we have focused on parts of the building stock and we propose to focus on apartment buildings over the next three years.

The strategy mainly focuses on the energy consumption that can be affected by a renovation, which means that the energy consumed in operations in the buildings is excluded.

6.2 Definitions and terms

A_{temp}: The area of all floors, attic floor and basement floor with temperature-controlled areas which are intended to be heated to over 10 degrees C and that are bounded by the inside of the building envelope. The area occupied by interior walls or openings for stairs, shafts and similar is included. However, area in garages, in the building in a residential building or in non-residential premises other than a garage is not included (Swedish National Board of Housing, Building and Planning building regulations BFS 2011:6).

Additionality: In order for an instrument to have high additionality, measures must be implemented that would not have been implemented without the instrument

Asymmetric information: Information that, in a perfect market economy, is assumed to be available to everyone is instead unevenly distributed between the parties that are to enter into an agreement or a financial transaction. One party has an information advantage and therefore knows more than the other.

The building's energy consumption: The energy that, for normal use during a normal year, needs to be supplied to a building (often referred to as "purchased energy") for heating, comfort cooling, hot tap water and the building's property energy.

The building's property energy: The part of the property electricity that is related to the building's needs. This includes fixed lighting in public and technical areas.

Energy performance/the building's specific energy consumption: The building's energy consumption spread over Atemp expressed in kWh/m^2 and year. Household energy or business energy consumed in addition to the building's basic requirements for heating, hot water and ventilation is not included (The Swedish National Board of Housing, Building and Planning building regulations, BFS 2011:6).

External effects: Effects that arise when one party in a market acts in a way that affects others without the party taking this into consideration in its decisions.

Household energy: The electricity or other energy consumed for household purposes. Examples of this include electricity consumption for dishwashers, washing machines, drying machines (including in communal laundry facilities), cookers, refrigerators, freezers and other household appliances as well as lighting, computers, TVs and other consumer electronics (Swedish National Board of Housing, Building and Planning building regulations BFS 2011:6).

Cost-effectiveness: A cost effective instrument means that all operators have the same cost for the last saved kilowatt hour. If there is a political objective for energy consumption, it is possible to carry out a cost-effectiveness analysis to analyse how the objective will be achieved at the lowest possible cost.

Profitability: A measure is considered to be profitable if the expected saving exceeds the cost. In profitability calculations, the expected lifespan of the measure should be taken into consideration.

Purchased energy: The energy, for normal use, that needs to be supplied to a building during a normal year.

Market failure: Situations that lead to operators systematically making decisions that mean that society's resources are not being optimally used.

Marginal cost: The relative cost in SEK/kWh, for example, for the last saved kilowatt hour.

Net heat: Net heat is the energy that the building needs for heating and hot water. Conversion losses in an oil boiler or heating element for a heat pump are not included in the measurement.

Roll-out rate: The rate at which a particular measure or level of renovation is carried out or distributed within a certain stock.

7 The national building stock

This chapter presents the part of the strategy requested in part:

a) An overview of the national building stock based, as appropriate, on statistical random sampling.

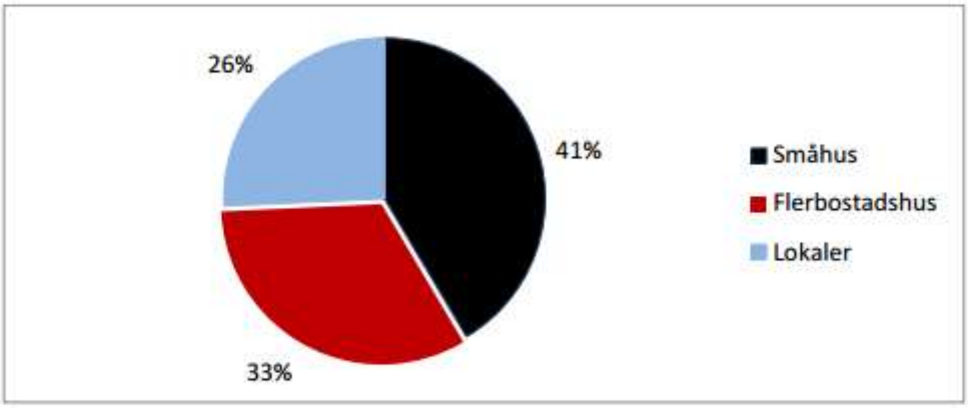
From an international perspective, Sweden has a young building stock dominated by buildings constructed in 1945–1980. Almost three quarters of the heated area in the Swedish building stock is more than 30 years old and was added prior to 1980. The housing and services sector account for just under 40 per cent of Sweden's total energy consumption. More than half the energy consumption in the sector goes to heating and hot water in housing and non-residential premises. The energy consumed in buildings derives largely from renewable sources. The heating method is primarily district heating, electricity and biofuels.

The trend shows that energy consumption for heating and hot water per square metre is decreasing in the total stock. This is largely due to more stringent energy requirements and measures regarding conversion from oil and electricity to heat pumps. A number of studies indicate that there is a need for more renovation in the apartment building stock than is taking place at present in order to maintain the state of the buildings. Further descriptions of the building stock are available in *Annex 1 An overview of the national building stock.*

7.1 Composition of the building stock

The heated area amounts to 641 million square metres and houses make up the largest proportion, approximately 41 per cent. The proportion for apartment buildings is 33 per cent, while non-residential premises account for the remaining 26 per cent. **Error! Reference source not found.** shows the distribution of the heated area in housing and non-residential premises in 2014.

Figure 4 Proportion of heated area of housing and non-residential premises between houses, apartment buildings and non-residential premises in 2014, percentage.

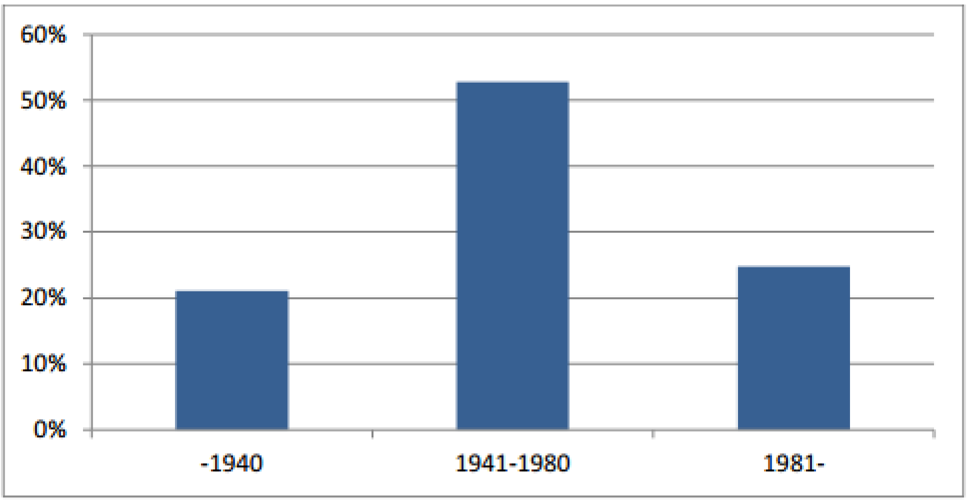


Source: The official energy statistics[61], hereinafter referred to as *Energistatisken* [the Energy Statistics]

Key:
Småhus= House
Flerbostadshus = Apartment building
Lokaler = Non-residential premises

From an international perspective, Sweden has a young building stock dominated by buildings constructed in 1945–1980. Almost three quarters of the heated area in the Swedish building stock is more than 30 years old and was added prior to 1980, see **Error! Reference source not found.**.

Figure 5 Proportion of heated area in housing and non-residential premises distributed by year of construction in 2014, percentage.

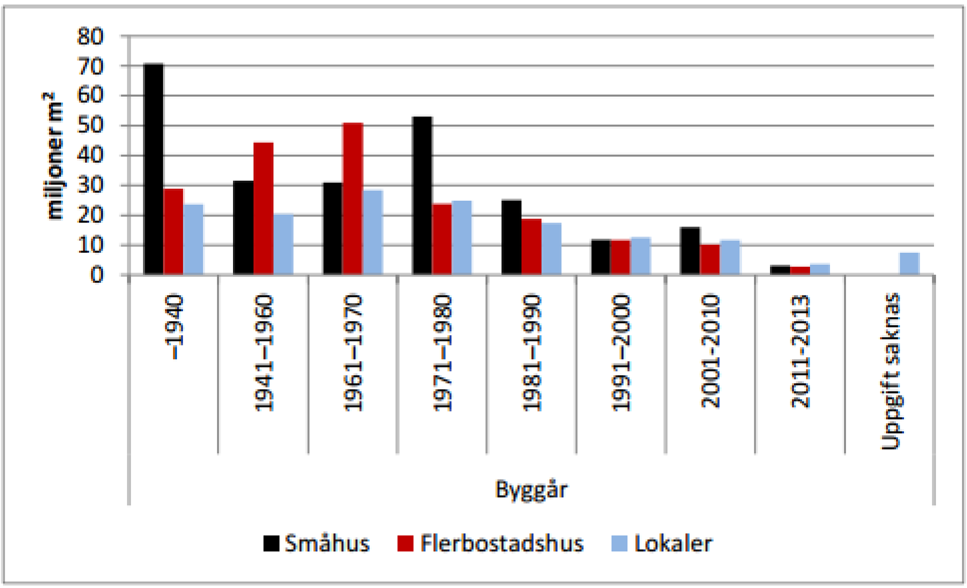


Source: The Energy Statistics

Apartment buildings built in the 1941–1970 period account for almost half the heated area in the stock of apartment buildings. Many of the houses were built before 1940, but most houses were built in the 1961–1980 period, during which more houses were built than the combined total from the period before 1940. As far as non-residential premises are concerned, just over 60 per cent of the heated area of non-residential premises was built before 1981, see Figure

[61] www.energimyndigheten.se

Figure 3. Heated area of housing and non-residential premises in 2014, broken down by year of construction and 2014, million m^2 building category



Source: The Energy Statistics

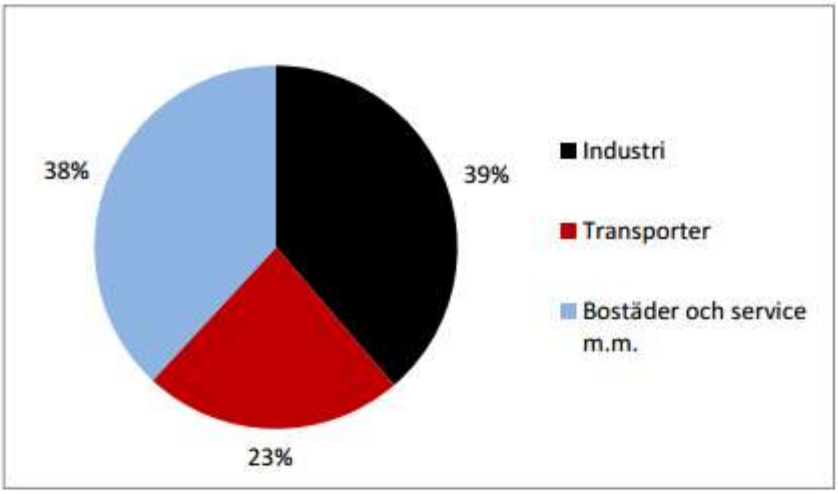
Key:
Miljoner m2 = Million m2
Byggår = Year of Construction
Småhus= House
Flerbostadshus = Apartment building
Lokaler = Non-residential premises
Uppgift saknas = No information

7.2 Energy consumption of the building stock

Sweden's total final energy consumption in 2014 amounted to 368 TWh[62] and Figure 6 shows how that energy consumption is divided among industry, transport and housing and services. The housing and services sector accounts for almost 40 per cent of the total energy consumption, approximately 140 TWh. The sector consists of agriculture, forestry and fisheries, combined with housing and non-residential buildings, with housing and non-residential premises accounting for around 90 per cent of the energy consumption. The energy consumption for heating and warm water is normally approximately 60 per cent of the energy consumption in the sector. For 2014, that means approximately 84 TWh. The remaining energy was used mainly for household electricity, business electricity and property electricity.

[62] The energy system can be divided into supply, transformation and end-use. The energy supply consists of added fuel for the user sectors and for transformation facilities such as cogeneration plants.

Figure 6 **Distribution of Sweden's total end-use energy in** 2014.



Source: The Energy Statistics

Key:
Industri = Industry
Transporter = Transports
Bostäder och service m.m. = Housing and services etc.

District heating and electricity (partly heat pumps) are the most common heating methods in Sweden. The amount of fossil fuels in electricity and district heating production is already extremely low at present and is expected to decrease further by 2030.[63] When it comes to fuel use in housing and non-residential premises, the use of oil has dropped sharply and is expected to disappear entirely in the near future.[64] Unlike many other countries in Europe, use of natural gas is low in Sweden, like the use of oil, and it is expected to continue to decrease.

The total energy consumption for heating and hot water in housing and non-residential premises amounted to 75 TWh in 2014. The largest proportion of energy was used in houses – approximately 41 per cent. Approximately 35 per cent was used in apartment buildings and the remaining approximately 24 per cent was used in non-residential premises. Figure 7 shows the total energy consumption according to year of construction and building category.

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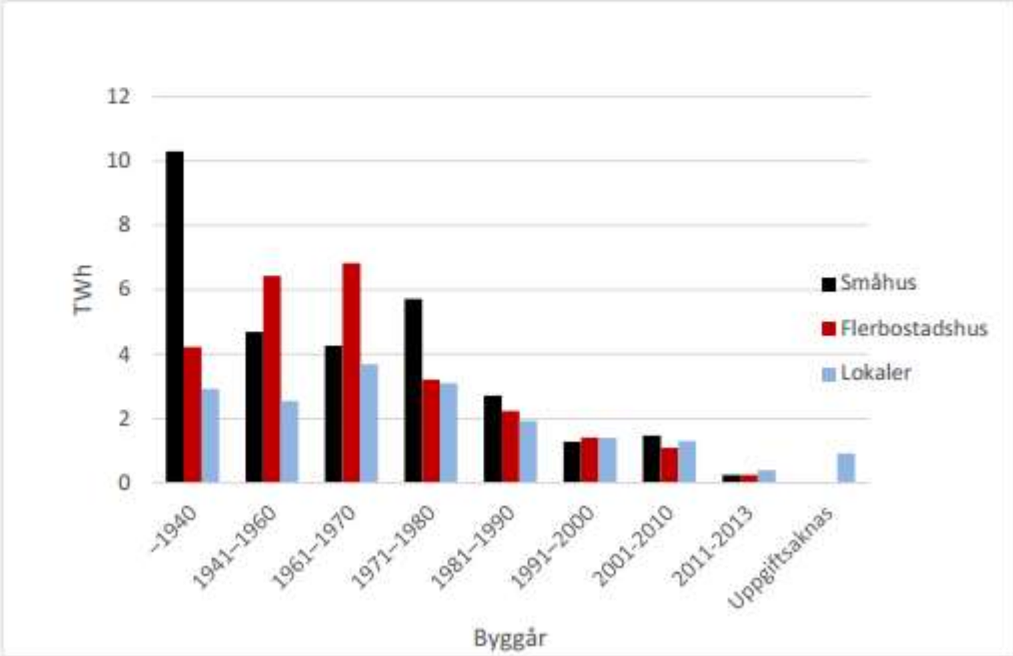
[63] The Swedish Energy Agency 2014, ER2014.
[64] The Swedish Energy Agency 2014, ER2014.

Figure 7 Total energy consumption in 2014 according to year of construction and building category, TWh.

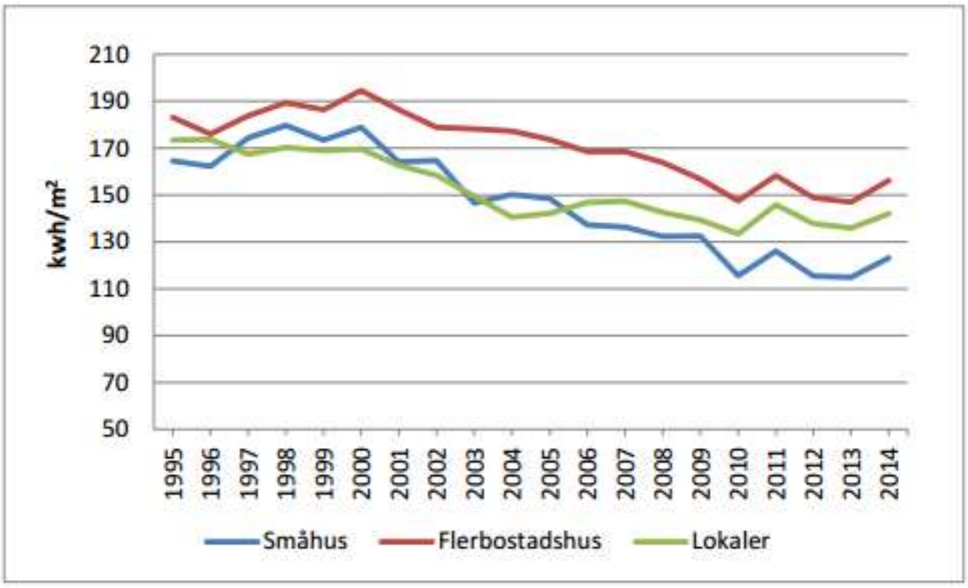


Source: The Energy Statistics

Key:
Byggår = Year of Construction
Småhus= House
Flerbostadshus = Apartment building
Lokaler = Non-residential premises

Energy consumption for heating and hot water has been in steady decline since 2000, see Figure , but flattened out from 2010 onwards.

Figure 6 Temperature-adjusted energy consumption (kWh) per square metre for heating and hot water 1995–2014, kWh/m^2.



Source: The Energy Statistics

Key:

Småhus= House
Flerbostadshus = Apartment building
Lokaler = Non-residential premises

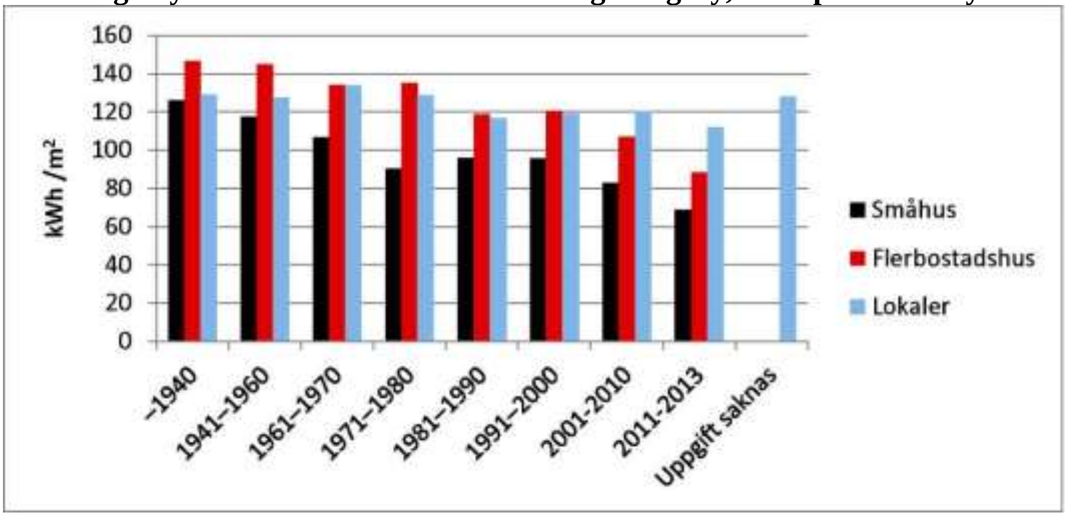
There are several reasons for the declining trend in energy consumption. Firstly, a rising number of installed heat pumps has meant that the purchased

energy reported has decreased. Secondly, the conversion from oil to electricity and district heating has meant that energy losses that occurred during the combustion of oil locally have now been partly moved to another sector. [65] Thirdly, energy-efficiency measures have been carried out in existing buildings at the same time as new, more energy-efficient buildings help reduce the average energy consumption. It is likely that the high energy prices in the 2000s were partly instrumental in leading many property owners to implement measures to reduce energy consumption. Stricter requirements regarding energy performance for newly-constructed buildings and other instruments are also considered to have contributed to a reduction in the average use.

The older stock generally uses more energy per square metre for heating and hot water, see Figure 8. Between 1980 and 2000, the average energy consumption for heating and hot water was roughly unchanged for all building categories and subsequently improved again. The average energy consumption in apartment buildings built before 1940 is over 140 kWh per square metre, whereas in those built between 2011 and 2013, it is less than 90 kWh per square metre. Houses built before 1940 use an average of 126 kWh per square metre, whereas the newest houses use less than 70 kWh on average. Studying the average values provides clear indications of the direction in which progress is heading. At the same time, it is worth noting that there is a spread between buildings with high and low energy consumption in all age categories.

[65] Purchased energy includes only losses that occur in the building's own energy system. The losses incurred in production and distribution of electricity and district heating occur outside the building. When a household changes from oil heating to a heat pump or district heating, the energy consumption therefore decreases in the housing and services sector, whereas energy consumption for district heating production increases. This is provided that the building's energy needs still remain the same.

Figure 8 Average energy consumption per square metre for heating and hot water in 2014, according to year of construction and building category, kWh per m^2 and year.



Note: Non-residential premises where there is no data on the year of construction are reported separately in the figure. Apartment buildings and houses where there is no data on the year of construction are reported along with buildings built before 1940.

Source: The Energy Statistics

Key:
Småhus= House
Flerbostadshus = Apartment building
Lokaler = Non-residential premises
Uppgift saknas = No information

The amount of energy needed for heating and hot water in a building in a year depends largely on how the building has been built, its shape, the amount of insulation, windows, ventilation, technical solutions, etc. The marked difference in energy consumption in properties of different ages can be explained partly by SBN 1980, the new building code that was introduced in 1980. It changed building methods and resulted in more stringent rules for insulation of buildings, among other things. Since the introduction of SBN 1980, a limit was also introduced on maximum energy consumption in buildings being built or renovated. These requirements were not previously specified in the building regulations.

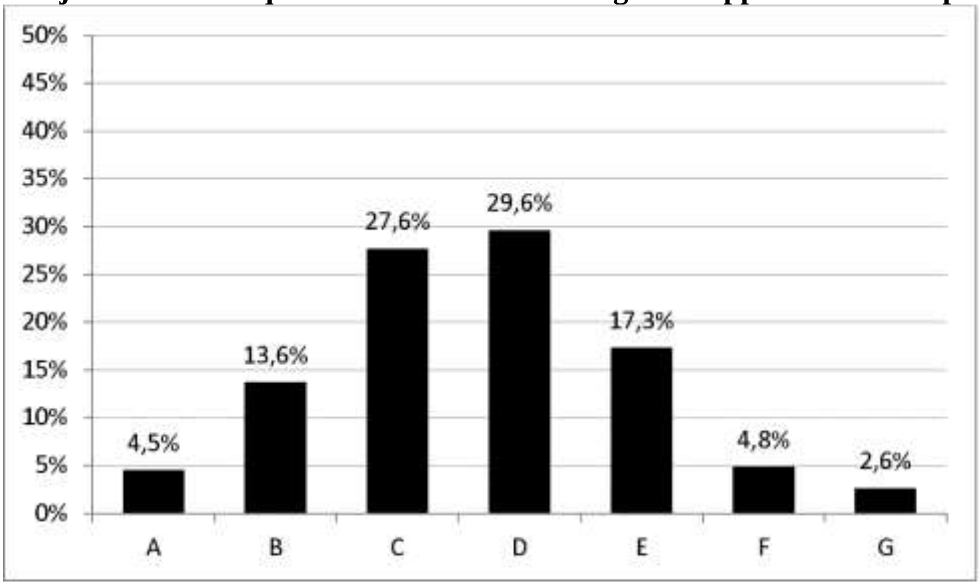
7.2.1 Distribution of the buildings' energy classes

Energy declarations for buildings have existed in Sweden since 2006 and the Swedish National Board of Housing, Building and Planning's register of energy declarations currently contains approximately 624,000 buildings, approximately 568,000 of which consist of housing and approximately 48,000 consist of non-residential premises. The register does not include all the buildings in Sweden because it is only obligatory to issue an energy declaration for a building when it is sold or leased. An energy declaration is valid for ten years. Of the housing in the register of energy declarations, approximately 425,000 are one- and two-apartment buildings and approximately 143,000 are apartment buildings.   There are two differences between the information in the energy declaration and the official energy statistics: the energy consumption in the energy declaration also includes property electricity and the area measurement reported is in Atemp instead of in BOA/LOA [*Boarea* [Living area]/*Lokalarea* [Non-residential area]].

A clearer description of the energy performance in the declarations was introduced in 2014 by placing the buildings in energy classes on a scale from A to G, where A means the best energy performance. A building that has an energy performance equivalent to the energy requirements imposed on a newly-constructed building is currently assigned to class C. Because the energy-rating is relatively new, many of the buildings that previously had energy declarations have no rating. If a new energy declaration is made for an old building, it is placed in the energy class that is related to the current requirements for a new building.

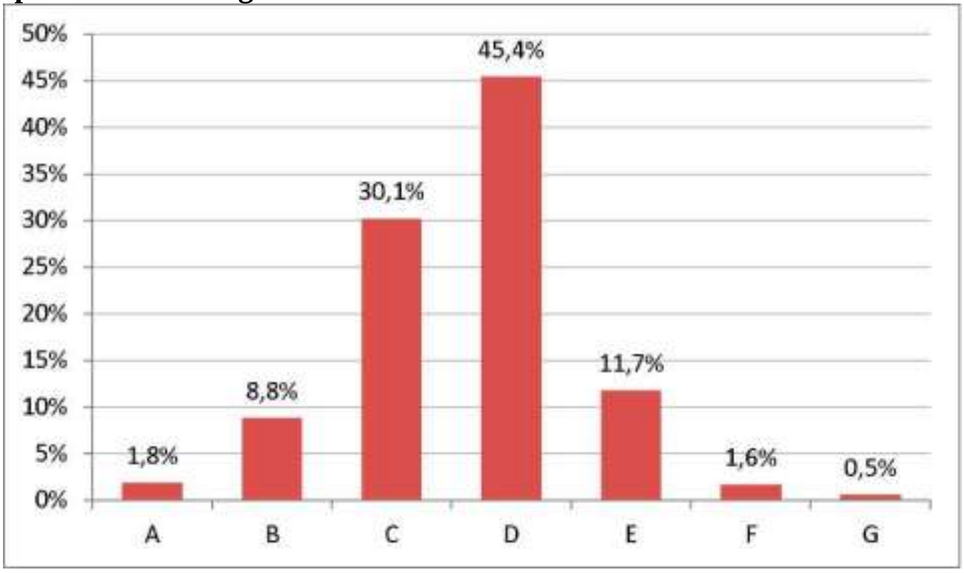
Figure 9, Figure 10 and Figure 11 show the distribution of energy classes per building category. The energy class is reported in relation to the requirements for newly-constructed buildings that applied when each building was constructed and are not related to the requirements contained in the current building regulations. If the energy performance of the building is equivalent to the energy requirements imposed by means of the building regulations when it was constructed, it has been assigned to energy class C in the figure. We therefore report the proportion of the area of the buildings that met the energy requirements imposed when they were built. For apartment buildings, 40 per cent meet or exceed the requirement. For houses and non-residential premises, that figure is around 45 per cent.

Figure 9 Distribution of energy class in the area in houses newly-constructed in the 2000–2015 period based on the area in square metres A_{temp}, excluding heated garages. The distribution is based on approximately 23.7 million square metres Atemp. The energy class is adjusted to the requirements for new buildings that applied for each apartment building.



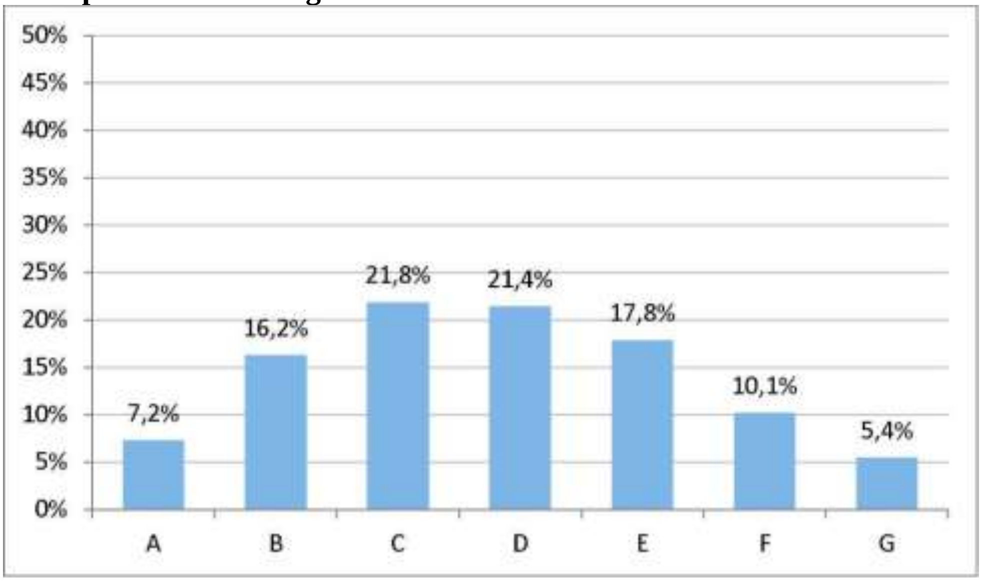
Source: The register of energy declarations

Figure 10 Distribution of energy class in the area in apartment buildings newly-constructed in the 2000–2012 period based on the area in square metres Atemp, excluding heated garages. The distribution is based on approximately 9.6 million square metres A_{temp}. The energy class is adjusted to the requirements for new buildings that applied for each apartment building.



Source: The register of energy declarations

Figure 11 Distribution of energy class in the area in non-residential premises newly-constructed in the 2000–2012 period based on the area in square metres A_{temp}, excluding heated garages. The distribution is based on approximately 8.2 million square metres Atemp. The energy classes adjusted to the requirements for new buildings that applied for each apartment building.



Source: The register of energy declarations

7.3 The renovation needs of the building stock

There is no definition of the term *renovering* [renovation] in building legislation. The terms *underhåll* [maintenance], *ändring* [modification] and *ombyggnad* [conversion] are used instead. Building permits, where measures are reported, are only required in certain modifications and that makes it difficult to monitor how many renovations are being carried out. Both completed studies and supplementary surveys initiated ourselves are used in this section to provide an indication of the need for renovation in Sweden. These studies and surveys mainly describe the need in apartment buildings but, because the supporting data is thin in places and more detailed studies only cover apartment buildings, the results should be used with caution.

7.3.1 The need for renovation according to various studies

Some attempts have been made in a number of studies to estimate the need for renovation in Sweden. In 2003, the Swedish National Board of Housing, Building and Planning carried out a government assignment that led to the report entitled *Bättre koll på underhåll* [Better Check On Maintenance]. The survey contained in the report clearly indicated that maintenance of the housing stock is being neglected. The survey also showed that the conditions for meeting maintenance requirements vary enormously, both regionally and among different categories of owner. Nevertheless, the study attempted to quantify the future need for maintenance.[66]

In 2008–2009, the Swedish National Board of Housing, Building and Planning carried out a comprehensive sample study entitled *BETSI -Byggnaders energianvändning, tekniska status och innemiljö* [Buildings' energy consumption, technological status and indoor environment]. In the study, the Swedish National Board of Housing, Building and Planning considered that approximately 66 per cent of all buildings in the country were damaged in some way. For houses, the figure was approximately 70 per cent and for apartment buildings, it was approximately 40 per cent. Around 45 per cent of the damage detected was moisture damage that can affect the indoor environment. However, most of the damage and defects recorded were not of a serious nature. The Swedish National Board of Housing, Building and Planning estimated that it would cost between SEK 230 and 330 billion to remedy all the damage identified and meet the need for maintenance. Damage at schools and preschools and noise measures were also included at that time.

Renoveringsbarometern [the Renovation Barometer] is the name of a survey of the various stages of the renovation process. It was conducted as a collaboration between the Department of Architecture at Chalmers University of Technology and the Department of Energy and Environment at SP Technical Research Institute of Sweden. The study looked at how property owners think about renovation, what skills they have, what they value and what action is being taken.[67] The Renovation Barometer focuses on companies' attitude towards renovation before, during and after the work. It also divides up the renovation work on the basis, *inter alia* of technical, environmental, economic, social, cultural and historical and architectural aspects. The most important reason for renovation is an urgent technical need or the fact that some component has become too old. Up to 70 per cent of the respondents ranked these as a trigger to a "very great extent" or a "great extent". This was followed by high operating costs, high energy consumption and high maintenance costs. More than 40 per cent of the companies specified raising standards as a reason for renovation.

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[66] Swedish National Board of Housing, Building and Planning 2003, Better Check On Maintenance
[67] https://www.renoveringsinfo.se/web/renoveringsbarometern-mater-trycket-i-branschen/29521, September 2016

7.3.2 The need for renovation in apartment buildings from interview studies

Several interview-based studies have been conducted and they indicate a considerable need to renovate apartment buildings. In 2011, *Industrifakta* [Facts about Industry] estimated that approximately 75 per cent of apartment buildings from the record years (1961–1975) were in need of renovation, which means approximately 600,000 apartments. Approximately 320,000 of these required more or less thorough renovation, mostly relating to a plumbing overhaul, in the next five years. That was equivalent to a need for renovation of 64,000 apartments per year, which is equivalent to 2.5 per cent of the apartments in the entire stock of apartment buildings or 8 per cent of the apartments in apartment buildings in the record year. The study does not specify the number of renovations that were actually planned.

Prognoscentret[68] [The Forecast Centre] produced an equivalent estimate of the need for renovation in 2013 and the results are around the same as for the *Industrifakta* survey.

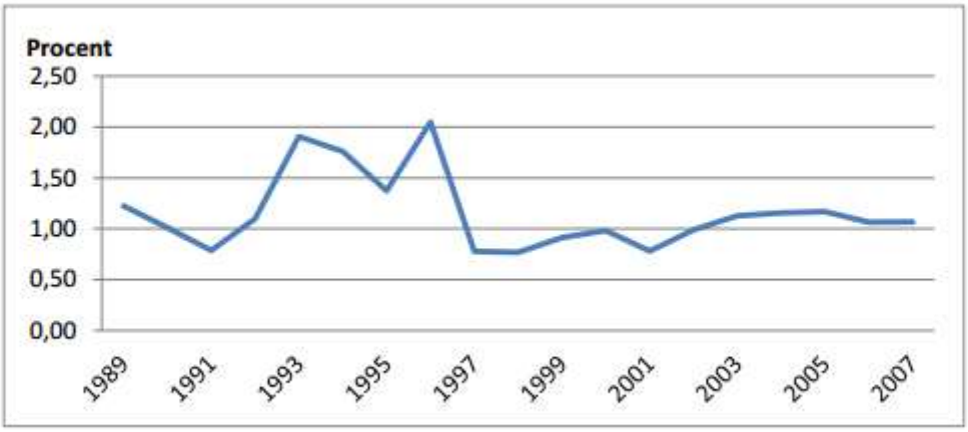
7.3.3. Completed conversions in apartment buildings 1989–2007 using State aid

Between 1989 and 2007, State aid existed in the form of interest-rate and investment subsidies for conversions in apartment buildings and the municipalities submitted detailed information on conversions to *Statistiska Centralbyrån* (SCB) [Statistics Sweden]. The average conversion rate was then about 1.2 per cent, with some variation between years, see Figure 12. The rate is measured here as a percentage of the total number of *apartments* in apartment buildings. It is possible that actions were carried out at a slightly higher pace than they would have been had the aid not existed. It is also possible that conversions were carried out without State aid and are therefore absent from the statistics.

The measures were categorised in the SCB statistics as: modernisation of an entire building, modernisation of part of a building, conversion from non-residential premises to apartments, conversion from attics to apartments, conversion from apartments to non-residential premises, conversion to special accommodation, redesign of apartment areas and extension of apartments. Most projects involved modernisation of an entire building followed by conversions and interior design for attics. The term "conversion" is defined here according to SCB's statistics, which is not the same definition as in the Planning and Building Act.

[68] *Prognoscentret* is an independent firm of analysts

Figure 12 Conversion rate in apartment buildings 1989–2007 using State aid, percentage of total number of apartments in apartment buildings

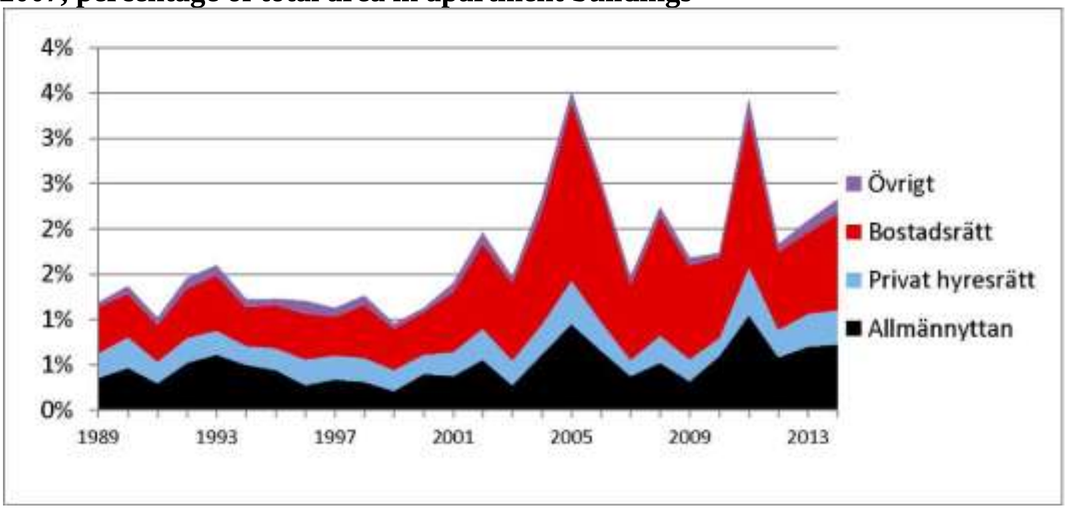


Source: The Conversion Statistics, SCB

7.3.4 The number of renovations can be monitored via real estate tax assessments

Another way of monitoring the number of renovations is to use the Swedish Tax Agency's real estate assessment register, which contain information on conversions that are of significance for the building's assessed value. In this context, conversion must not be interpreted as conversion in accordance with the Planning and Building Act. In accordance with the real estate assessment register, the estimated conversion rate in the 1989–2014 period varied between 1 and 4 per cent, see Figure 13. The rate is measured in this case as a proportion of the total area in the apartment building. Figure 13 also shows that public utility housing companies and tenant owner apartments made the largest contribution to total conversions.

Figure 13 Conversion rate in apartment buildings according to category of owner 1989–2007, percentage of total area in apartment buildings



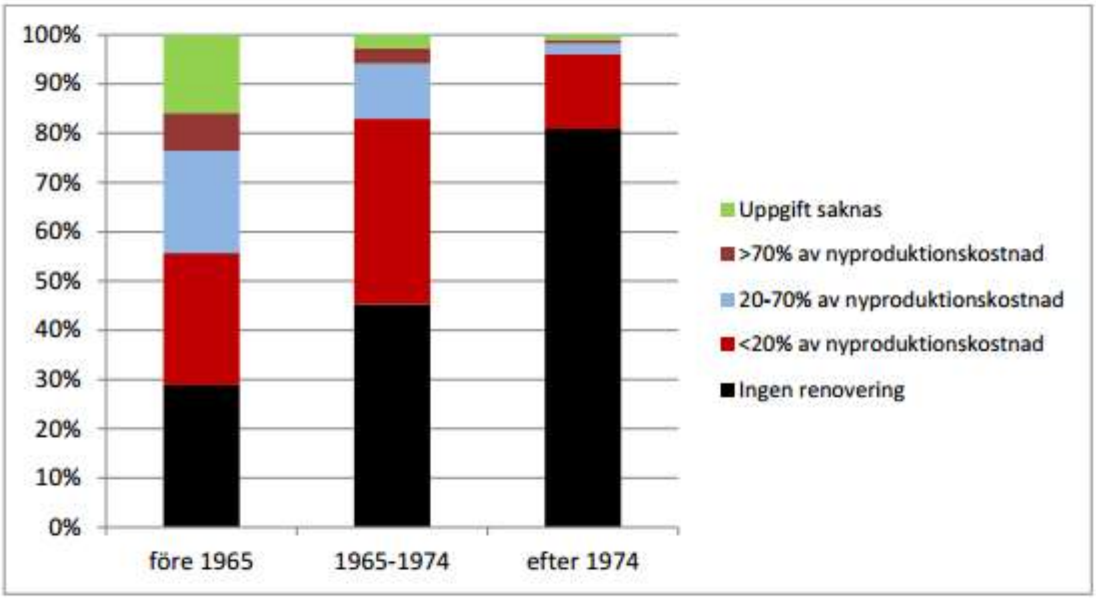
Source: Johansson and Mangold (2016) with data from the real estate assessment register.

Key:
Övrigt = Other
Bostadsrätt = Tenant owner accommodation
Privat hyresrätt = Private rental accommodation
Allmännyttan = Public utility

Figure 14 shows how the area in apartment buildings is distributed on the basis of the year of construction of the building and the scope of registered conversions in accordance with the real estate assessment register. The terms "*ombyggnad*" [conversion] and "*renovering*" [renovation] are used synonymously here. The scope of the conversions is specified as the size of the renovation cost in relation to the estimated new production cost.

Apartment buildings built before 1965 have a larger proportion of renovated area compared to buildings constructed in the 1965–1974 period. Areas in buildings constructed after 1974 are the least renovated. It is also possible to deduce that renovations whose cost exceeds 70 per cent of the new production cost are quite unusual.

Figure 14 Distribution of renovated area in apartment buildings according to scope of the renovation and period of construction of the apartment building, percentage in 2014



Source: The real estate assessment register and supporting data from SCB.

Key:
Uppgift saknas = No information
> 70% av nyproductionskostnad = > 70% of new production cost
20-70% av nyproductionskostnad = 20-70% of new production cost
<20% av nyproductionskostnad = < 20% of new production cost
ingen renovering = no renovation

Figure 14 also shows that around 45 per cent of the area in apartment buildings newly built in the 1965–1974 period have had no renovations registered since the buildings were constructed. This may indicate that almost half the area has not undergone any significant renovation such as overhaul of plumbing. Almost 38 per cent have undergone minor renovations that cost less than 20 per cent of the new production cost.

7.3.5 Connection between renovation and implementation of energy-efficiency measures

It is a reasonable assumption when a part of the building that affects the energy consumption is repaired or replaced. A repaired or replaced component should lead to the function becoming more energy efficient because technical development in many areas has led to new components being more energy efficient. It is difficult to see any statistical difference between the groups of converted and non-converted buildings. Buildings that may be assumed to have undergone extensive conversions have higher energy consumption than those that are assumed to have undergone less extensive measures. One explanation for this may be that extension and conversion also include renovations without measures that affect the energy consumption of the building. Another explanation is that measuring renovations using change in value year is a blunt instrument because relatively extensive continuous maintenance can lead to a building maintaining its value year and in that case the need for renovation is overestimated. *Annex 1 An overview of the national building stock* shows the results for energy consumption per square metre in apartment buildings broken down according to degree of renovation.

7.4 Combining energy efficiency and conservation

The building stock in Sweden contains environments, buildings and areas of great cultural and historical value. That means that special consideration must be given to these when renovating and improving energy efficiency. Certain measures, such as additional insulation, window replacement and channel routing can be particularly sensitive. Increases in the knowledge base and greater discussion regarding caution and cultural values in combination with energy efficiency measures reduce the risk of carrying out incorrect measures. It is not only cultural values that may be lost; there is also a risk that buildings that are carelessly renovated may develop moisture and mould problems. The fact that it is possible to combine energy efficiency with conservation of historical buildings and objects shows the results of the research project within the R&D programme *Spara och bevara* [Save and preserve][69], which has been financed by the Swedish Energy Agency since 2006.

[69] www.sparaochbevara.se

8 Cost-effective measures for improving energy efficiency when renovating

This chapter presents the part of the strategy requested in part:

b) Identification of cost-effective approaches to renovations relevant to the building type and climatic zone.

This Chapter presents the calculation results for measures normally carried out to improve energy performance when renovating houses, apartment buildings and non-residential premises.

Further information is contained in *Annex 2 Identification of cost-effective measures for improved energy efficiency*.

8.1 Overall results

The results are based on preliminary studies in the Swedish Energy Agency and BeBo[70] project *Halvera Mera* from 2012, as well as on the Swedish National Board of Housing, Building and Planning BETSI study from 2010. Both projects analysed possible energy efficiency measures for actual buildings. The expected costs and energy savings were then calculated.

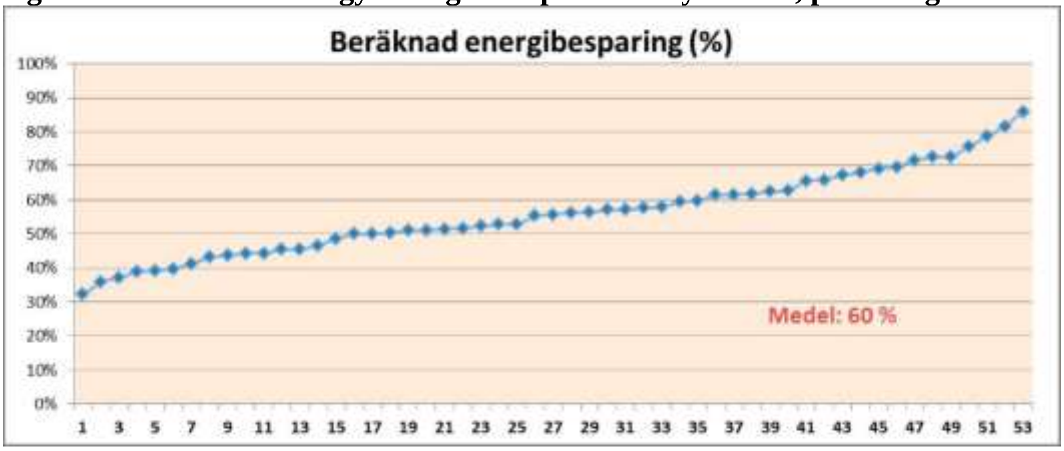
The results from *Halvera Mera* showed that the key to considerable energy savings in apartment buildings often lies in more extensive measures for heating and ventilation systems and building envelope measures. The measures are often relatively costly per saved kilowatt hour. In BETSI, the results showed that technical installation measures and, to some extent, additional insulation of attics and cellars, were among the more cost-effective measures, though the costs of the measures could vary greatly. On the other hand, the calculated profitability of measures in the building envelope was often poorer.[71]

[70] Bebo stands for *Beställargruppen Bostäder* [Client Group Housing] and is a network of property owners that promotes energy-efficient apartment buildings. BeBo is financed by the Swedish Energy Agency.
[71] One limitation of the studies is that there is no information on some costs, which affects the results of the profitability calculations. The results of the calculations are extremely sensitive to changes in costs such as energy prices.

8.2 Results from *Halvera Mera* – measures that halve energy consumption in apartment buildings

The objective of *Halvera Mera* was to carry out preliminary studies that would contain proposals for possible energy efficiency measures. Around 50 preliminary studies have been carried out so far aimed at putting forward proposals for measures that would halve energy consumption when renovating apartment buildings. Just over 70 per cent of the preliminary studies succeeded in simulating an expected halving of the energy consumption. The average saving was 60 per cent, which is equivalent to an average improvement in energy performance of 77 kWh/m2 Atemp and year. The spread varied between 30 and 85 per cent, see Figure 15. The calculated energy performance after the measures in the various buildings varied between 21 and 154 kWh/m2 A_{temp} and year.[72]

Figure 15 Calculated energy saving in 53 preliminary studies, percentage



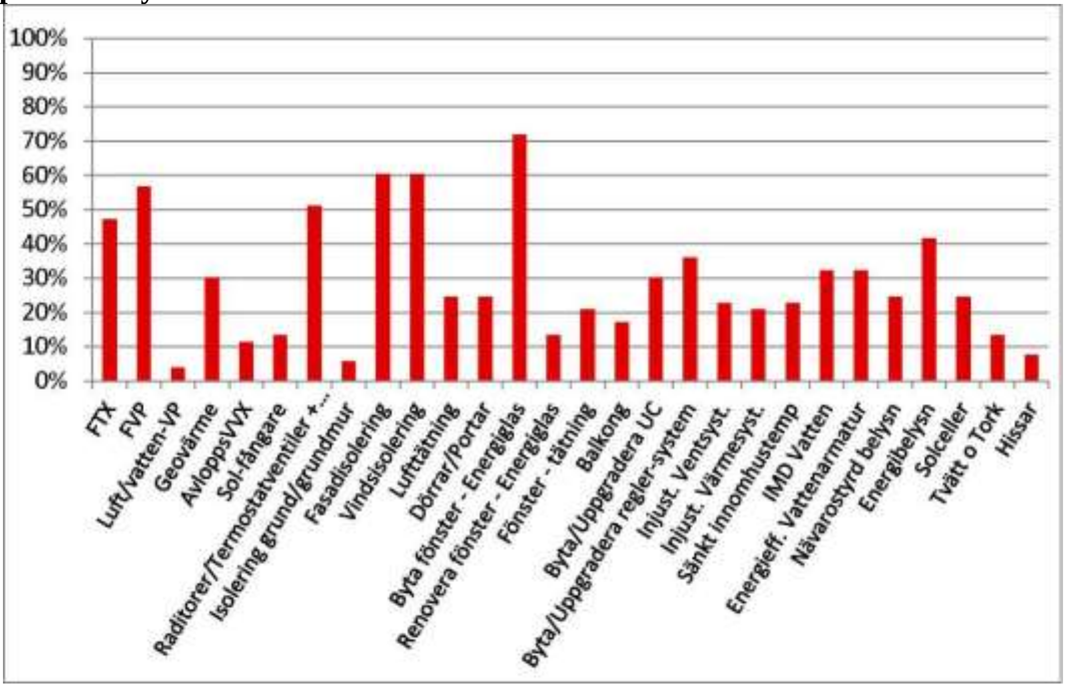
Source: *Halvera Mera*

Key:
Beräknad energibesparing (%) = Calculated energy saving
Medel: 60% = Average: 60%

The most common actions were window replacement, additional insulation in attics and façades, replacement of thermostatic valves and installation of extractor heating pumps (FVP), or ventilation with heat recovery (FTX), see Figure 16. Tenant housing associations focused more on operational measures than private and municipal companies did. Property owners in northern Sweden focused more on building envelope measures than property owners in southern and central parts of the country.

[72] WSP Environmental, 2015. *Halvera Mera* 1+2 – Analysis.

Figure 16 Measures studied in *Halvera Mera*, percentage of all apartment buildings in the preliminary studies



Source: BeBo, *Halvera Mera*

Key:
FTX = Ventilation with heat recovery
FVP = Extractor heating pumps
Luft/vatten-VP = Air/water heating pumps
Geovärme = Geothermal heating
AvloppsVVX = Sewage HVAC
Sol-fångare = Solar panels
Raditorer/Termostatventiler + = Radiators/thermostat ventilators
Isolering grund/grundmur = Installation ground/ground walls
Fasadisolering = Facade installation
Vindisolering = Attic installation
Lufttätning = Airtightness
Dörrar/Portar = Doors/Gates
Byta fönster – Energiglas = Replace Windows – Energy glass
Renovera fönster – Energiglas = Renovate Windows – Energy glass
Fönster – tätning = Windows – Sealing
Balkong = Balcony
Byta/Uppgradera regler-system = Replace/Upgrade control system
Injust. Vensyst. = Balance Ventilation system
Injust. Värmesyst. = Balance Heating system
Sänkt inomhustemp. = Reduce indoor temperature
IMD Vatten = IMD Water
Energieff. Vattenarmatur = Energy efficiency = Water fittings
Närvarostyrd belysn = Presence detector lighting
Energibelysn. = Energy lighting
Solceller = Solar cells
Tvätt o Tork =-Laundry and drying
Hissar = Elevators

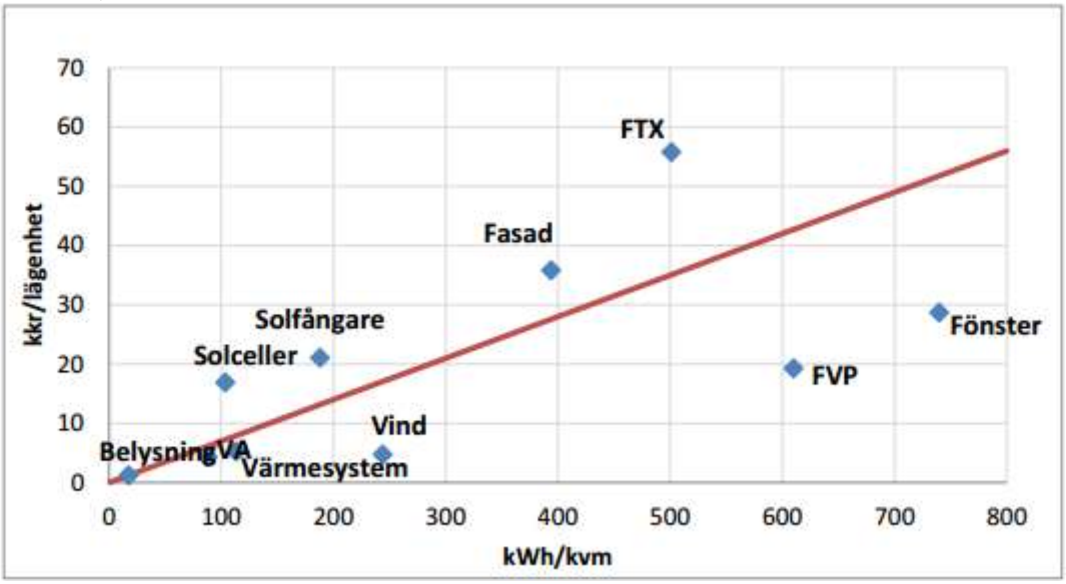
Figure 17 shows the average investment cost for various measures and potential energy savings.[73] The total investment cost in thousand SEK per apartment is on the y axis and the total energy saving for different measures in kWh/square metre over the lifespan of the measure is on the x axis[7474]. The diagonal line in Figure 17 corresponds to an energy price of SEK 1 per kWh and indicates the standard economic saving that a particular energy saving in an apartment of 70 square metres can mean.

The installation of extractor heating pumps (FVP), ventilation with recovery of exhaust air (FTX) and measures relating to the building envelope provide the largest energy savings on average according to Figure 17. At the same time, these measures, apart from FVP, involve the highest investment costs. The actions regarding windows and FVP have a low investment cost in relation to their savings and are profitable on average because they are below the diagonal line. On the other hand, FTX, façade insulation and installation of solar cells and solar panels are above the diagonal line, which means that their average investment cost is higher than the value of the energy saving.

[73] The cost calculations that we report are based on the investment cost of the energy efficiency measures, which usually includes the cost of materials and labour, whereas other costs, such as building costs, annual operating expenses and the cost of obtaining information are not included. If they were to be included, it would be detrimental to the profitability of the measures.

[74] A lifespan of 15 years has been assumed for installation measures and a lifespan or 40 years has been assumed for technical building measures, in accordance with the BeBo guide values. The energy price is assumed here to be actually unchanged.

Figure 17 Total average energy saving over the lifespan of the measure and cost per measure, SEK thousand



Source: BeBo, *Halvera Mera*

Key:
kkt/lägenhet = TSEK/apartment
Belysning = Lighting
Solceller = Solar cells
Solfångare = Solar panels
Fasad = Facade
Värmesystem = Heating system
Fönster = Windows
Vind = Attic
kvm = m2

In each preliminary study, the property owners have carried out profitability assessments on the measures. They have also stated which measures they intend to go ahead with. The results show that profitability differs for an action depending on the building and the owner, but attic insulation, FVP and upgrades of control systems are measures that have often been considered to be profitable. In most cases, where a follow-up has been carried out, a decision has been made to proceed with some of the measures proposed in the preliminary study, whereas decisions had been made not to proceed with other measures, sometimes for financial or technical reasons More information is contained in *Annex 2 Identification of cost-effective measures for improved energy efficiency*.

8.3 Results from BETSI – analysis of measures in houses, apartment buildings and non-residential premises in order to meet energy targets

BETSI was a comprehensive statistical survey of the building stock's energy consumption, technical status and indoor environment. The survey included 1384 residential buildings, of which 826 were houses and 483 were apartment buildings. 160 non-residential premises were included[75].

[75] They corresponded to 60.6 million square metres Atemp divided into offices, healthcare facilities with 24-hour operations, other healthcare premises, schools, grocery stores and other shops.

The partial study[76] on energy consumption in housing and non-residential premises contained an estimate of the costs of reducing energy consumption in buildings to achieve the existing national energy-efficiency targets for building.[77] In order to

[76] The Swedish National Board of Housing, Building and Planning, 2010, p. 95–138. Energy in building – technical characteristics and calculations Results from the BETSI project.

[77] The environmental quality objective Good Built Environment contained an interim target that total energy consumption per heated area unit in housing and non-residential premises should be reduced. The reduction would be 20 per cent by 2020 and 50 per cent by 2050 in relation to use in 1995. The interim target was removed when the environmental objectives system was changed in 2010 but, according to the decision, it must not be interpreted to mean that the objective for energy consumption in buildings has been altered in substance.

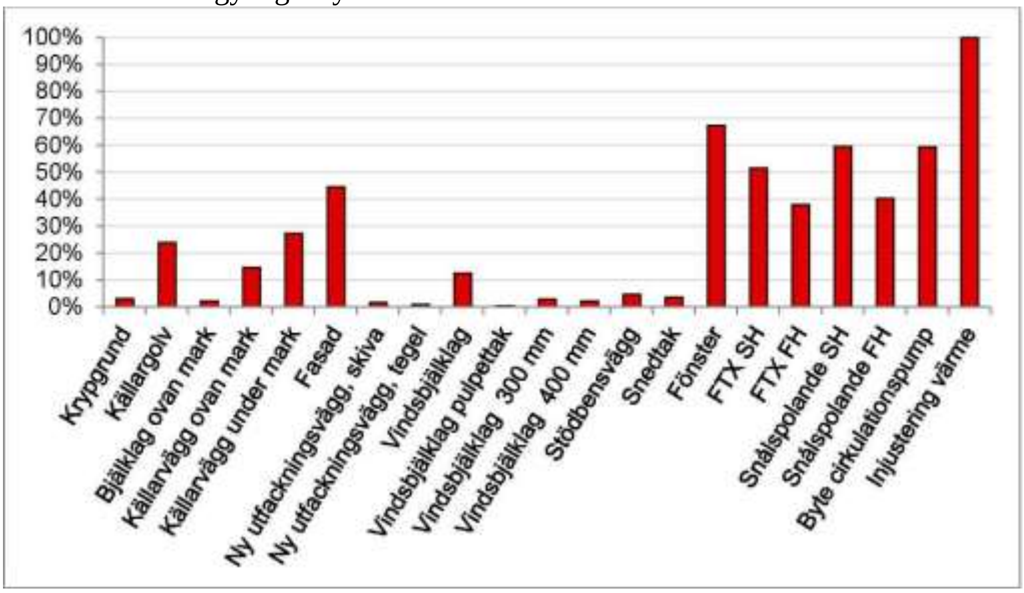
carry out the calculated energy balances for the buildings included in the survey. The study analysed which energy efficiency measures would be possible in houses, apartment buildings and non-residential premises. The measures were analysed according to the conditions applicable to each individual building and the costs of the measures and expected energy savings were calculated. The results were then scaled up to give an estimate of the possibilities and the costs of improving energy efficiency in the national building stock.

8.3.1. Measures for energy efficiency in houses and apartment buildings studied

A total of 21 types of measures were studied for the buildings in BETSI and Figure 18 shows how common measures were in the analyses. For example, balancing of heating systems was a measure of immediate interest in all residential buildings. In addition, the installation of low-flow hot water fittings and FTX and measures relating to windows were also common. A more detailed list of the measures is contained in *Annex 2 Identification of cost-effective measures for improved energy efficiency.*

Figure 18 Measures studied in houses and apartment buildings in BETSI, percentage of all houses and apartment buildings in surveys

Source: BETSI processed by the Swedish National Board of Housing, Building and Planning & the Swedish Energy Agency



8.3.2. Assumptions for cost and energy saving calculations

Key:

Krypgrund	Crawlspace
Källargolv	Cellar floor
Bjälklag ovan mark	Joist beams above ground
Källarvägg ovan mark	Cellar walls above ground
Källarvägg under mark	Cellar wall below ground
Fasad	Façade
Ny Utfackningsvägg, skiva	New infill panels, slabs
Ny Utfackningsvägg, tegel	New infill panels, brick
Vindsbjälklag	Attic joist beam
Vindsbjälklag pulpettak	Attic joist beams lean-to roof
Vindsbjälklag 300 mm	Attic joist beams 300 mm
Vindsbjälklag 400 mm	Attic joist beams 400 mm
Stödbensvägg	Stabiliser wall
Snedtak	Sloping roof
Fönster	Windows
FTX SH	Ventilation with heat recovery House
FTX FH	ventilation with heat recovery Apartment building
Snålspolande SH	Low-flush House
Snålspolande FH	Low-flush Apartment building
Byte cirkulationspump	Replacement circulation pump
Injustering värme	Balance heating

The calculations in BETSI are based on an overall technical analysis. The starting point was to examine which energy efficiency measures can be implemented in order to achieve set energy targets. Because deficiencies and uncertainties exist, as in all large-scale assessments, the results must be seen as indicative estimates rather than quantitative truths.

One of the uncertainties consists of when it will be possible to implement the measures examined. Many of the measures studied are only possible in conjunction with a replacement or renovation of a subsystem. These measures provide an opportunity to increase energy efficiency and it is the energy saving that has been calculated, but there is uncertainty as to when a replacement or renovation takes place. For windows, walls and some attics in the stock, it can take a long time before additional insulation or a replacement becomes necessary.

Certain energy efficiency measures also require an upgrade of the ventilation system before the measure can be implemented. This complicates the assessment of expected energy savings from a measure. It is not known what has occurred in the buildings since the BETSI survey and it is therefore not possible to specify the extent to which the measures analysed have actually been implemented.

Another limitation is that the costs reported only include materials and work and additional maintenance such as filter replacement entails installation of mechanical ventilation in a building with natural ventilation.[78] There are other costs that are relevant in order to gain a complete picture of the costs of the measures, such as project design, analysis, the cost of obtaining information, etc.

The costs include VAT because most owners of residential buildings are unable to deduct that expense. Prices in BETSI are given at 2009 levels, but have been scaled up to 2015 price levels with the aid of a construction price index. To enable costs to be compared, they have been calculated at annual amounts, known as annuities, with a real imputed interest rate of 4 per cent. I shows the assumed economic lifespan of the measures.

Table 37 Assumed technical lifespan of measures in BETSI

Measures in the building envelope	40 years
Installation of FTX	20 years
Replacement of circulation pump	15 years
Installation of low-flow water fittings	10 years
Balancing of heating systems	10 years

In order to report on the cost-effectiveness of the measures, the cost of the measure per saved kilowatt-hour, SEK/kWh, has been calculated. In reality, a kilowatt hour of energy has different monetary values depending on the energy carrier. In this section, we have

[78] The socio-economic cost of improved energy efficiency must also include search costs for obtaining knowledge, the subjective cost for any inconvenience during the conversion phase as well as the value of any negative effects that may result from the measures to increase energy efficiency.

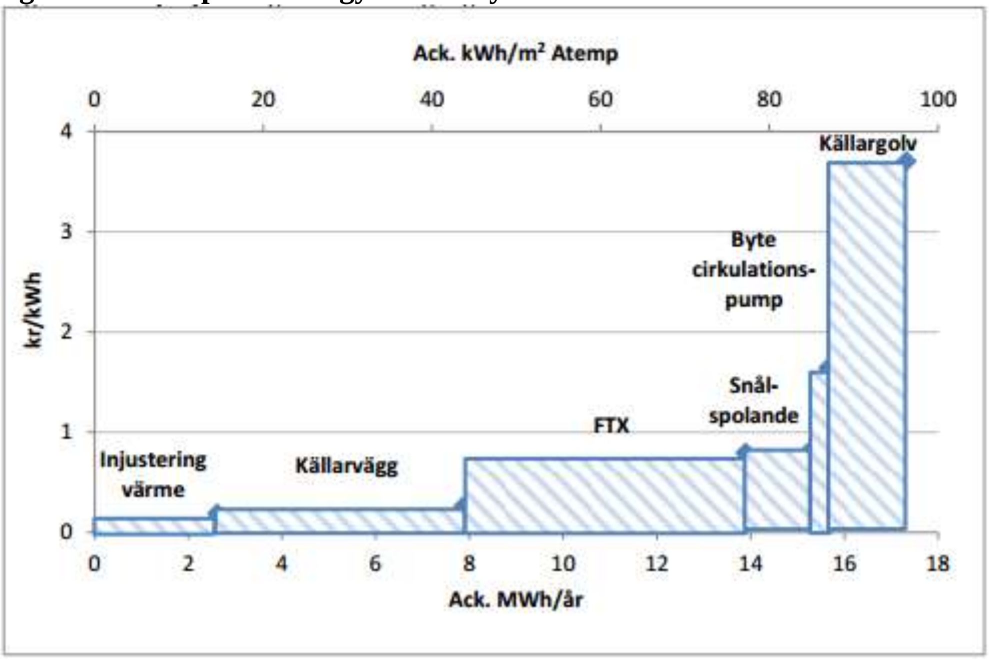
not made any distinction concerning the type of energy saved. The energy savings have not been valued in monetary terms, which also means that there is no assessment of whether the measures are profitable.

8.3.3 Example of a calculation of the cost-effectiveness of measures in a house

In order to assess the cost-effectiveness of a measure, the measure have been examined one by one in each building. The measures have been applied and ranked according to cost-effectiveness in the calculations. "Cost-effectiveness" means that a measure that saves more energy per SEK invested (SEK/kWh) is chosen before a measure that saves less energy per SEK invested. Costs for project design, obtaining information and other building costs that are relevant in order for the energy-efficiency measures to be actually implemented are not included.

An example of how each individual analysis was carried out is given in Figure 19. The example refers to a house built in 1969 with an area of 177 square metres Atemp. Six measures were examined in this case, with a total investment cost of SEK 1.73 million or 9,800 SEK/m2. Overall, it was calculated that the measures could provide an annual energy saving of just over 98 kWh/m^2, or 17 MWh.

Figure 19 Example of energy-efficiency measures in a house



Source: BETSI processed by the Swedish National Board of Housing, Building and Planning & the Swedish Energy Agency

Key:

Källargolv	Cellar floor
Byte cirkulationspump	Replacement circulation pump
Snålspolande	Low-flush
FTX	Ventilation with heat recovery
Källarvägg	Cellar wall
Injustering värme	Heat balancing
Ack. M/Wh/år	Accumulated MWh/year
Ack. k/Wh/m2 Atemp	Accumulated. k/Wh/m2 Atemp

Figure 19 shows the marginal cost curve (cost ladder) for the energy-efficiency measures The ladder shows the extent to which each measure contributes to the total energy saving in the house and how much each measure costs relative to the saving. **Heat balancing** is the cheapest measure and is calculated to save 2.6 MWh/year at an annual cost of SEK 0.19/kWh. This is followed by additional insulation of **cellar walls** which is calculated to save a further 5.2 MWh/year at an annual cost of SEK 0.26/kWh. **FTX** gives the largest saving of 6 MWh/year and

costs SEK 0.79/kWh. The most expensive measure is insulation of **cellar floors** , which gives a saving of 1.7 MWh at a cost of SEK 3.7/kWh.

8.3.4. Dissemination of the calculated costs of the measures and energy savings in houses and apartment buildings

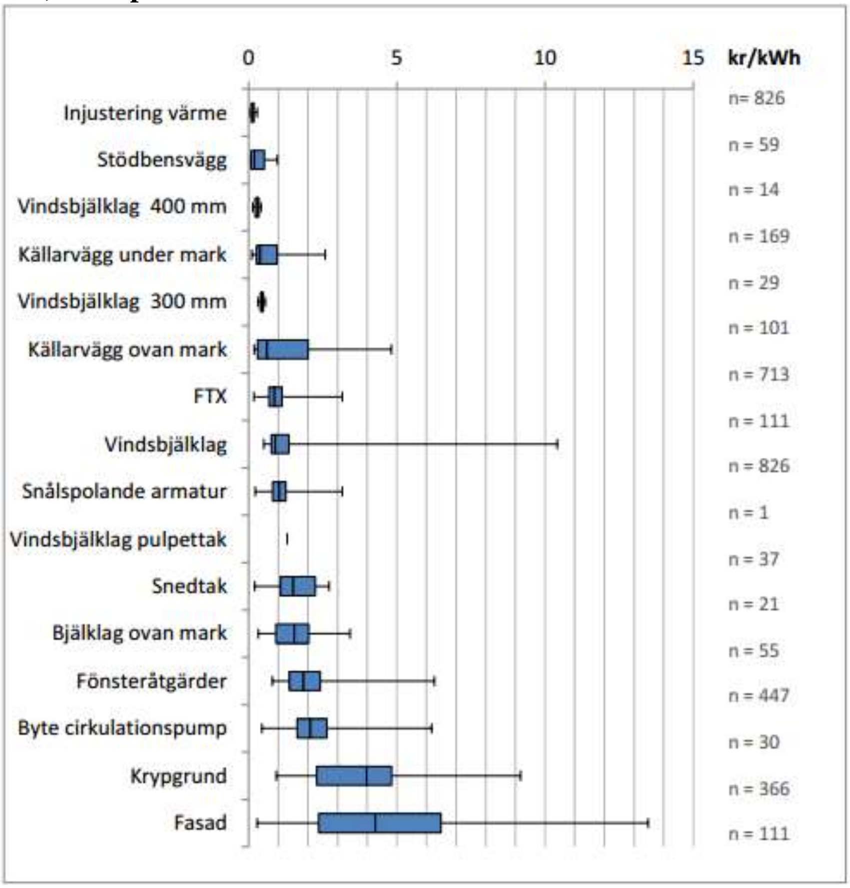
In this section, the costs of the measures is reported in relation to the expected savings for all houses and apartment buildings included in BETSI.

Seventeen types of measures were examined in the houses that were included in BETSI and the estimated cost and energy saving for the same type of measure differed according to the different conditions of the buildings. Figure shows the variation in annual saving cost in SEK/kWh for each measure. It shows, for example, that insulation measures in **façades** were examined in 111 houses and that the cost per saved kilowatt hour varied widely from the cheapest, which was SEK 0.29 and the most expensive, which was SEK 13.47. In 75 per cent of cases, the cost ended up between SEK 2.36 and SEK 6.49. The median cost of façade measures in houses was 4.28 SEK/kWh.

The measures in Figure are ranked according to their median cost.[79] Measures in the building envelope usually come last in the order of priority, in other words they usually have the highest saving cost or the lowest cost-efficiency. Highest in the order of priorities are measures relating to technical installation measures and certain insulation measures in attics and cellars.

[79] The box diagram shows the median value for the saving cost for each measure (in the middle of the box), the first quartile (the left-hand end of the box), the third quartile (the right-hand end of the box) and the minimum and maximum values (the ends of the horizontal bars).

Figure 19 The calculated average cost for measures in houses ranked according to median cost, SEK per kWh



Note 1: The number of houses in which each measure was of immediate interest is specified at the right hand side of the figure. Balancing of heating systems has been examined for all 826 houses, whereas additional insulation of attic ceiling beams where the building had a lean-to roof only occurred in one case.

Source: BETSI processed by the Swedish National Board of Housing, Building and Planning & the Swedish Energy Agency

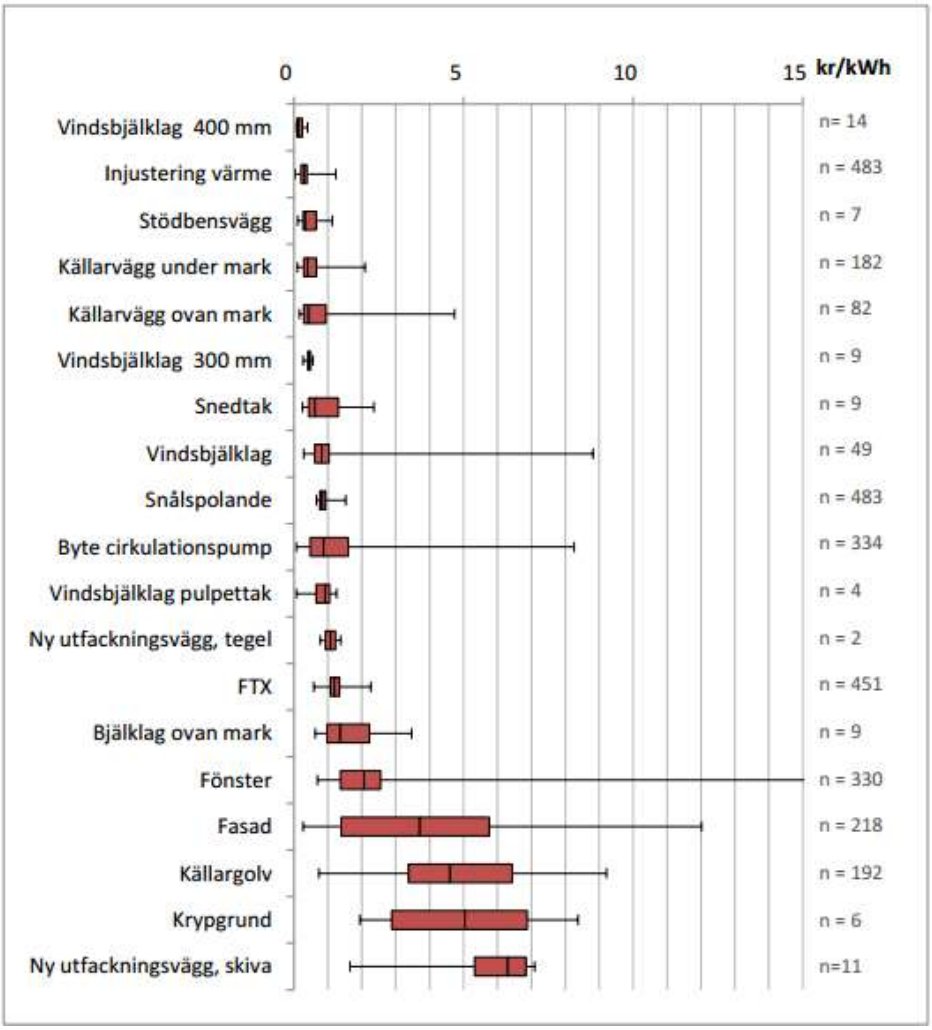
Key:

Injustering värme	Heat balancing	Snålspolande armatur	Low-flush fittings
Stödbensvägg	Stabiliser wall	Vindsbjälklag pulpettak	Attic joist beams lean-to roof
Vindsbjälklag 400 mm	Attic joist beams 400 mm	Snedtak	Sloping roof
Källarvägg under mark	Cellar wall below ground	Bjälklag ovan mark	Joist beams above ground
Vindsbjälklag 300 mm	Attic joist beams 300 mm	Fönsteråtgärder	Window measures
Källarvägg ovan mark	Cellar walls above ground	Byte cirkulationspump	Replacement circulation pump
FTX	FTX	Krypgrund	Crawlspace
Vindsbjälklag	Attic joist beam	Fasad	Façade

The measure **balancing of heating systems** had the lowest calculated median cost per kilowatt-hour and is up at the top in the above figure. **Additional insulation of attics** and of **cellar walls** also belongs to the more cost-effective measures examined in the houses, whereas **additional insulation of crawlspace, cellar floor** and **façade** belong to the less cost-effective measures. Several measures have a median cost of around SEK 1/Wh, for example FTX, and low-flow fittings.

Even for the apartment buildings, **balancing of heating systems** and additional insulation of **attics and basement walls** were among the more cost-effective measures in terms of the median cost of the measures, see Figure 20. The more expensive measures included **façade insulation, window measures** and insulation of **crawlspace.**

Figure 20 The calculated average cost for measures in apartment buildings ranked according to median cost, SEK per kWh



Source: BETSI processed by the Swedish National Board of Housing, Building and Planning & the Swedish Energy Agency

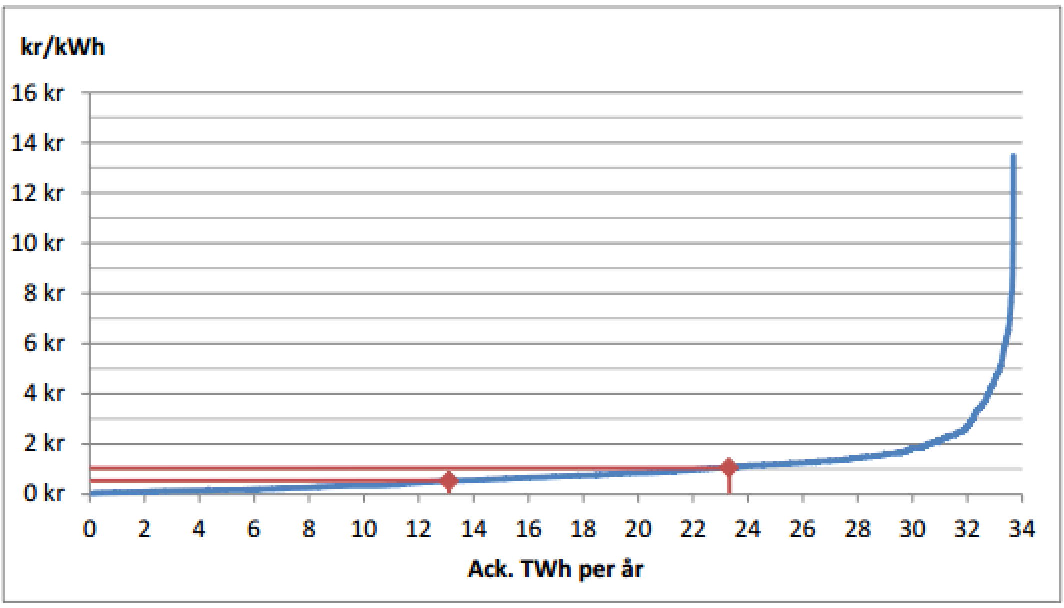
Key:

Vindsbjälklag 400 mm	Attic joist beams 400 mm	Vindsbjälklag pulpettak	Attic joist beams lean-to roof
Injustering värme	Heat balancing	Ny utfackningsvägg, tegel	New infill panels, bricks
Stödbensvägg	Stabiliser wall	FTX	FTX
Källarvägg under mark	Cellar wall below ground	Bjälklag ovan mark	Joist beams above ground
Källarvägg ovan mark	Cellar walls above ground	Fönster	Window
Vindsbjälklag 300 mm	Attic joist beams 300 mm	Fasad	Façade
Snedtak	Sloping roof	Källargolv	Cellar floor
Vindsbjälklag	Attic joist beam	Krypgrund	Crawlspace
Snålspolande	Low-flow	Ny utfackningsvägg, skiva	New infill panels, slabs
Byte cirkulationspump	Replacement circulation pump		

8.3.5 Estimate of energy efficiency in houses and apartment buildings at national level

In this section, the analysed measures for all houses and apartment buildings have been combined and then scaled up to national level. The blue line in Figure 21 shows the marginal cost curve (cost ladder) for the energy-efficiency measures in houses. The x axis represents the accumulated energy efficiency in TWh per year, whereas the y axis represents the cost of the measures in SEK per kWh. The measures are ranked according to the cost of the measure, from lowest to highest. That means that the more energy efficiency is achieved, the more the cost of additional measures increases.

Figure 21 Marginal cost curve for possible energy efficiency improvements in the national stock of houses



Source: BETSI processed by the Swedish National Board of Housing, Building and Planning & the Swedish Energy Agency

Key:
kr/kWh = SEK/kWh
Ack. Twh per år = Accumulated TWh per year

Two energy prices are also included in Figure 21: SEK 0.5 per kWh and SEK 1 per kWh. The first of these prices is at a level that a house owner may pay with a heat pump installed and with a heat factor of three. Studying the intersection of energy price and marginal cost gives an indication of the possibility of profitable energy efficiency improvements in the stock of houses. At an energy price of SEK 0.5 per kWh, the intersection is at 13 TWh per year.[80] At an energy price of SEK 1, the potential amounts to as much as 23 TWh per year.[81]

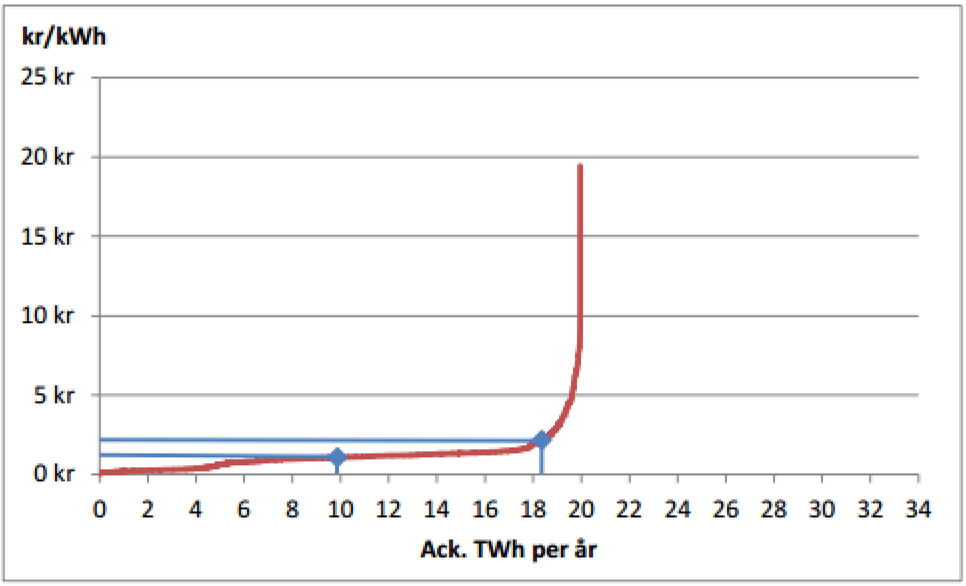
It is difficult to obtain a realistic view in a figure of the profitable energy efficiency measures in houses. This is because houses are heated in different ways. Many of them use heat pumps, whereas others use direct resistive electric heating and district heating is used in a third category. The cost of adding energy varies greatly. With existing heat pumps, the heating cost is approximately SEK 0.5 per kWh; with district heating it is approximately SEK 0.8 per kWh on average; and with direct resistive electric heating it is around SEK 1.5 per kWh. Despite this limitation, the BETSI results indicate that there is potential for profitable energy efficiency improvements in houses.

According to the BETSI supporting data, possible energy efficiency improvements in apartment buildings are not as extensive as in houses, see Figure 22. The energy prices included in Figure 22 are SEK1 per kWh and SEK 2 per kWh. At an energy price of SEK 1, the intersection for profitable

[80] The combined investment cost is estimated at just under SEK 3 billion per year for the measures expected to give an energy saving of 13 TWh per year. See more in Annex 2
[81] The combined investment cost is estimated at just over SEK 10 billion per year for energy efficiency improvements at this level. See more in Annex 2

energy efficiency improvements is just under 10 TWh per year.[82] If energy efficiency improvements are carried on for longer, the additional energy efficiency improvements are unprofitable, in other words the additional measures cost more than the energy saving is worth. Because the marginal cost curve is extremely flat, the potential profitability is extremely sensitive to the assumed energy price. With an energy price of SEK 1.2 per kWh, the profitable potential increases by 3 TWh to 14 TWh per year (not shown in the figure).

Figure 22 Marginal cost curve for possible energy efficiency improvements in the national stock of apartment buildings



Source: BETSI **processed by the Swedish National Board of Housing, Building and Planning & the Swedish Energy Agency**

Key:
kr/kWh = SEK/kWh
Ack. Twh per år = Accumulated TWh per year

It is important to stress once again that only labour and material costs are included in the BETSI supporting data. If other costs, such as transaction costs, were also included, the marginal cost curves would be shifted upwards. If we assume that costs left out amount to 50 per cent of the investment cost, the profitable potential is significantly reduced. *Appendix 2 identification of cost-effective measures for improved energy efficiency* contains figures that include such an assumed transaction cost. For apartment buildings, the profitable potential falls from just under 10 TWh per year to 5.4 TWh per year at an energy price of SEK 1 per kWh. In a house and at heating price of SEK 0.5 per kWh, the potential is reduced from 13 TWh to 10.8 TWh. This shows how sensitive the results are to what is included in the cost of energy efficiency improvements. It also shows that a reduction in all costs increases the profitability of energy efficiency improvements.

[82] The combined investment cost is estimated at SEK 5 billion per year for the measures expected to give an energy saving of 10 TWh per year. See more in Annex 2

8.3.6 Estimate of energy efficiency improvements in non-residential premises at national level

The possibilities of achieving the objective through energy efficiency improvements in non-residential premises was also analysed in the BETSI study.[83] The energy calculations were carried out for non-residential premises for offices, healthcare, schools and shops. The cost for each category was obtained by adding together the results for all the buildings in the category. The investment cost for the energy savings for the two applicable target years, 2020 and 2050, are presented in Table 38[8484].

For shops, it was impossible to achieve savings of 50 per cent, see Table 38. The total results are produced by first applying the measure with the lowest profitability in each building and then the measure with the next-lowest cost and so on until a total 20 per cent and 50 per cent energy-saving has been achieved in each individual building. The disadvantage of this procedure is that measures are included for some buildings, mainly shops, in which large investments are needed to give relatively low-energy saving. If a more selective method were applied, more measures in buildings with a low saving cost could make up for fewer measures in other, less suitable, buildings. The total investment costs could be reduced by this means.

Table 38 Investment costs and energy saving in the various categories of non-residential premises in order to achieve the interim target for energy in buildings, SEK excluding VAT, 2009 prices

Category	2020 Energy saving: 20%		2050 Energy saving: 50%	
	Investment	**Saving**	**Investment**	**Saving**
Offices (19.8 Mm^2)	621 MSEK	951 GWh	10192 MSEK	2379 GWh
Healthcare 24 hour (16.3 Mm^2)	589 MSEK	767 GWh	6431 MSEK	1918 GWh
Healthcare 8 hour (11.0 Mm^2)	231 MSEK	456 GWh	4894 MSEK	1140 GWh
Schools (38.7 Mm^2)	1594 MSEK	1702 GWh	19500 MSEK	4254 GWh
Shops, Grocery (1.6 Mm^2)	124 MSEK	120 GWh	-	-
Shops, Other (11.9 Mm^2)	569 MSEK	606 GWh	-	-
Total (128.1 Mm^2)	**4832 MSEK**	**5934 GWh**	**80982 MSEK**	**14835 GWh)**

Source: BETSI

[83] The analysis is carried out on behalf of a consultant and the supporting data for calculations in the analysis was not available for the preparation of this report. For that reason, parts of the results are presented as they were reported in the BETSI study. Total and average costs for different degrees of energy saving are specified. The costs are at 2009 price levels and have not been scaled up to today's levels.

[84] The calculations were based on a calculation period of 10 and 40 years.

9 Instruments that contribute to energy-efficient renovations

This chapter presents the part of the strategy requested in part:

c) Instruments and measures to encourage cost-effective total renovation of buildings, including total renovation carried out in stages.

The chapter first presents an overview of existing instruments with regard to renovation and energy efficiency improvements. The chapter also presents the main barriers we have identified in this area.

Two scenarios for progress up to 2050 are then described. The first, which is our reference alternative, is based on the fact that existing instruments (including those introduced in 2016) continue until 2050. In this alternative, energy consumption falls from 132 to 96 kWh/m^2 per year, calculated from 2014 to 2050. In our alternative scenario, it is assumed that both renovation and energy efficiency improvements will increase as a consequence of the introduction of new instruments and changes in existing instruments. In this scenario, the energy consumption is calculated to have fallen to 94 kWh/m^2 per year by 2050.

More information on existing instruments, barriers and a methodological description of the scenarios is contained in *Annex 3 Instruments that contribute to energy-efficient renovations*

9.1 Instruments for renovation and improved energy efficiency

Sweden has many instruments that provide incentives for implementing measures to improve energy efficiency when renovations are carried out. There are different categories of instruments and it is customary to divide them into administrative, economic and information instruments and research and innovation, depending on how they are designed and how they operate. The various categories of instruments complement one another. For example, information on what energy-efficiency measures are possible and an energy tax can be required in order for a property owner to implement the measures.

In addition, society's resources are allocated as efficiently as possible. That means, for example, that the amount of energy and what energy (for example electricity or oil) is used will have a price that includes all the energy consumption's direct and indirect costs[85]. From a socio-economic perspective, instruments are needed when situations occur that mean that free market forces do not successfully allocate resources optimally and there is therefore reason to redirect the allocation of resources. The market's failure to function optimally can, for example, be caused by market failure with regard to information. An information failure can in turn give rise to inefficient use of energy.[86] Another reason for introducing instruments is to ensure that objectives that have been adopted are achieved at the lowest possible cost. That means that the cheapest measures should be implemented first and all operators should have the same marginal cost for the last saved kilowatt hour.

Barriers to renovation and energy efficiency measures and instruments to address barriers
When the supporting data for the first renovation strategy was drawn up in 2013, an analysis was carried out of barriers to the implementation of energy-efficiency measures in connection with renovations.[87] The analysis showed that there were 179 barriers to the implementation of energy-efficiency measures and we discovered that many operators lack information on which energy-efficiency measures are suitable for implementation. An information centre was therefore proposed as a solution to remedy the problem of information. That proposal was developed further in the assignment in 2015.[88] For more information, see the section entitled *Fler energieffektiva renoveringar genomförs* [More energy efficient renovations are carried out]

In this study, we have analysed the barriers for renovations through a study of the literature and discussions with key operators. Table 39 summarises what the study considers to be the greatest barriers for renovations, along with ideas on instruments that can overcome them. A more detailed description of the barriers we identified is contained in *Annex 3 Instruments that contribute to energy-efficient renovations.* Chapter **Error! Reference source not found.** ***Error! Reference source not found.*** contains a review of all identified barriers and a discussion is also included on whether they can constitute market failure. The overall assessment from the survey is that the profitability problem is the greatest barrier for renovation. Availability of financing and necessary expertise among property owners and clients have also been considered as important barriers, though not to the same extent.

Table 39 lists the barriers along with ideas for instruments to overcome them. Some of the instruments are the ones that we propose should be implemented, see section *9.2.2.* This applies above all to initiatives relating to information such as dissemination of good examples and guidance for tenant consultation to improve conditions for the renovations. Chapter **Error! Reference source not found.** describes instruments that the study proposes for further investigation and that have a greater bearing on the profitability problem.

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[85] That means that the benefit from the used kilowatt hour on the margin is equal to the cost.
[86] For more information on market failure, see, for example, the Swedish Environmental Protection Agency (2011), section 2.3 *Marknadsmisslyckande som snedvrider energianvändningen* [Market Failure that Distorts Energy Consumption] p. 26–30.
[87] The Swedish Energy Agency 2013, ET 2013:24, the Swedish National Board of Housing, Building and Planning, 2013, Bov 2013:22
[88] The Swedish Energy Agency 2015, ET 2015:17, the Swedish National Board of Housing, Building and Planning, 2015, Bov 2015:47

Table 39 The main barriers for renovation, possible causes and instruments that can overcome them.

Barriers	Barriers - possible cause	What can overcome them?
1. Renovation is not profitable	a) The residents have moderate or low ability to pay, which limits necessary rent increases	• Greater tenant consultation • Low VAT on the rent • Subsidies for property owners • Rent subsidies
	b) In places where there is a surplus of housing and property owners are unable to renovate due to the risk of more vacancies at higher rents	
	c) The system of establishing rents provides incentives for "wrong" renovations	• Changes in the system for establishing rents
	d) The development of productivity on the part of entrepreneurs is too low	• Technology procurement
	e) Competition in the construction market is too low.	• No proposals have been submitted, but it is pointed out that greater competition is key
	f) Labour shortage	• Reduced VAT on capital brought into a business
	g) Taxes and fees on materials and labour are too high	• Higher deduction for repair, conversion and extension work for houses and tenant housing associations • Deduction for repair, conversion and extension work for rental accommodation
2. Property owners lack financing (own capital or the ability to borrow)	a) Property owners have not set aside funds for future renovations due to unfavourable tax rules	• Tax free maintenance fund
	a) Property owners have not set aside funds for future renovations because the proportion of vacant apartments is too high	
3. Insufficient knowledge among property owners and	a) Property owners have insufficient insight into the need for renovation. The transaction costs are high	• Greater tenant consultation • "Renovate right – dialogue" -

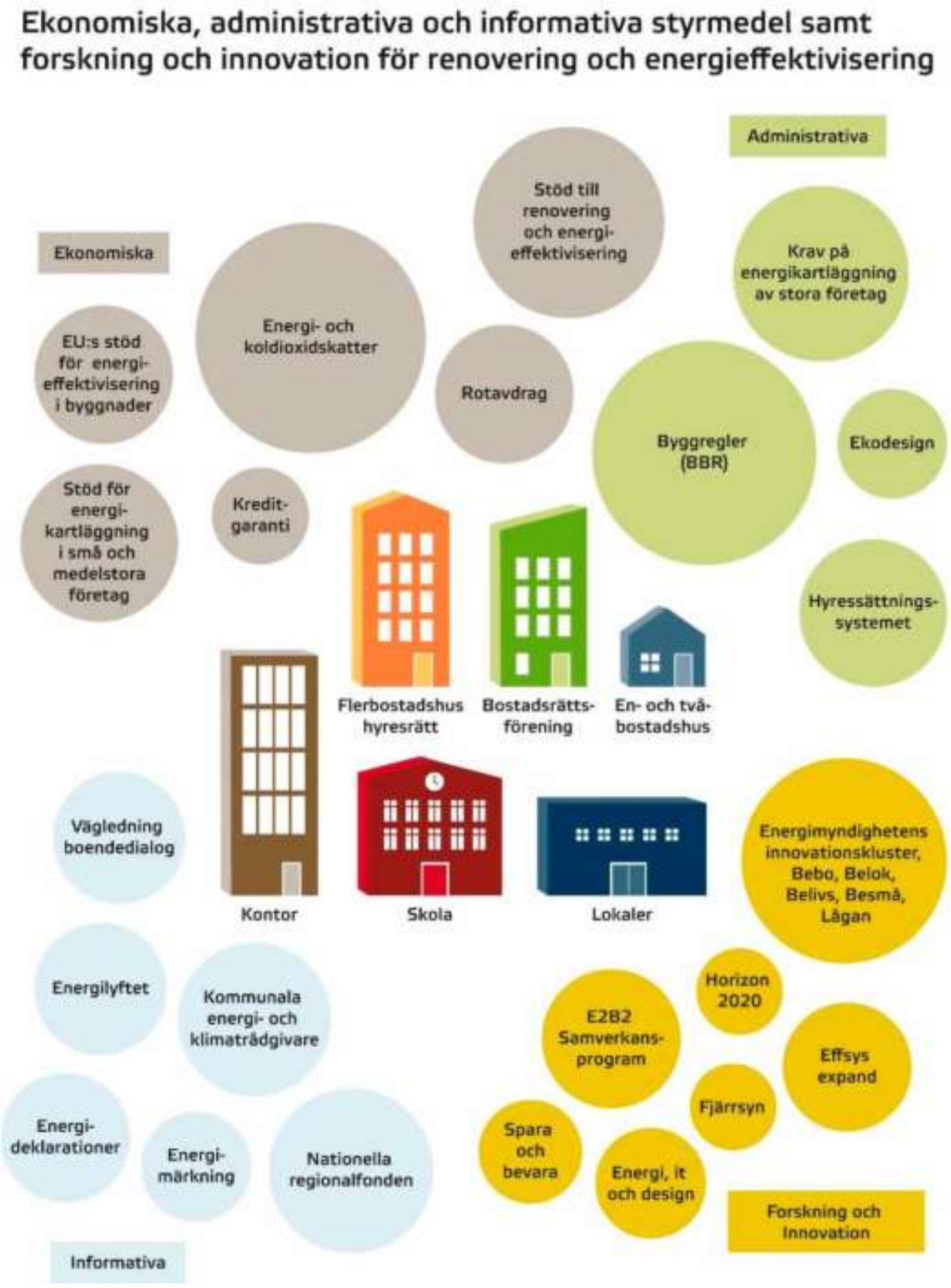
Barriers	Barriers - possible cause	What can overcome them?
clients	compiling knowledge on the nature of the housing stock b) Property owners have insufficient knowledge of possible measures for renovation and of the size of costs and benefits of renovation	A training initiative similar to Bygga-Bo Dialogen • Good examples • Requirement for a maintenance plan • Preliminary studies for sustainable renovations • Subsidies like the one for the inventory of availability in the stock of apartment buildings

Source: Study of the literature and external and internal reference groups in the study

9.1.1. Existing instruments

There are more than twenty existing instruments aimed at ensuring that renovation and energy efficiency measures are implemented. Some instruments, such as energy taxes, are cross-sectoral, whereas others have a more direct connection to the energy performance of buildings. Most of the instruments presented here are aimed at energy efficiency and only a few have any direct impact on whether a renovation is carried out. Figure 23 shows the existing instruments aimed at making buildings more energy efficient and facilitating renovations. A more detailed description of the instruments is contained in *Annex 3 Instruments that contribute to energy-efficient renovations*

Figure 23 Existing instruments for renovation and energy efficiency. The size of the circles is a schematic representation of the expected impact of the instrument or the amount of funds set aside in the instrument.



Key:

Ekonomiska	Economic
EU:s stöd för energieffektivisering i byggnader	EU support for energy efficiency in buildings
Stöd för energikartläggning i små och medelstora företag	Support for energy audits in small and medium-size enterprises
Energi och koldioxidskatter	Energy and carbon taxes
Kreditgaranti	Credit guarantee
Stöd till renovering och energieffektivisering	Support for renovation and energy efficiency
Rotavdrag	Deduction for repair, conversion and extension work

Administrativa	Administrative
Krav på energikartläggning av stora företag	Requirement for energy audits of large companies
Byggregler (BBR)	Building regulations
Ekodesign	Eco-design
Hyressättningssystemet	Rent establishment system
Flerbostadshus hyresrätt	Apartment building rental accommodation
Bostadsrättsförening	Tenant owner association
En- och två-bostadshus	One- and two-apartment buildings
Kontor	Offices
Skola	Schools
Lokaler	Premises
Vägledning boendedialog	Resident dialogue for guidance
Energilyftet	Energilyftet
Kommunala energi och klimatrådgivare	Municipal energy and climate advisers
Energi deklarationer	Energy declarations
Energimärkning	Energy labelling
Nationella regionalfonden	National Regional Fund
Informativa	Informative
Energimyndighetens innovationskluster, Bebo, Belok, Belivs, Besmå, Lägen	Swedish Energy Agency innovation clusters, Bebo, Belok, Belivs, Besmå, Lägen
Horizon 2020	Horizon 2020
E2B2 Samverkansprogram	E2B2 Cooperation programme
Spara och bevara	Save and conserve
Energi, it och design	Energy, IT and design
Fjärrsyn	Fjärrsyn
Effsys	Effsys
Forskning och innovation	Research and innovation

9.1.2 New instruments and instruments in progress

A number of new economic instruments for renovation and energy efficiency were introduced in 2016: economic aid for renovation and energy efficiency improvements aimed at rental accommodation in socio-economically vulnerable areas and an initiative for training in low energy building, Energilyftet. The Government has also adopted an initiative for a State investigation into the possibility of designing an energy-saving loan. The investigation will submit its first interim report on 30 November 2016 and the final report no later than 29 September 2017.

9.2 Scenarios

Two scenarios have been developed in order to describe possible progress in the energy performance of buildings by 2050. These two scenarios consist of a reference alternative and an alternative 1. The reference alternative represents the results of the renovation and energy efficiency measures that it can be assumed will be implemented in the existing stock of buildings with existing instruments, including those introduced in 2016. Alternative 1 assumes more extensive renovation and an increase in the number of energy efficiency measures as a result of the fact that some existing instruments are changed and new instruments are introduced. A third scenario has been developed – an extra ambitious energy efficiency scenario. The results of this extra scenario are presented in Chapter ***Error! Reference source not found. Error! Reference source not found.***.

9.2.1 Reference alternative

The reference alternative describes the expected progress in energy consumption if all existing instruments continue to exist up to 2050. The results of our analysis show that the average energy consumption for heating and hot water falls throughout the stock from 132 to 96 kWh/m^2 per year, or just over 27 per cent, between 2014 and 2050. In 1995, the energy consumption for heating and hot water was 170 kWh/m^2. In this scenario, heating will have decreased by around 44 per cent between 1995 and 2050. Electricity consumption is assumed to remain relatively unchanged up to 2050[89].

Saving and energy efficiency in net heat

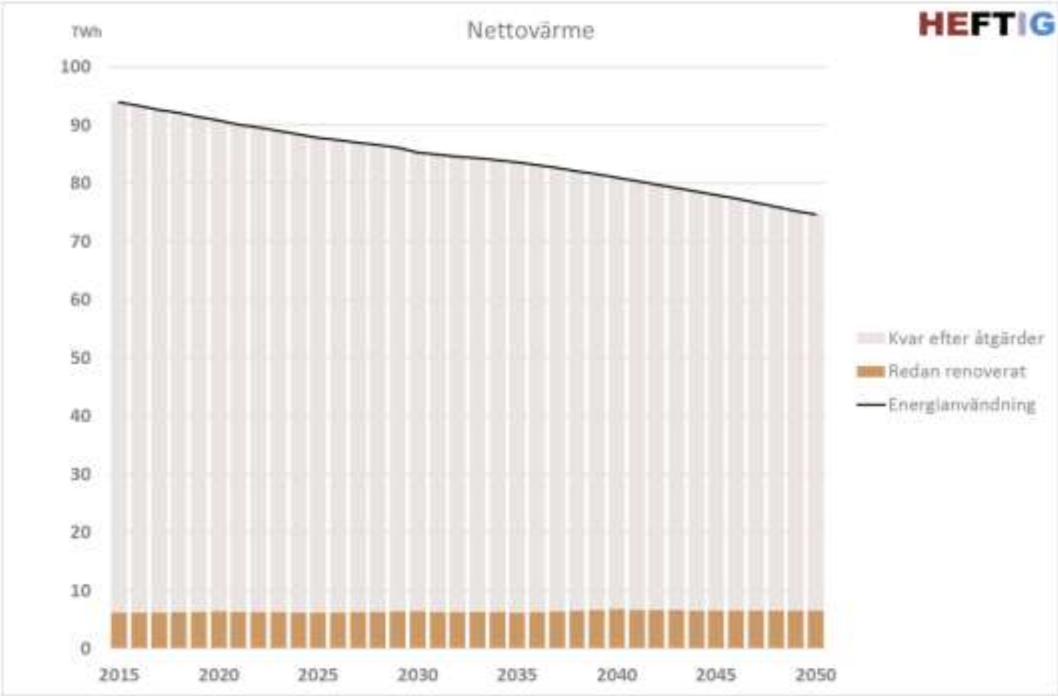
Net heat is another way of illustrating the heat consumption in buildings[90]. The major difference between purchased energy for heating and net heat is that net heat is not affected by conversion from one heating method to another.

Figure 24 shows how net heat consumption in the buildings decreases from 92,742 to 74,651 GWh during the 2014–2050 period. It is a total saving in net heat of 18 TWh, which corresponds to an annual saving of 0.56 per cent. *Annex 3 Instruments that contribute to energy-efficient renovations* describes the reduced energy consumption broken down by apartment buildings, offices and schools.

[89] Electricity consumption includes both property and business electricity.

[90] Net heat is energy for heating to keep the building climatised. For net heat, installations outside the system boundary and their degree of efficiency or effectiveness are not a factor when determining buildings' energy needs.

Figure 24 The progress of net heat for the entire building stock in the reference alternative from 2015 to 2050.



Key:
Nettovärme = Net heat
Kvar efter åtgärder = Remaining after measures
Redan renoverat = Already renovated
Energianändning = Energy consumption

Table 40 shows total and annual net heat and energy saving as well as energy consumption per square metre by 2050 for the entire building stock. In addition, it shows the saving divided into the building categories of apartment buildings, offices, schools, other non-residential premises and houses. Table 40 shows that the annual percentage heat saving is expected to be highest in houses – 0.72 per cent – and lowest in office – 0.26%.

Table 40 Results for the reference alternative. Total and annual heating and energy saving and energy consumption per square metre by 2050 for the various building categories of apartment buildings, offices, schools, other non-residential premises and houses.

Building category	Net heat saving	Annual saving, heat	Electricity saving	Annual saving, electricity	Total net heat and electricity by 2050
	By 2050 (GWh)	%	2050 (GWh)		(kWh/m^2)
Total building stock	18091	0.56	*823*	*0.07*	149
Apartment blocks	3934	0.41	55	0.02	152
Offices	291	0.26	554	0.6	181
Schools	1085	0.48	214	0.22	183
Other non-residential premises	1984	0.43	0	0	201
Houses	10797	0.72	0	0	123

Source: Renovation levels for apartment buildings, schools and offices, An interview study and analysis in HEFTIG, CIT 2016

Renovations are being carried out, but the scope varies

The results in the reference alternative are based on an analysis of the expected number and scope of renovations in the stock. It is considered that all existing buildings will be renovated by 2050[91] in the reference alternative, but the scope of the renovations varies. We have divided the scope of the renovations into four levels with different degrees of energy efficiency improvements:

- Level 0: daily operation and maintenance with a 4 per cent improvement in energy efficiency.
- Level 1: maintenance/lights renovation with a 10 per cent improvement in energy efficiency.
- Level 2: Standard improvement with a 30 per cent improvement in energy efficiency.
- Level 3: Deep renovation with a 50 per cent improvement in energy efficiency (40 per cent for offices).

When a property owner carries out a renovation, it is assumed to conform to one of the four levels. How the renovations are distributed at the different levels in the reference alternative has been assessed through in-depth interviews with property owners. The results are described in Table 41, where they have been divided into the building categories of

[91] The proportion of the total area that is considered to be renovated in 2015 has been excluded from the area that is being renovated. For more information, see *Annex 4 Description of methodology.*

apartment buildings, schools and offices and ownership types. For more information, see *Appendix 3 Instruments that contribute to energy-efficient renovations*

The renovations in Table 41 add up to 100 per cent for each owner type in a building category The results show that renovations at level 1, i.e., maintenance/easy renovation with a 10 per cent improvement in energy efficiency, are the most common in almost all building and owner categories. Table 41 shows that half of the renovations in privately owned apartment buildings are carried out at level 1. The next most common are the renovations at level 2, which account for just over a third. In tenant owner apartments, almost all renovations are at level 0 and in-depth renovations at level 3 are extremely uncommon in all categories. The interviews revealed that in-depth renovations at level 3 are carried out as isolated examples to test new technology.

There is no level for renovation packages for other non-residential buildings and houses (in addition to schools and offices). In that case, we assume a general energy efficiency improvement rate of 0.5 per cent per year.

Table 41 Distribution of estimated renovation packages that property owners are carrying out in the existing stock in the reference alternative.

	Proportion of apartment buildings (%)		
	Private	Public	Tenant owner apartments
Level 0	10	15	90
Level 1	50	60	10
Level 2	35	24	0
Level 3	5	1	0
		Proportion of schools (%)	
	Private	Public	
Level 0	10	10	
Level 1	55	60	
Level 2	30	25	
Level 3	5	5	
		Proportion of offices (%)	
	Private	Public	
Level 0	10	10	
Level 1	70	60	
Level 2	17	25	
Level 3	3	5	

Source: Renovation levels for apartment buildings, schools and offices, An interview study and analysis in HEFTIG, CIT 2016

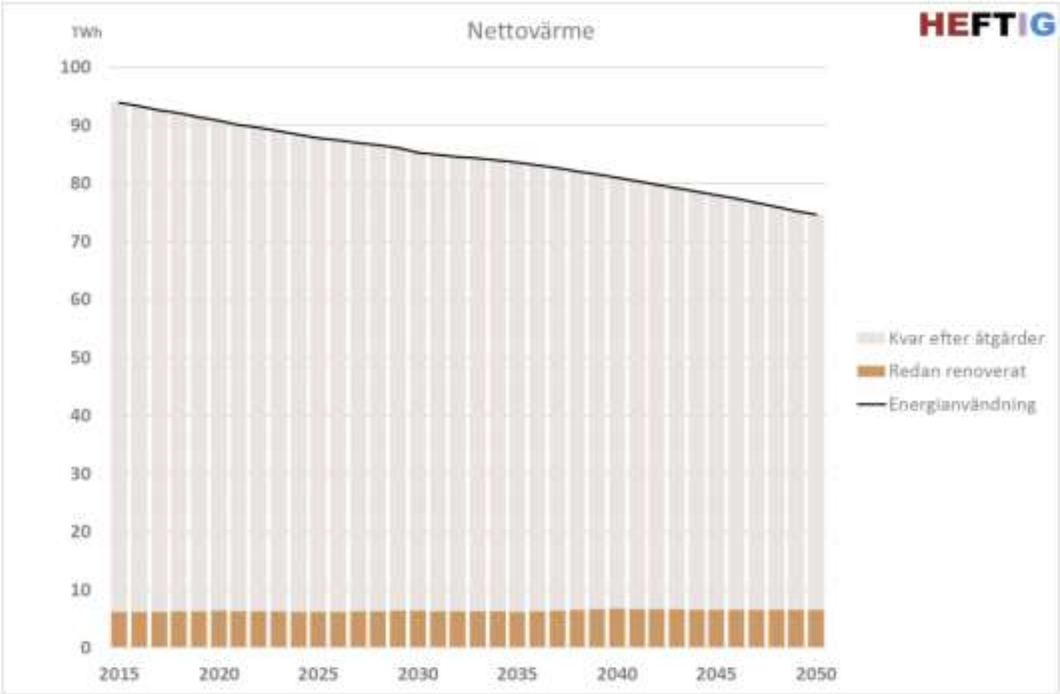
9.2.2 Alternative 1

The scenario presented here, we call alternative 1. In alternative 1, we take a step towards further energy efficiency improvements in the stock by introducing a couple of new instruments, while some of the existing instruments are developed. The changes to the instruments are presented below. In alternative 1, the energy consumption for heating in the entire stock decreases from 132 to 94 kWh/m^2 per year, or just over 29 per cent, between 2014 and 2050. A slight decrease in comparison to the reference alternative, where the decrease was of just over 27 per cent. In 1995, the energy consumption for heating was 170 kWh/m^2. With alternative 1, the energy consumption for heating will thus have fallen by around 45 per cent between 1995 and 2050. The electricity consumption is assumed to have remained relatively unchanged up to 2050, just as in the reference alternative.

Saving and energy efficiency in net heat

The progress of net heat between 2014 and 2050 is illustrated in Figure 24 below and involves a decrease of around 19 TWh. *Annex 3 Instruments that contribute to energy-efficient renovations* describes how the energy consumption decreases, broken down by apartment buildings, offices and schools.

Figure 24 The progress of net heat for the entire building stock in the reference alternative from 2015 to 2050.



Key:
Nettovärme = Net heat
Kvar efter åtgärder = Remaining after measures
Redan renoverat = Already renovated
Energianändning = Energy consumption

Table 42 shows total and annual heat and electricity saving as well as energy consumption per square metre by 2050 for the entire building stock. The information is also divided into categories of buildings.

Table 42 Results for scenario alternative 1. Total and annual heating and energy saving and energy consumption per square metre by 2050 for the various building categories of apartment buildings, offices, schools, other non-residential premises and houses.

Building category	Heat saving 2050 (GWh)	Annual saving, heat %	Electricity saving 2050 (GWh)	Annual saving, electricity (%)	Total net heat and electricity by 2050 (kWh/m2 and year)
Total	19161	0.59	629	0.05	148
the building stock					
Apartment buildings	4926	0.51	-146*	-0.04*	149
Offices	191	0.17	574	0.62	184
Schools	1263	0.56	201	0.62	180
Other non-residential premises	1984	0.43	0	0.00	201
Houses	10797	0.72	0	0.00	123

* A negative value means that electricity consumption increases. This is because the instruments that have been assumed to be effective are considered to contribute to more property owners choosing to renovate at Level 2, which in turn means that more extractor heat pumps are installed and electricity consumption increases.

Source: Renovation levels for apartment buildings, schools and offices, An interview study and analysis in HEFTIG, CIT 2016

More energy efficient renovations are being carried out

In alternative 1, the scope of the renovations carried out is increasing. This also affects which energy efficiency measures are implemented and therefore also the energy saving. Table 43 shows an assessment of what will be implemented in the building categories of apartment buildings, schools and offices. The distribution in the reference alternative is described in brackets.

Table 43 shows that the percentage of renovations at level 2 is increasing from 35 to 45 per cent in privately-owned apartment buildings. If the same kind of changes in the scope of the renovations takes place in publicly-owned apartment buildings and in tenant owner apartments, the proportion of renovations at both level 1 and level 2 is expected to rise. The proportion of in-depth renovations in level 3 is unchanged compared to the reference alternative.

Table 43 Distribution of the renovation packages property owners are carrying out in the existing stock in alternative 1.

	Proportion of apartment buildings (%)		
	Private	Public	Tenant owner apartments
Level 0	10 (10)	15 (15)	70 (90)
Level 1	40 (50)	55 (60)	20 (10)
Level 2	45 (35)	29 (24)	10 (0)
Level 3	5 (5)	1 (1)	0 (0)
	Schools	**Proportion of schools (%) Universities**	
Level 0	10 (10)	10 (10)	
Level 1	45 (55)	50 (60)	
Level 2	40 (30)	35 (25)	
Level 3	5	5	
	Private	**Proportion of offices (%)** Public	
Level 0	10 (10)	10 (10)	
Level 1	70 (70)	50 (60)	
Level 2	17 (17)	35 (25)	
Level 3	3 (3)	5 (5)	

(Source: Renovation levels for apartment buildings, schools and offices, An interview study and analysis in HEFTIG, CIT 2016

New instruments and changes in existing instruments bring about increases in the scope of renovation and energy efficiency

The instruments adopted or developed in alternative 1 are presented in Table 44 and Figure 25 and include an information centre, marketing of the Swedish National Board of Housing, Building and Planning guidance for tenant consultation, greater knowledge of the impact of energy efficiency measures in the indoor environment, expansion of the Swedish National Board of Housing, Building and Planning credit guarantees, improvements in energy declarations and guidance on the energy conservation requirement in *PBL Kunskapsbanken* [the PBA (Planning and Building Act) Knowledge Bank].

The instruments help to overcome the barriers that have been identified for improvements in energy efficiency and for renovation[92] and are intended primarily to overcome information barriers. The instruments mainly stimulate a higher standard of energy-efficiency measures in the case of renovations already planned and, above all, higher quality in the renovations being carried out, though they also contribute in part to increasing the number of renovations. The proposals are described in summarised form in Table 44 and a more detailed description of the instruments is contained in *Annex 3 Instruments that contribute to energy-efficient renovations.* Proposals for instruments have been put forward and have been investigated previously (in the reports in 2013 and 2015) or have been discussed in our internal and external reference groups.

Table 44 A description of the proposals for new or amended existing instruments that mean that more energy-efficient renovation packages are implemented in alternative 1.

Instruments	Subject matter	Budgetary cost	Responsibility
Information centre*	To raise the standard of energy efficiency improvements by making knowledge of renovation and energy efficiency measures available	SEK 10 million/year**	The Swedish National Board of Housing, Building and Planning through calls to operators
Marketing of the Swedish National Board of Housing, Building and Planning guidance for tenant consultation	To increase the number of renovations and ensure that they are carried out at the correct level. More information also means that renovations can be carried out in a simpler/smoother way.	SEK 1 million	Swedish National Board of Housing, Building and Planning
Greater knowledge of the impact of energy efficiency measures on the indoor environment and also the impact on the utility value of the housing	To increase the standard of energy efficiency improvement through awareness of the ability to charge higher rent for measures implemented, which helps increase the profitability of the measures.	SEK 1 million	
Expansion of the Swedish National Board of Housing, Building and Planning credit guarantees to include renovation measures*	To increase the number of renovations	More human resources and possibly an extended guarantee framework – though an extended guarantee framework does not affect the State budget	Swedish National Board of Housing, Building and Planning
Improvements in energy declarations	To raise the standard of energy efficiency improvements by acting as an information tool in the property market.		Swedish National Board of Housing, Building and Planning
Guidance on the energy	Raising the standard of energy	SEK 2 million	Swedish

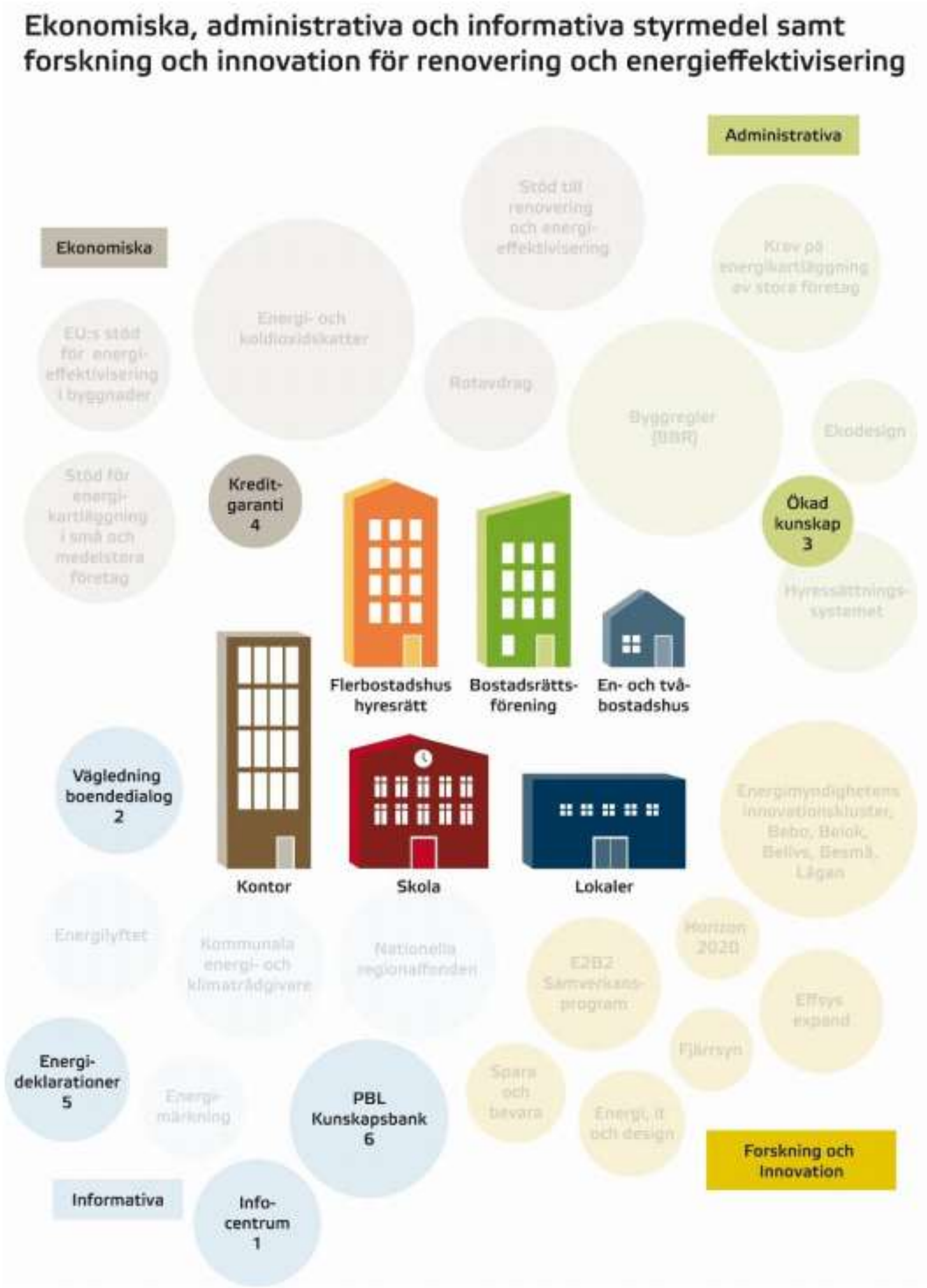
[92] See section *Barriers for renovation and energy efficiency measures.*

conservation requirement is produced for the PBA Knowledge Bank	efficiency improvements by improving the supervision of the energy conservation requirements will help meet the energy requirements and ensure that they met in a simpler way	National Board of Housing, Building and Planning

Proposal in 2013, 2015 or both the previous studies.

** Funds allocated in the budget for 2017.

Figure 25 Proposals for new or revised instruments in alternative 1.



Key:

Ekonomiska	Economic
Kreditgaranti 4	Credit guarantee 4
Ökad kunskap 3	Greater knowledge 3
Administrativa	Administrative
Flerbostadshus hyresrätt	Apartment building rental accommodation
Bostadsrättsförening	Tenant owner association
En- och två-bostadshus	One- and two-apartment buildings
Kontor	Offices
Skola	Schools
Lokaler	Premises

Vägledning boendedialog 2	Resident dialogue for guidance 2
Energi deklarationer 5	Energy declarations 5
PBL Kunskapsbank 6	PBA Knowledge Bank 6
Infocentrum 1	Information centre 1
Informativa	Informative
Forskning och innovation	Research and innovation

Information Centre is expected to have an effect on most building categories by stimulating renovation and energy efficiency measures through more active dissemination of expertise in relevant channels. The right expertise and guidance at the right time can determine whether a renovation is carried out and whether it will also include profitable energy efficiency measures. Those who are already highly skilled, such as those who own private offices are expected to be affected by the introduction of an information centre to a lesser extent.

Resident consultations are expected to be of significance primarily for the building categories of schools, privately owned apartment buildings, public offices and tenant housing associations through users becoming more involved. Houses and private offices are not expected to be significantly affected. **Knowledge of the possibility of being able to raise rents** may have some impact on privately-owned apartment buildings. Some effect can also be obtained in the category of publicly-owned apartment buildings.

Credit guarantees could have some impact on energy efficiency measures, particularly for private and publicly-owned apartment buildings. **Improvements in energy declarations** are expected to have an impact mainly on houses, privately-owned apartment buildings, tenant owner associations and possibly privately-owned offices. **The guidance on the energy conservation requirement** is expected to affect mainly rental properties. The scenario shows that the amendments to instruments proposed have some effect on the total energy consumption compared to the reference alternative.

10 A forward-looking perspective for buildings in Sweden

This chapter presents the part of the strategy requested in part:

d) A forward-looking perspective to guide investment decisions by individuals, the construction industry and financial institutions.

The introduction to this Chapter describes future investment needs for renovations in the stock of apartment buildings. Substantial investments will be required both to address deferred maintenance in the stock and to keep pace with the future need for renovation. It also briefly describes barriers for investment as well as national objectives, how renovations are financed and Swedish Energy Agency's work on the study *Fyra framtider* [Four futures]. The national strategy will cooperate with and reinforce other initiatives aimed at achieving the national objectives.

10.1 National objectives

The building sector accounts for approximately 40 per cent of energy consumption in the EU and, in Sweden, housing and services account for almost 40 per cent of total energy consumption. In order to achieve the overall national objectives for a sustainable society, more energy efficiency measures need to be implemented and an increased proportion of renewable energy is also required. Sweden has an overall objective for community planning, housing markets, construction and land surveying activities that means that everyone, throughout the country, should have a good living environment from a social perspective in which satisfactory long-term conservation of natural resources and energy is promoted and that facilitates house building and economic development. The Government aims to build at least 250,000 new homes by 2020. [93]

Sweden also has an overall objective for environmental policy that will enable the next generation to take over a society in which the major environmental problems have been solved, without Sweden having caused greater environmental and health problems outside the country. The generational objective that was adopted in 2010 when the system of environmental objectives was changed is a guideline objective that provides guidance on the social transformation required to achieve the desired environmental quality. Achieving the objective by 2020 requires an ambitious environmental policy in Sweden, in the EU and in an international context. Indent number five under the generational objective includes the objective for energy and states that the proportion of

[93] Objectives for building and housing, http://www.regeringen.se/regeringens-politik/boende-och-byggande/mal-for-boende-och-byggande/ 26/10/2016

renewable energy will increase and that energy consumption will be efficient, with minimal impact on the environment.

In 2009, the Riksdag decided on a sector-wide objective of reducing the energy intensity by 20 per cent between 2008 and 2020 and the Swedish Energy Agency report entitled *Energiscenarier över Sveriges energisystem* [94] [Energy scenarios regarding Sweden's energy system] presents a reference case in which energy intensity is expected to decrease by 18.9 per cent between 2008 and 2020. Since the reference case was taken from 2014, several external factors have changed and the decision to decommission nuclear reactors and to stop an increase in power of a reactor has had the greatest impact on the outcome. These changes in nuclear power make it likely that the intensity objective will be achieved by 2020.

On 10 June 2016, the Government, *Moderaterna* [the Moderate Party], *Centerpartiet* [the Centre Party] and *Kristdemokraterna* [the Christian Democrats] presented an agreement on Sweden's long-term energy policy. It states that an objective for increasing energy efficiency between 2020 and 2030 must be developed and adopted no later than 2017.[95] Overall, the targets for energy efficiency and house building are ambitious and the measures proposed in the national strategy for renovation to increase energy efficiency will help achieve them.

10.2 The buildings' role in the future sustainable energy system

The renovation strategy will contribute to a society in which buildings are both resource- and energy- efficient and robust and flexible, with good energy performance. Cooperation and a holistic view are the keywords for achieving that vision. It is a question of cooperation between many different parties – between property owners and residents, between municipalities, the business world, academia and others. As far as a holistic view is concerned, it is a question of a uniform view of the challenges facing Sweden, though the challenges are not only national, but also require a holistic view and cooperation in international terms.

Most of Sweden's property stock consists of older buildings, many of them in great need of renovation. For the Million Programme properties, energy efficiency measures are only part of the challenge posed by socially, economically and ecologically sustainable development. Renovating older housing areas, including the Million Programme areas, requires initiatives to develop packaged solutions and innovative system solutions for energy-saving measures along with other improvements that are of value to residents.

The buildings of tomorrow form a basis for flexible energy systems in which large-scale production and storage combine with locally-produced and locally-stored electricity. Today, we are already seeing examples of buildings that not only use energy, but

[94] The Swedish Energy Agency 2014, ER2014.
[95] http://www.regeringen.se/artiklar/2016/06/overenskommelse-om-den-svenska-energipolitiken/

that can also act as small-scale electricity producers. Solar energy is well suited to production in or in the vicinity of buildings, but flexible buildings are required in order to create a more flexible energy system in Sweden that can cope with a more uneven supply of power such as solar and wind energy.

As new buildings become more energy efficient, the significance of the use of energy at stages of the buildings' life cycle other than the operating phase increases. Selection of materials, energy consumption at the construction phase and recycling and final handling of materials becomes more important. When a building is undergoing renovation, the conditions are different from the conditions in the case of a new building and it is necessary to relate to the given conditions of the building. The measures can be divided into three categories to ensure that the building's net energy requirement is low. The first category is the building envelope and examples of measures include insulating the façade, renovating or replacing windows, improving waterproofing in the building or providing additional insulation for the attic. The second category is energy-efficient technical installations such as energy-efficient ventilation and good lighting. The third category consists of a review of the possibilities of supplying renewable electricity and heating and the possibilities of producing electricity and heating in or in the vicinity of the building.

Effective solutions in these three categories ensure low energy requirements in the building. This in turn means that the building's energy consumption will be less affected by energy carriers. This reduces the importance of the energy supply for the building. It achieves flexibility as far as the choice of technology is concerned. Flexibility and transparency also increase the opportunities for future changes in the operation of a building and conversion of the energy system.

10.3 Need for investment and remaining renovation costs

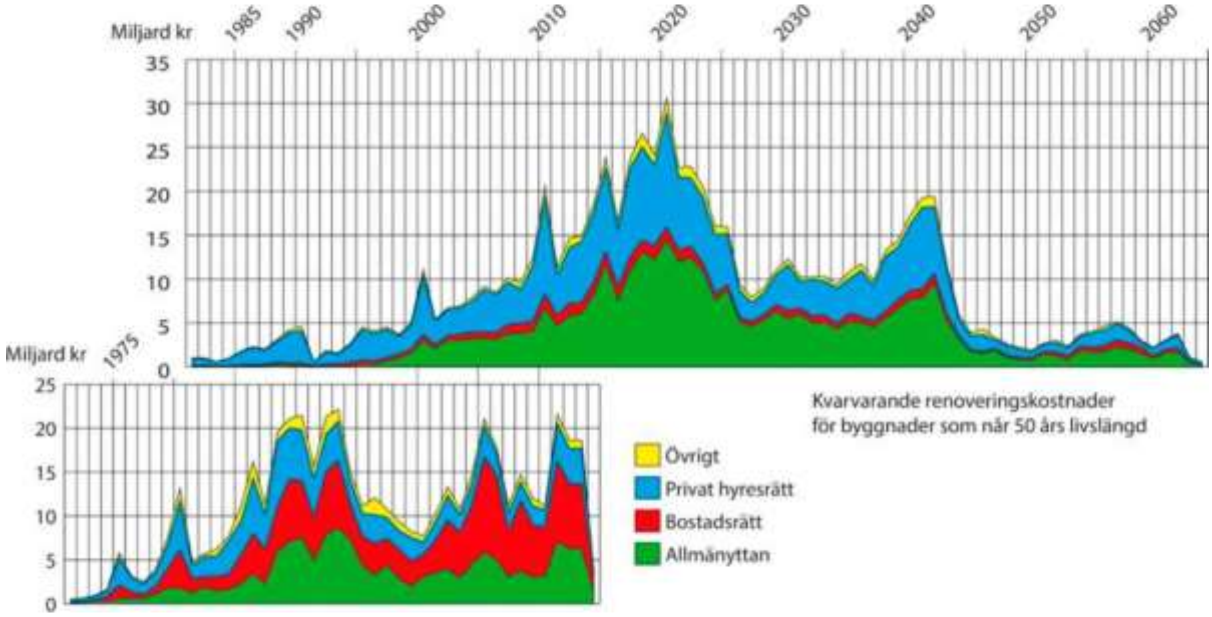
The challenges faced by Sweden's property owners can be illustrated by the need for renovation of apartment buildings. Approximately 3 per cent of the area of an apartment building will need to undergo renovation in the years up to 2020. That estimate is based on the assumption that buildings with a value year[96] around 1970 need to be renovated around 2020. At the same time, the deferred renovations that remain from the years prior to 2014 need to be taken into account in the need for renovation.

Figure 26 shows a snapshot of both the renovations that have been carried out and those that remain up to 2050. It is clear that there is a peak culminating around 2020 and that there will be a new peak around 2040, when large-scale investment in the stock of apartment buildings will also be required. In a situation where all buildings were renovated, there would be no coloured area to the left of 2016 in the figure above. The area can therefore be interpreted as an illustration of the deferred need for renovation existing in buildings, in other words

[96] Value year is calculated on the basis of a technical lifespan of 50 years. A building with value year 1950 is assumed to need renovation in 2000; a building with value year 1964 is assumed to need renovation in 2014, and so on.

buildings that, according to the assumptions in the analysis, should have been renovated but have still not been attended to. If this area were repaired, it would be moved down to the lower figure, which shows what has been renovated.

Figure 26 Comparison of previously registered renovation costs and presumed renovation costs according to the standard of renovation assumed in HEFTIG, for apartment buildings.[97]



Registered renovation costs

Key:
Kvarvarande renoveringskostnader för byggnader som når 50 års livslängd = Remaining renovation costs for buildings reaching a lifespan of 50 years
Övrigt = Other
Privat hyresrätt = Private rental
Bostadsrätt = Tenant owner
Allmänyttan = Public utility

Source: **T Johansson** & M Mangold, 2016. Geographical analyses regarding the need for renovation of and energy efficiency improvements to apartment buildings. Department of Industrial and Sustainable Construction, Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology

In the upper part of Figure 26, it is assumed that the scope of the renovations differs according to the four levels presented in section 9.2 Scenarios. The total renovation cost is estimated to be over SEK 30 billion for the renovations to be implemented by 2020. The renovations that were carried out between 1990 and 2015 have cost close to SEK 20 billion per year, whereas the deferred renovations corresponded to approximately SEK 5–20 billion per year[98].

10.4 Financing of renovation projects

The forward-looking perspective is important for creating a long-term approach that can make it easier for property owners to manage buildings. In the analysis of barriers, a lack of profitability

[97] T Johansson, M Mangold, Department of Industrial and Sustainable Construction, Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology, Lulea, October 2016
[98] The cost is not indexed.

was perceived to be the biggest barrier and that means that profitability assessments and financing of renovation projects become important questions.

A property owner investigates a range of investment alternatives prior to a renovation.[99] A renovation involves an investment that provides a return over time and in order to assess the profitability of the investment, the property owner must weigh increased revenues and reduced operating costs against investment costs throughout the period of the returns. Revenue increases and reductions in operating costs mean that the value of the property rises. In rental accommodation, renovation measures that involve raising standards in accordance with established practice mean increases in rent or fees. Measures that only lead to lower operating and maintenance costs do *not* lead to rent increases; instead they lead to cost savings. The difference between rental income and operating and maintenance costs is referred to as *net operating income* and a property owner must decide whether a renovation option increases the net operating income enough to cover the costs of the measures. If there are several (more or less comprehensive alternatives to renovation), the alternative that means the highest profitability should be chosen.[100]

10.4.1 The credit market

In Sweden, the property owner has primary responsibility for maintenance and is responsible for investment and reinvestment in the building. Financing of a renovation project usually takes place through own capital, shareholders' capital or borrowed capital. There are number of operators on the credit market that offer loans to private individuals, tenant owner associations, property companies, foundations, etc. Banks are usually willing to grant loans equivalent to 60 to 85 per cent of the value of the property.[101] In the loan application, the bank carries out an ordinary profitability assessment of the project and a credit check.

In order for the bank to approve a loan, the property owner must first demonstrate that the investment is profitable. The bank examines both the assumptions and the results of the property owner's calculations in order to assess the profitability of the investment. In order for the bank to assess whether an investment calculation is sustainable, the investment should have sufficient cash flow to pay the interest on the loan and pay off the loan at a desirable level.

Publicly-owned operators in the credit market

Besides private credit institutions, there are also public operators such as SBAB, a state-owned limited company engaged in profit-oriented banking, and the limited company Kommuninvest[102], which is largely owned by municipalities, county councils and regions and finances municipal housing companies, among other entities. The Swedish National Board of Housing, Building and Planning also manages State credit guarantees for conversions.

A newly-appointed Government committee will study the feasibility and need for a State energy-saving loan. The committee will assess matters such as the possible impact of such a loan on the number of renovations and energy efficiency measures in buildings and look

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[99] This section is from Copenhagen Economics (2015), unless otherwise specified.

[100] For a more detailed review of the rules for financial decision-making in the case of renovations, see Lind (2014).

[101]

[102] Kommuninvest consists of two parts. On the one hand there is the limited company, Kommuninvest i Sverige AB, which offers loans and financial expertise and, on the other, there is the economic association *Kommuninvest ekonomisk förening*, which owns the limited company. The economic association has 90 per cent of Sweden's municipalities, county councils and regions as members.

at effects on the State budget. If the investigator considers that there is a need for a State-financed energy-saving loan and that an energy-saving loan makes a positive impact on the number of renovations and energy efficiency measures in the buildings, the committee will also put forward proposals on how a State-financed loan for energy efficiency measures should be designed for the Swedish market. The assignment will be presented in a final report no later than 29 September 2017.[103]

10.5 Four different futures

Investments in energy are long-term. The planning beginning today will shape society for decades to come. Nevertheless, there has been no discussion on the future concerning the kind of society in which the energy will be integrated. To what extent will households be involved in producing their own electricity? How do we want to connect growth and energy? Is energy primarily a matter for Sweden, or a matter for the world?

There are currently a large number of operators that together make up the energy system in Sweden. It is possible to distinguish three main groups: the public sector, private for-profit operators and private non-profit operators, primarily households. All operators have a role in ensuring that the energy system moves in a direction that is sustainable in the long term.

But the roles and responsibilities of different operators in the energy system are not obvious and they also change over time. Today's consumer is perhaps tomorrow's electricity producer with the ability to store energy. In the report entitled *Fyra framtider*[104] [Four futures], the Swedish Energy Agency has devised four scenarios that attempt to describe what form the future energy system may take, depending on what the community thinks is important in terms of energy. The report describes four visions of the future: Forte, Legato, Espressivo and Vivace, which are terms from the world of music. *Forte* means strong; *legato* means flowing, *espressivo* means expressive; and *vivace* means lively. The names show the key priority in any future.

The energy consumed comes from different kinds of energy and is used in different ways in the four scenarios. The extent of the energy consumed differs in the various scenarios. Nevertheless, the fact that energy is not an isolated issue, but is closely connected with other parts of society, for example how people live and work and how society is organised, is common to all futures.

In FORTE, it is important for society to ensure that energy prices are low, particularly for industry. Welfare is based on economic growth and the availability of jobs. Secure access to energy is a key priority.

In LEGATO, it is a question of reducing the environmental impact of the energy system and help solve a global issue. Ecological sustainability and global justice, which are characteristic features of the solutions, are important in this scenario.

[103] Energy Saving Loan Committee Directive 2016:68 Sveriges Riksdag
[104] The report entitled "*Fyra Framtider Energisystemet efter 2020*" [Four Futures; the Energy System after 2020], the Swedish Energy Agency 2016 ET 2016:04

ESPRESSIVO is based largely on own initiative and consumers who want individual solutions and flexibility. Green energy is a strong motivator in this scenario. Decentralisation, small-scale own production and purchases of services are key elements in Espressivo.

VIVACE involves a strong focus on the climate. Sweden has chosen to become a leading country when it comes to green growth and it is developing an export market for environmental technology and bio-industry, which creates new kinds of jobs.

Work on the scenarios in Fyra Framtider is exploratory in nature and builds on the various priorities and driving forces that have the potential to shape society. The future that will become reality will probably consist of parts of all the various futures together, along with parts that the study could not foresee. But, no matter what the future is like, maintenance, renovation and energy efficiency measures will form an important part of the social structure.

11 An evidence-based estimate of expected energy savings and benefits in a wider sense

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This chapter presents the part of the strategy requested in part:

e) an evidence-based estimate of expected energy savings and benefits in a wider sense

This chapter contains a description of how renovations can provide benefits in addition to reduced energy consumption, such as:

- higher social status in renovated residential areas

- higher quality of indoor air, which in turn may lead to reduced incidence of respiratory diseases and sick building syndrome and greater ability to perform

- better air quality outdoors due to the reduced number of particles in the air

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11.1 Added value of ambitious energy-efficient renovations

Renovations can lead to better quality of life and have a number of social effects, such as a better atmosphere and better reputation for the residential area and reduced energy consumption and thus, in particular, a reduced need for heating.

In addition to these obvious benefits, other positive effects in addition to the direct energy savings can also result from renovations in the building stock. Examples of advantages include better health due to higher quality of outdoor air and better indoor environments. These benefits are often omitted in various analyses, which can result in a risk of sub-optimisation when policies and initiatives are designed. So far, there are few measurable effects of the size of the advantages, but attempts have been made to estimate the impact at European level and in one or two EU Member States. It is also important to identify new benefits at national level because these may differ from one country to another. It provides better supporting data when decisions on measures are to be made.

We consider that the following benefits of energy-efficient renovation exist, based on Swedish conditions:

- Energy savings

- Health effects of a better indoor climate

- o Reduced incidence of asthma and sick building syndrome
- o Improved productivity for office workers and students, for example

- Health effects of better air quality, through reduced emissions of nitrogen and sulphur oxides (NOx, SOx) and fine particles

An ambitious future scenario for energy-efficient renovation has been used in order to carry out a quantitative estimate. This scenario is more extensive than those presented as the reference scenario and alternative 1 in Chapter *9 Instruments that contribute to energy-efficient renovations.* It is based on a future where all buildings become as energy efficient as possible when they are renovated. The results of this scenario are presented in Chapter ***Error! Reference source not found. Error! Reference source not found,***[105]'. In this scenario, energy consumption for buildings has fallen from around 75 TWh to 50 TWh by 2030. Based on forecasts for the progress of energy prices, the savings will be worth around SEK 8.5 billion per year by 2030[106].

Figure 27 Added value in the case of more ambitious renovations. Please note that the value of health effects is still somewhat uncertain and may change. The impact on economic activity depends on the economic situation and will therefore change when changes occur in the economy.

Source: Copenhagen Economics 2016

[105] The saving effects on which Copenhagen Economics based its calculations also include the energy efficiency measures being implemented in houses. These savings are equivalent to just over 45 per cent of the total saving.
[106] The calculations are based on Swedish Energy Agency recommended uncertainty ranges for the progress of energy prices of +/- 10 per cent and result in a range of SEK 7.6 billion to SEK 9.3 billion per year

In this scenario, in addition to energy savings, reduced air pollution and improved quality of indoor air can, in particular, be expected from renovations to increase energy efficiency. Based on cost calculations of outdoor pollution, reduced nitrogen and sulphur oxides in 2030 can provide benefits worth approximately SEK 390 million per year. This is mainly due to a decrease in district heating production, where production is based on biofuel and, to a small extent, on coal. The value of reduced emissions increases to between SEK 1.9 billion and SEK 2.1 billion when the reduction in fine particles is included. These estimates are unreliable since the valuation of fine particles varies greatly from one source to another and because the analysis does not take into account the geographical area where the emissions take place, which has a very significant impact on the valuation.

Better quality of indoor air can be of great benefit to Swedish society. The existence of asthma, other respiratory diseases and so-called sick building syndrome are unwanted consequences of poor indoor air quality. There are relatively well-established methods for estimating the value of reducing the incidence of these conditions. Methods to estimate the causal link between renovations and the reduced incidence of various forms of respiratory diseases and sick building syndrome are not as well established, but estimates of the value have been carried out. The renovations carried out need to have a slightly broader scope than just energy efficiency measures so that measures to improve ventilation and lighting are adopted in order for these benefits to come about. Based on information on the existence of sick building syndrome and assuming that approximately 33–50 per cent is alleviated through renovation, this will increase productivity in Swedish society by approximately SEK 0.4 billion to SEK 1.1 billion per year by 2030.

In addition, the improvement in air quality in Swedish schools as a consequence of the renovations in the scenario may be expected to affect students' learning. It is estimated that improved ventilation will increase the number of students who pass exams in reading and mathematics by around 3 per cent.[107]

Advantages in the form of greater energy security, reduced carbon dioxide emissions[108] or reduced need for investment in renewable energy are nevertheless not considered to be relevant to any great extent in Sweden, given that the proportion of oil and coal is small and the proportion of renewable energy is already large. As far as Sweden is concerned, nor is any increase in economic activity through more renovations desirable at present. The GDP gap[109] in Sweden is positive, which means that utilisation of resources is high. That means that more renovations and even higher economic activity is not sure to be positive. However, if Sweden were to be affected by an economic downturn, increased economic activity may benefit the economy. In view of the current situation in the economy, the introduction of some form of economic stimulus for more

[107] Haverinen-Shaughnessy et al (2011)
[108] Reduction of CO2 only has an estimated value of around SEK 230 million per year by 2030.
[109] A common measurement of utilisation of resources in the economy is the GDP gap – the percentage difference between actual and potential GDP. A negative GDP gap means that there are resources in the economy that are not being utilised. However, a positive gap means that utilisation of resources is high. 30/10/2016 *Konjunkturinstitutet* [National Institute of Economic Research] http://www.konj.se/var-verksamhet/sa-gor-vi-prognoser/potentiell-bnp.html

renovations could contribute to overheating of the economy and could trigger countermeasures in financial and monetary policy.

Public finances will be adversely affected by reduced tax revenues from energy-related taxes and the positive impact of energy efficiency measures in buildings for public use The net effect of this is expected to be a reduction in costs of approximately one billion by 2030. The deficit mostly consists of reduced tax revenues from tax on electricity.

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Energy Efficiency Action Plan

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Annex 1 An overview of the national building stock

About the supporting data

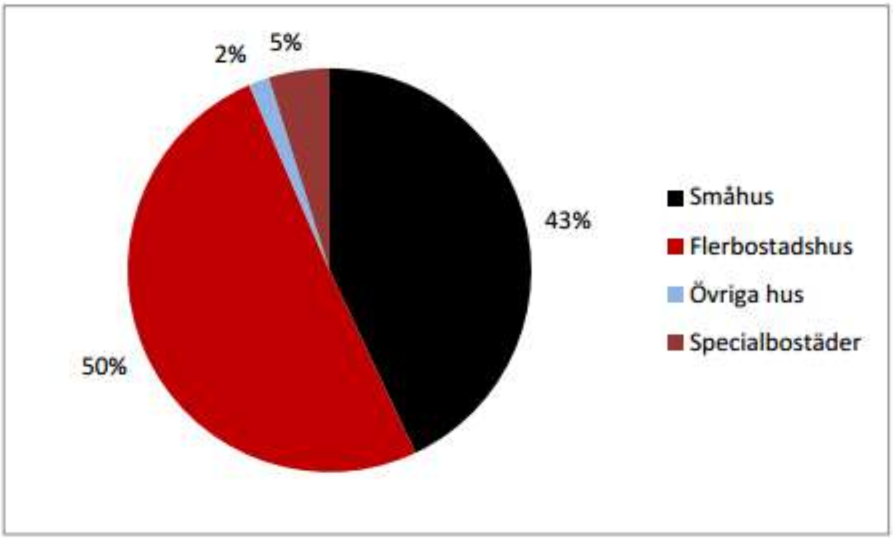
The overview of the building stock is based on data from the official energy statistics for houses, apartment buildings and non-residential premises (referred to herein as the energy statistics), supporting data obtained from the Swedish National Board of Housing, Building and Planning database for energy declarations (Gripen) and processed data from the real estate assessment register. The official energy statistics are taken from the Swedish Energy Agency and are based on sample surveys. They involve a random selection of property owners answering questions about the building, the heating method and energy consumption. The surveys are nowadays conducted every other year.

The information in the official energy statistics was obtained from property owners, whereas the information in the energy declarations is based on an assessment of energy consumption by a certified expert. Data from the energy statistics and Gripen have different aims. The purpose of the energy statistics is to allow trends to be identified for energy consumption in the entire building stock, whereas the purpose of an energy declaration is to give the property owner a snapshot of and information on the building's specific energy consumption. The Swedish National Board of Housing, Building and Planning database, known as Gripen, currently contains approximately 632,000 energy declarations drawn up since 2006. Because it is not obligatory for an energy declaration to be submitted for all buildings in Sweden, the register does not cover the entire stock.

Number of apartments and distribution of ownership category

Figure 28 shows the distribution of the number of residential apartments according to building type.

Figure 28 Distribution of the number of residential apartments according to building type for 2014.



2% 50/0

Source: Statistics Sweden

Key

Småhus	Houses
Flerbostadshus	Apartment buildings
Övriga hus	Other buildings
Specialbostäder	Special housing

Table 45 shows the distribution of ownership category for apartments in 2014.

Table 45 Distribution of ownership category for apartments in 2014.

Ownership category									
State, county council, municipality		Private		Tenant housing associations		Public utility		All	
10	± 5	721	± 36	986	± 42	769	± 39	2,487	± 65

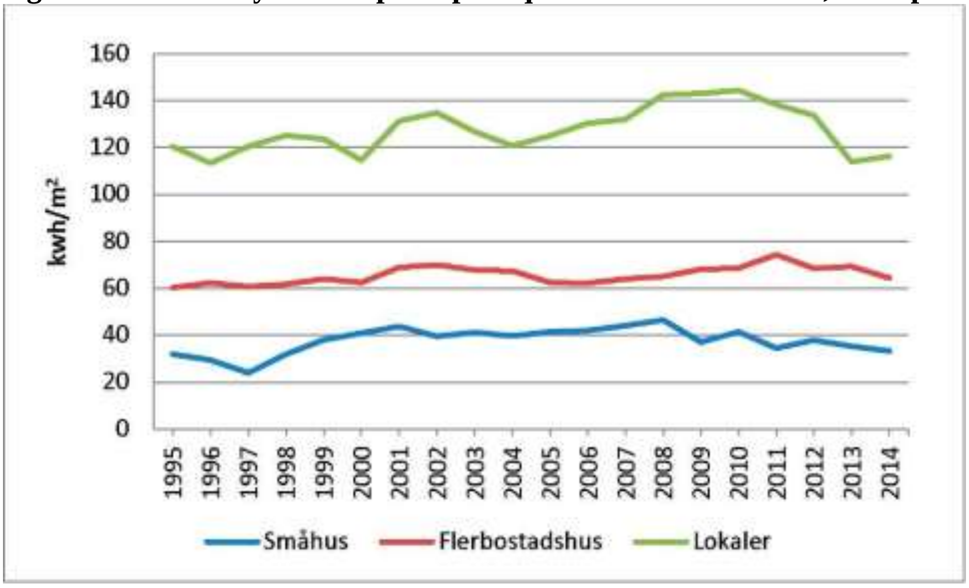
Source: The Energy Statistics

Energy consumption in the building stock

The electricity consumption per square metre in apartment buildings and houses has been relatively stable in the long term. In non-residential premises, electricity consumption increased significantly up to 2009, but has decreased in recent years.

Figure 29 shows the use of household electricity in houses, the use of property electricity and household electricity in apartment buildings, and the use of property electricity and business electricity in non-residential premises.

Figure 29 Electricity consumption per square metre 1995–2014, kWh per m^2.



Source: The Energy Statistics

Key:

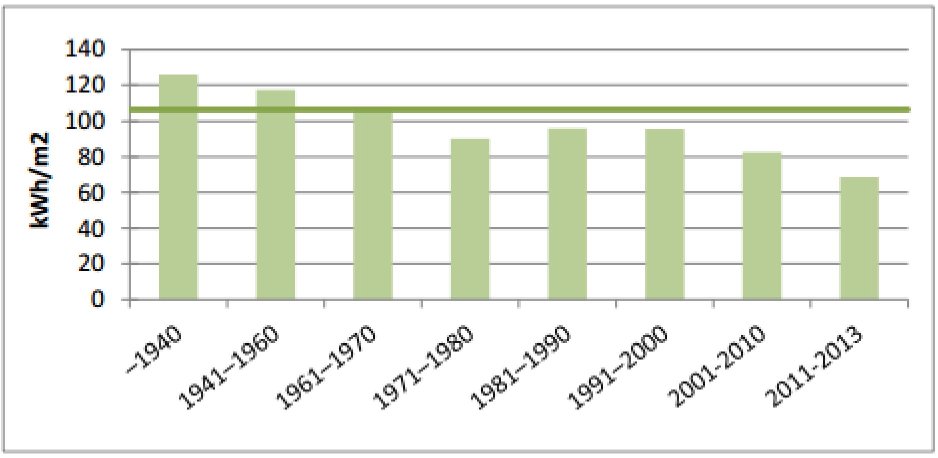
Småhus	Houses
Flerbostadshus	Apartment buildings
Lokaler	Non-residential premises

The use of household, property and business electricity runs counter to energy consumption for heating. The use is influenced by two opposing trends – the imposition of more stringent requirements for more electricity-efficient installations and appliances, partly as a consequence of the Eco-design Directive and the existence of more appliances in households. This applies particularly to home electronics devices such as televisions, computers and peripherals. The reasons why business electricity is increasing per square metre in non-residential premises include greater heat recovery, more stringent demands on indoor environments and better ventilation and more lighting points and appliances.

Energy consumption and heating methods in houses with different years of construction

Figure 30 shows the average energy consumption for heating and hot water per square metre in houses, distributed according to year of construction.

Figure 30 Average energy consumption per square meter for heating and hot water (excluding household electricity) in houses in 2014, distributed according to year of construction, kWh per m^2 and year



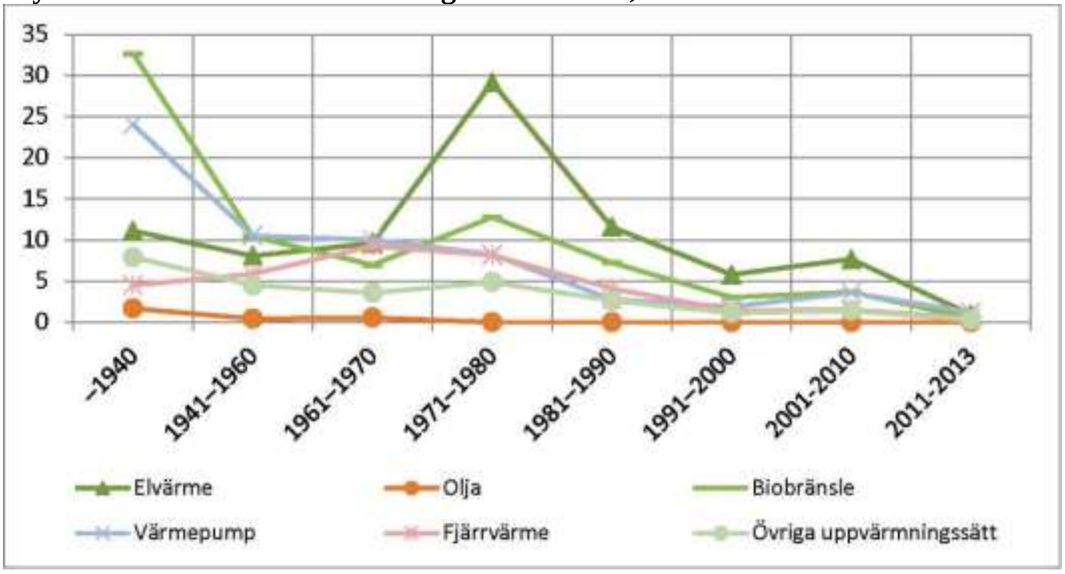
Source: The Energy Statistics

Figure 30 shows that there is a clear difference in energy consumption in houses built in different time periods, with older houses consuming more energy on average than houses that were built later. The horizontal line in Figure 30 represents the average energy consumption per square metre for houses, regardless of the year of construction, in 2014. It is 106 kWh per square metre.

Houses built in 1940 or earlier consumed an average of 126 kWh per square metre per year, whereas the newest houses, built in 2011 or later, used approximately 69 kWh per square metre per year.

Figure 31 shows which heating method was used in 2014 in houses, depending on when the house was built.

Figure 31 Heated area (including gross floor area) in houses in 2014, distributed according to year of construction and heating method used, million m^2.



Note: Total heated area in houses is 288 million Source: The Energy Statistics

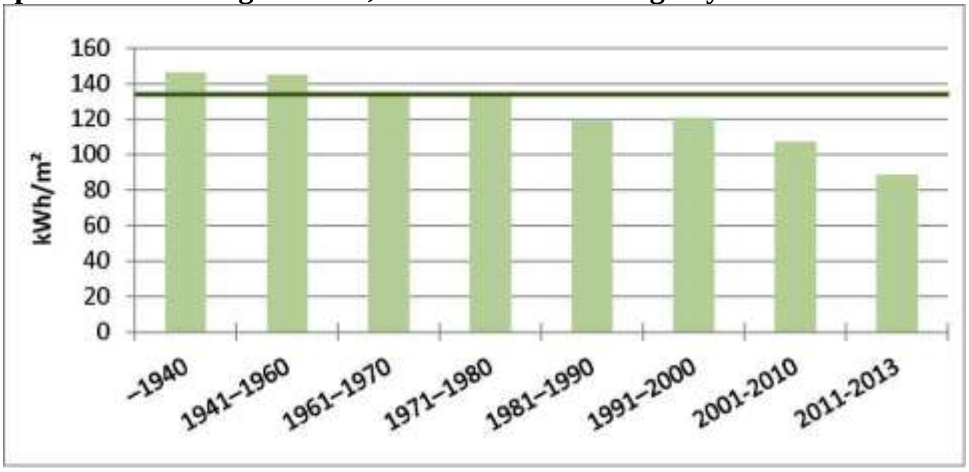
Key:
Elvärme = Electric heating
Olje = Oil
Biobränsle = Biofuel
Värmepump = Heat pump
Fjärrvärme = District heating
Övriga uppvärmningssätt = Other heating method

Heating with oil has declined and is unusual. A total of,38 000 houses were heated using oil alone or oil in combination with other heating methods in 2014, which corresponds to approximately 2 per cent of the total number of houses. It is currently estimated that almost half (993,000) of the houses in the country are equipped with some kind of heat pump, with air-source heat pumps being the most common. In 2014, more than half the heat pumps installed in houses were some kind of air-source heat pump.

Energy consumption and heating method in apartment buildings with different years of construction

Figure 32 shows the average energy consumption for heating and hot water per square metre for apartment buildings in 2014, distributed according to year of construction.

Figure 32 Average energy consumption in kWh/m^2 per year for heating and hot water in apartment buildings in 2014, distributed according to year of construction.

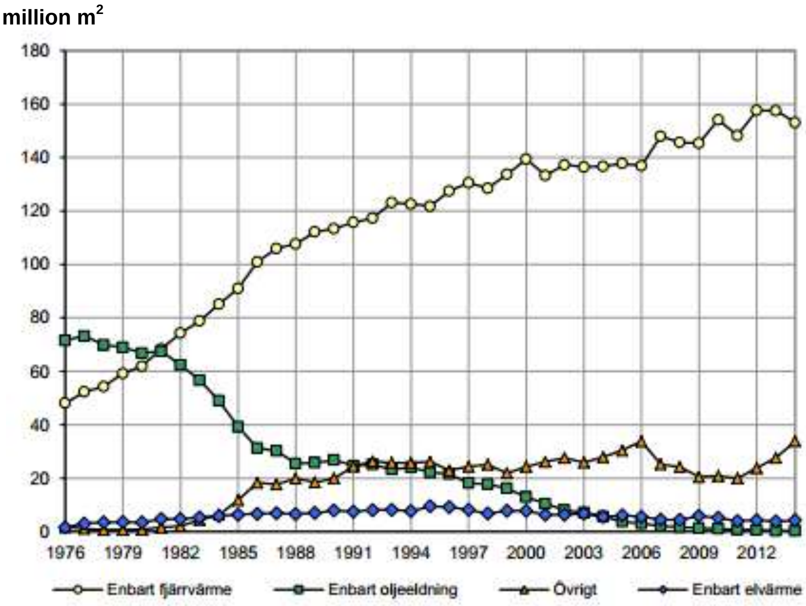


Source: The Energy Statistics

Even among apartment buildings, there is a clear difference in energy consumption depending on the period when the building was constructed. Older buildings have higher average energy consumption than buildings constructed later. The horizontal line in Figure 32 represents the average energy consumption per square metre for apartment buildings, regardless of year of construction in 2014 – 134 kWh.

Apartment buildings constructed in 1960 or earlier consume more energy than the average, whereas buildings constructed in 1961–1980 consume, in principle, the same amount of energy as the average. In more recently-constructed buildings, the average consumption is 88 kilowatt hours per square metre per year for buildings constructed in 2011–2013 and 120 kWh per square metre per year for buildings constructed in 1981–2000 for heating and hot water.

Figure 33 Total area in million m² for different energy sources and energy carriers in apartment buildings in 1976–2014



Source: The Energy Statistics

Key:
Enbart fjärrvärme = Only district heating
Enbart oljeeldning = Only oil heating
Övrigt = Other
Enbart elvärme = Only electric heating

Energy consumption in non-residential premises with different years of construction

Figure 34 shows the average energy consumption for non-residential premises. It has decreased from 123 kWh/m² per year for buildings constructed before 1940 to 109 kWh/m² per year for buildings constructed between 2011 and in 2013.

Figure 34 Average energy consumption in kWh per m² per year for heating and hot water in non-residential premises in 2014, distributed according to year of construction

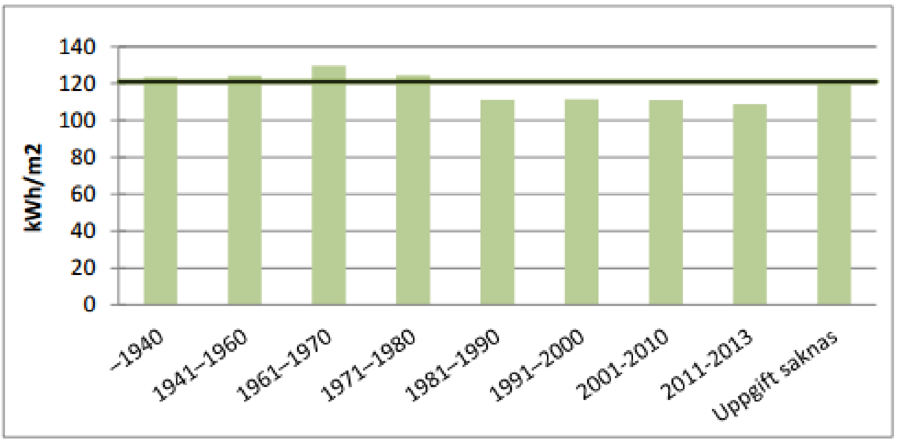


Table 46 shows energy consumption per square metre for apartment buildings in 2014, distributed according to degree of renovation, year of construction and temperature zone,

kWh/m^2. The grouping is based on the conversion and extension cost in relation to an estimated new construction cost at the time of the conversion. In Group 1, the conversion and extension cost is over 70 per cent of the estimated new construction cost. Group 4 includes the buildings for which all data is missing and Group 5 includes those that have not been converted

Table 46 Energy consumption per square metre in apartment buildings in 2014, distributed according to degree of renovation, year of construction and temperature zone, kWh per m^2. The grouping is based on the conversion and extension cost in relation to an estimated new construction cost at the time of the conversion. In Group 1, the conversion and extension cost is over 70 per cent of the estimated new construction cost. Group 4 includes the buildings for which all data is missing and Group 5 includes those that have not been converted.

	Group 1		Group 2		Group 3		Group 4		Group 5		All	
ALL	**136**	**± 11**	**143**	**± 7**	**137**	**± 4**	**140**	**± 8**	**127**	**± 3**	**134**	**± 2**
-1964	141	± 14	147	± 9	142	± 6	144	± 9	141	± 7	143	± 4
1965-1974	116	± 21	132	± 10	137	± 6	137	± 22	136	± 6	135	± 4
1974-	121	± 22	139	± 24	124	± 10	102	± 16	113	± 4	116	± 4
No information	-		-		-		-		-		-	
Temperature zone 1+2												
Total Temperature zone 1+2	140	± 20	143	± 14	144	± 9	155	± 15	137	± 8	142	± 5
-1964	140	± 24	151	± 19	146	± 16	165	± 19	149	± 19	150	± 9
1965-1974	151	± 27	122	± 13	142	± 14	161	± 20	142	± 10	141	± 7
1974-	-		123	± 16	145	± 9	118	± 41	126	± 9	129	± 7
No information	-		-		-		-		-		-	
Temperature zone 3												
Total Temperature zone 3	143	± 16	147	± 10	140	± 5	144	± 9	128	± 5	137	± 3

	Group 1			Group 2			Group 3		Group 4		Group 5		All		
-1964	152	±	19	151	±	13	144	± 7	148	± 9	143	± 10	147	±	5
1965-1974	111	±	23	141	±	15	142	± 9	145	± 41	137	± 9	139	±	6
1974-	120	±	32	127	±	21	124	± 14	94	± 15	115	± 6	116	±	5
No information	-			-			-		-		-		-		
Temperature zone 4															
Total Temperature zone 4	118	±	20	133	±	11	125	± 7	126	± 15	120	± 6	124	±	4
-1964	120	±	23	133	±	11	132	± 13	131	± 20	133	± 9	131	±	7
1965-1974	115	±	44	114	±	15	123	± 10	112	± 16	131	± 11	125	±	7
1974-	87	±	15	173	±	63	107	± 16	102	± 34	104	± 8	108	±	8
No information	-			-			-		-		-		-		

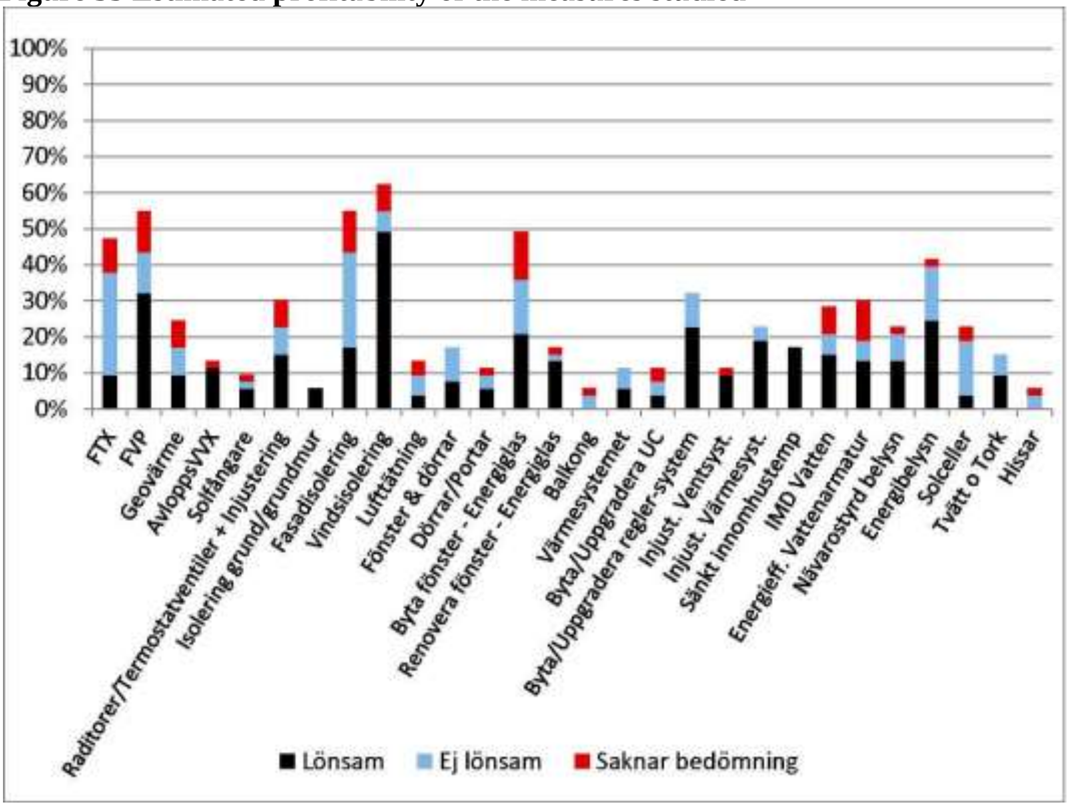
Source: Processed supporting data from Statistics Sweden's compilation from the real estate assessment register and the energy statistics.

Annex 2 Identification of cost-effective measures for increased energy efficiency

More information on *Halvera Mera*

In each preliminary study in *Halvera Mera*, the property owners have assessed the profitability of various measures and the bars in Figure 35 show the measures that have been assessed as profitable. Attic insulation, FVP and upgrading of control systems are included in the measures that are often assessed as profitable.

Figure 35 Estimated profitability of the measures studied



Source: BeBo, *Halvera Mera*

Key: Key:
FTX = Ventilation with heat recovery
FVP = Extractor heating pumps
Luft/vatten-VP = Air/water heating pumps
Geovärme = Geothermal heating
AvloppsVVX = Sewage HVAC
Sol-fångare = Solar panels
Raditorer/Termostatventiler + = Radiators/thermostat ventilators
Isolering grund/grundmur = Installation ground/ground walls
Fasadisolering = Facade installation
Vindisolering = Attic installation
Lufttätning = Airtightness
Dörrar/Portar = Doors/Gates
Byta fönster – Energiglas = Replace Windows – Energy glass

Renovera fönster – Energiglas = Renovate Windows – Energy glass
Fönster – tätning = Windows – Sealing
Balkong = Balcony
Byta/Uppgradera regler-system = Replace/Upgrade control system
Injust. Vensyst. = Balance Ventilation system
Injust. Värmesyst. = Balance Heating system
Sänkt inomhustemp. = Reduce indoor temperature
IMD Vatten = IMD Water
Energieff. Vattenarmatur = Energy efficiency = Water fittings
Närvarostyrd belysn = Presence detector lighting
Energibelysn. = Energy lighting
Solceller = Solar cells
Tvätt o Tork =-Laundry and drying
Hissar = Elevators

Lönsam = Profitable
Ej lönsam = Not profitable
Saknar bedömning = No assessment

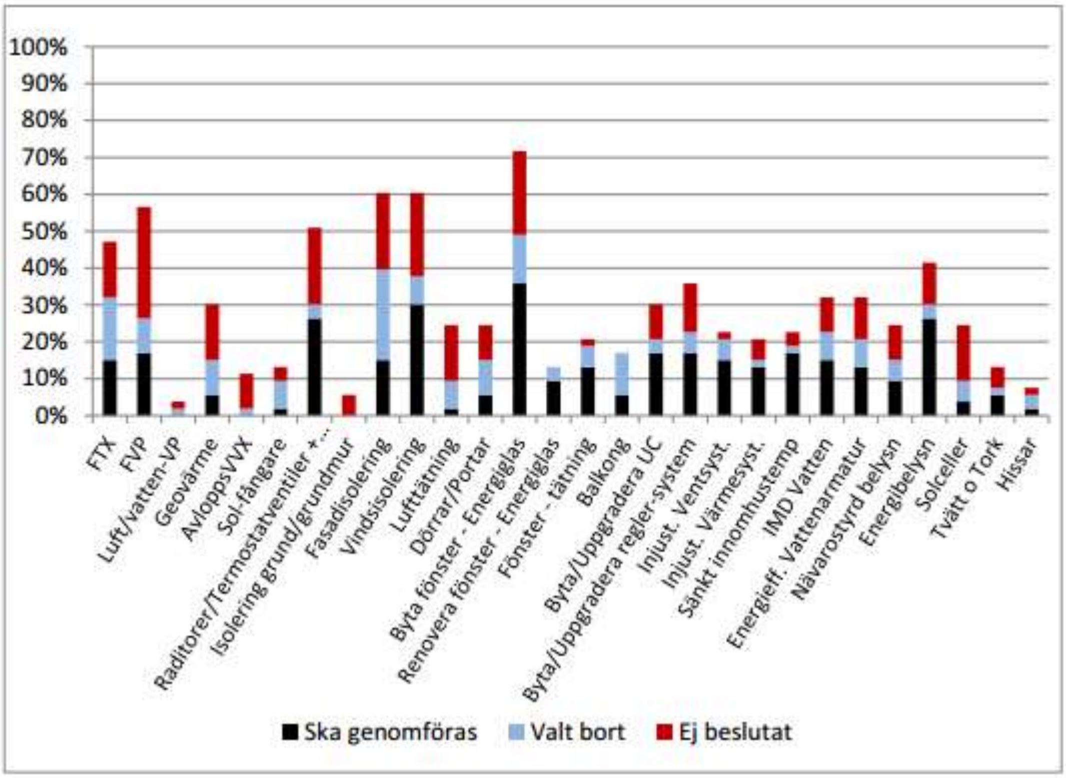
The profitability calculations reported in the preliminary reports are of varying quality and it has emerged that many property owners and consultants are uncertain as to how a profitability calculation should be carried out. In profitability assessments, property owners base their calculations on their own imputed interest rate, which was approximately 5.1 per cent on average.

Measures for a lower indoor temperature, heat recycling in waste water and balancing of the ventilation system have been analysed a few times but have always been considered profitable. Window renovation, attic insulation and balancing of the heating system are also often deemed to be profitable. However, installation of solar cells and FTX are measures that are often deemed to be unprofitable.

In most cases, where a follow-up has been carried out, a decision has been made to proceed with some of the measures proposed in the preliminary study, whereas decisions had been made not to proceed with other measures, sometimes for financial or technical reasons Figure 36 presents the measures expected to be carried out or, in the case of a follow-up, that have been carried out, and the measures that have actually been implemented. The blue part of the bars represents cases where the measures were planned and the green part of the bars represents cases where it was decided not to carry out the measures for some reason. The red areas represent the property owners who have studied the measures but have not yet made any decision on implementation.

Figure 36 shows that decisions are often made not to carry out FTX, façade insulation and balcony renovations. That may be due to low profitability, but the link between profitability and implementation is not clear. For instance, measures relating to balcony and elevator renovation have never been deemed profitable whenever they have been studied, but they are still planned in almost a third of all cases. Measures relating to recycling of waste water and solar panels, on the other hand, have often been considered profitable, but are rarely implemented.

Figure 36 Implementation of measures studied.



Source: BeBo, *Halvera Mera*

Key:
FTX = Ventilation with heat recovery
FVP = Extractor heating pumps
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Injust. Vensyst. = Balance Ventilation system
Injust. Värmesyst. = Balance Heating system
Sänkt inomhustemp. = Reduce indoor temperature
IMD Vatten = IMD Water
Energieff. Vattenarmatur = Energy efficiency = Water fittings
Närvarostyrd belysn = Presence detector lighting
Energibelysn. = Energy lighting
Solceller = Solar cells
Tvätt o Tork =-Laundry and drying
Hissar = Elevators

Ska genomföras = Will be implemented
Valt bort = Decided against
Ej beslutat = No decision

At the mid-point of 2014, five *Halvera Mera* projects had been completed, with evaluation and reporting of implemented measures. The energy consumption was monitored with measurements to verify the saving and to identify discrepancies and shortcomings compared to the calculated results. Major savings were achieved in the projects, but for all projects except one, the measured energy saving was 10–20 percentage points lower than calculated. In one case, the measured energy saving was approximately 15 percentage points higher.[110]

Detailed information on the measures in BETSI

Table 47 shows measures in houses and apartment buildings in the BETSI study. It can be seen that different variants of a category of measures have been used, depending on the conditions in the building. For example, additional insulation of attic joist beams varied in terms of thickness between 200 and 400 millimetres and in cost, depending on the roof of the building.

The costs shown in Table 47 are listed in annual amounts, known as annuities, for which an imputed interest rate of 4 per cent has been used. They also take account of the expected lifespan of the measures, which is also indicated in the table. When the costs are specified in annual amounts, they can be compared to the expected annual energy savings that result from the measures.

Error! Reference source not found. come from BETSI and the costs are therefore given at 2009 prices, but in the calculations carried out in Chapter 8, the expenses were calculated using the construction index.

Table 47 also states how many actual buildings each measure has been tried in and how many buildings this represents at national level. In Table 48, the measures reported were tested in non-residential premises in BETSI.

[110] http://www.bebostad.se/rr2-genomforande-och-mal/

Table 47 Measures studied in BETSI for houses and apartment buildings, 2009 prices

Type of measure	Annuity [SEK/year]	Lifespan [year]	Buildings studied	Buildings at national level
External air ventilated crawlspace to warm crawlspace foundation	80/m^2	40	31	52,000
Crawlspace to ground base	90/m^2	40	11	52,000
Cellar floor broken up, dug out and insulated	126/m^2	40	332	378,000
Insulation of joist beams above unheated cellar	40/m^2	40	31	138,000
Insulation of cellar walls above ground	70/m^2	40	204	383,000
Insulation of cellar walls below ground	29/m^2	40	377	582,000
Insulation exterior, façade of wood panelling, boards, plate	50/m^2	40	202	678,000
Insulation exterior, façade of concrete, lightweight concrete, LECA	62/m^2	40	83	54,000
Insulation exterior, façade of brick*. New façade, brick	48/m^2	40	89	115,000
Insulation inside façade	53/m^2	40	245	391,000
Infill wall, façade of brick, demolished. New with panels	89/m^2	40	17	6,000
Infill wall with façade of panels demolished. New same	87/m^2	40	5	1,500
Infill wall with brick façade demolished. New same	87/m^2	40	14	1,500
Insulation 200 mm top attic joist beams, gabled roof	9/m^2	40	120	268,000
Insulating attic joist beams where storage space exists	66/m^2	40	10	3,700
Insulation underside of attic joist beams	40/m^2	40	44	128,000
Insulation top of floor joists lean-to roof	11/m^2	40	7	1,400
Insulation 300 mm top attic joist beams**	11/m^2	40	39	93,000
Insulation 400 mm top attic joist beams**	13/m^2	40	30	71,000
Insulation outside support wall	13/m^2	40	66	256,000
Insulation of sloping roofs	38/m^2	40	51	224,000
Window replacement	188/m^2	40	882	1,336,000
Replacement of glass for glass with hard LE coating***	131/m^2	40	15	48,000
Replacement of double glazing to glass with hard LE coating***	158/m^2	40	37	157,000
Installation of FTX in house with S or F	4775/building	20	575	1,606,000
Installation of FTX in house with FT or	3092/building	20	138	203,000

Type of measure	Annuity [SEK/year]	Lifespan [year]	Buildings studied	Buildings at national level
FTX				
Installation of FTX in apartment building with S or F	4775/apartment	20	403	131,000
Installation of FTX in apartment building with FT or FTX	3092/apartment	20	121	26,000
Installation of low-flow hot water fittings – house	1130/building	10	826	1,888,000
Installation of low-flow hot water fittings – apartment building	678/apartment	10	558	166,000
Change of circulation pump in water-based heating system House	685/building	15	447	992,000
Change of circulation pump in water-based heating system Apartment building	1737/building	15	373	111,000
Balancing of heating, water-based	4/m^2	10	952	1,293,000
Balancing of heating, other	2/m^2	10	432	760,000

* Brick façade must be replaced due to damage.
** Depends on the original U value of the structure.
*** Low emission coating.

Table 48 Measures studied in BETSI for non-residential premises, 2009 prices

Measure	Cost (excluding VAT)	Working life
Building envelope		
Wall – insulation 100 mm	1200 SEK/m^2	40 years
Wall – insulation 200 mm	1500 SEK/m^2 + 1000 SEK/window	40 years
Ceiling – short fibre insulation 300 mm	114 SEK/m2	40 years
Ceiling – short fibre insulation 500 mm	180 SEK/m2	40 years
Windows/Building envelope – sealing	1200 SEK/m2	40 years
Window – Insulating panel	2400 SEK/m2	40 years
Window – replace	7000 SEK/m2	40 years
Sunlight protection	1800 SEK/m2 + 3000 SEK/motor	40 years
Air treatment		
Unit – replace	120000 SEK + 65 SEK/(l/s)	20 years
Filters – replace	1000 SEK/unit/year	1 years
Fan/Motor – replace	29 SEK/(l/s)	20 years

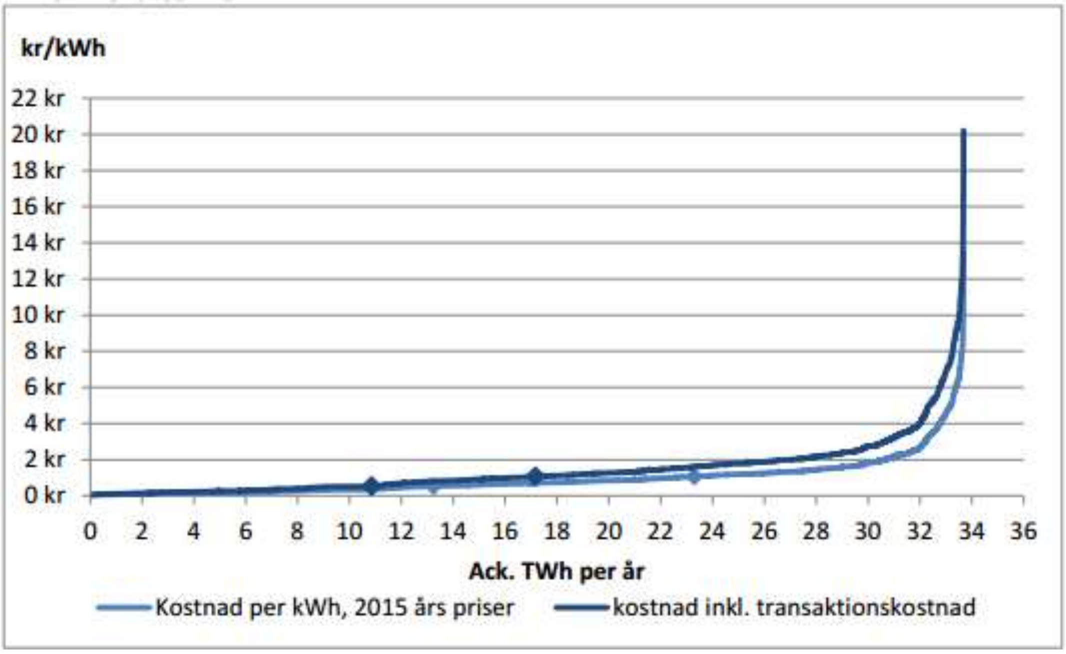
Measure	Cost (excluding VAT)	Working life
Air flow – fixed/ideal balancing	15 SEK/m2	10 years
Airflow - needs adjustment (VAV)	240 SEK/m2	40 years
Supply air temperature – fixed adjustment (15 – 21 °C)	SEK 6000	40 years
Supply air – adjustment according to need	SEK 25000	40 years
Operating times – adjustment	SEK 6000	40 years
Night cooling	SEK 6000 (for CAV/VAV system)	40 years
Heating system		
Thermostats – replace	18 SEK/m2	10 years
Balancing	18 SEK/m2	10 years
Circulation pumps – replace	6 SEK/m2	20 years
Other		
Lighting – switch to low energy	200 SEK/m2	20 years
Lighting – presence detectors	10 SEK/m2	10 years
Hot tap water – switch to low-flow	37.5 SEK/m2	20 years

Estimate of improvements in energy efficiency in houses and apartment buildings at national level when assumed transaction costs are included

Marginal cost curves for energy efficiency measures in houses and apartment buildings are presented in section 8.3.5. The costs presented in that section include materials, labour and some maintenance, but did not take into account of other costs that may be relevant such as project planning, obtaining information, etc. These other costs are referred to collectively herein as transaction costs.

Figure 37 shows two marginal cost curves for houses. The light blue curve shows the marginal cost not taking into account any transaction cost, whereas the dark blue curve includes an assumed transaction cost (standard) that amounts to 50 per cent of the investment cost. With transaction costs included, we see that the curve shifts upwards.

Figure 37 Marginal cost curve for energy efficiency in houses with and without transaction costs

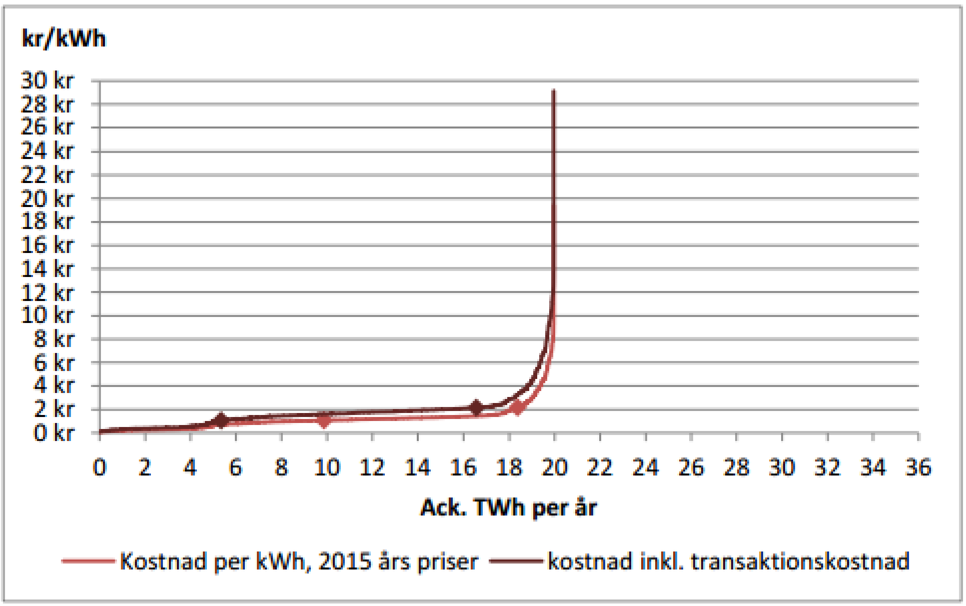


Key:
Ack. TWh per år = Acc. TWh per year
Kostnad per kWh, 2015 års priser = Cost per kWh, 2015 prices
kostnad inkl. transaktionskostnad = Cost including transaction cost

The points in Figure 37 show the intersection point for the profitable measures, given an energy price of SEK 0.5 and SEK 1. At an energy price of SEK 0.5, we see that the profitable measures can provide a total energy saving of 13 TWh, if transaction costs are not included. If transaction costs are included in the calculation, however, the profitability falls and fewer measures would be implemented. At an energy price of SEK 0.5, the profitable energy efficiency measures in houses would be close to only 11 TWh.

Figure 38 shows the corresponding marginal costs for apartment buildings. The light red curve shows the marginal cost without considering transaction costs and the dark red adds a transaction cost of 50 per cent. For apartment buildings, the profitable potential falls from just under 10 TWh per year to 5.4 TWh per year at an energy price of SEK 1 per kWh. This shows how sensitive the results are to what is included in the cost of energy efficiency improvements. It also shows that a reduction in all costs increases the profitability of energy efficiency improvements.

Figure 38 Marginal cost curve for energy efficiency measures in apartment buildings with and without transaction costs



Key:
Ack. TWh per år = Acc. TWh per year
Kostnad per kWh, 2015 års priser = Cost per kWh, 2015 prices
kostnad inkl. transaktionskostnad = Cost including transaction cost

Appendix 3 Instruments that contribute to energy-efficient renovations

Table 49 shows the barriers we identified in our study of the literature. We also report on the type of barrier in question, whether it affects profitability and its impact on other barriers.

Table 49 Barriers for renovation and an account of the type of barrier in question, whether it affects profitability and its impact on other barriers.

Barriers	Type of barrier	Impact on profitability	Impact on other barriers
Lack of understanding of the need for renovation	Information/ knowledge		
Little knowledge of possible actions	Information/ knowledge		
Little knowledge of the cost of measures costs and revenues	Information/ knowledge		
Little knowledge of profitability and balance calculations	Information/ knowledge		
Evacuation possibilities lacking	Limited resources		
Construction resources lacking (human resources)	Limited resources		
Limits in the investment budget	Limited resources/ financing		
Difficulties in obtaining revenue for renovations	Profitability	Difficult to achieve profitability	
Lack of own capital	Financing	Difficult to achieve profitability	
High borrowing costs	Profitability	Difficult to achieve	

Barriers	Type of barrier	Impact on profitability	Impact on other barriers
		profitability	
Strong housing market	Structural/geographical		Evacuation possibilities. Strong markets with high housing shortage make it difficult to evacuate residents in the case of extensive renovation
Weak housing market	Structural/geographical	It is difficult to raise the rent -> difficult to achieve profitability	Moving patterns as a consequence of renovation. Tenants with high rental price sensitivity. They can be difficult to move back into a renovated apartment due to higher rent.
Rent adjustment	Conflicting objectives, conflict of instruments		
Socio-economic profitability in terms of property economics	Conflicting objectives + financing	The benefits to society are greater than the benefits to the property owner – difficult to get the property owner's calculations to balance	
Maintenance operations provide low or no income			
Moving patterns as a consequence of renovation		Lower rental income due to vacancies. Problem in weak housing markets	Weak housing market. Renovation that leads to tenants moving can mean vacancies for the property owner in weak housing markets

Existing instruments

This section describes the existing instruments that affect the extent of renovation and standard of energy efficiency improvement. The instruments are broken down into the categories of economic, administrative and informative.

Economic instruments

Energy tax and carbon tax

Energy tax is a collective term for the taxes on fuel and electricity and includes energy tax, carbon tax, tax on sulphur and the nitrogen oxide charge. Energy tax in Sweden has historically been levied for a fiscal purpose. This means that the primary objective has been to generate tax revenue and not to actively promote restrictions in the use of the taxed resource. Since 2009, energy tax has increasingly determined resources and has been aimed at reducing the use of the taxed fuels.

Carbon tax, unlike energy tax, has been levied mainly for the purposes of environmental control and is intended to internalise external costs from carbon dioxide emissions and thus bring about a reduction in emissions.

There is also an energy tax on electricity consumption. The tax varies depending on what the electricity is being used for and where it is used. The Swedish Tax Agency is the authority responsible for energy and carbon dioxide taxes.

Credit guarantees

Credit guarantees are an insurance policy that a lender can take out for a loan for new construction and conversion of housing. They are managed by the Swedish National Board of Housing, Building and Planning. The aim of credit guarantees is to reduce the risk for the bank when granting loans and to make it possible for property owners to obtain further mortgages on the property.

At present, credit guarantees are clearly linked to the definitions for new building and conversion as specified in the Planning and Building Act. The Swedish National Board of Housing, Building and Planning and the Swedish Energy Agency have proposed use of credit guarantees to stimulate renovation by expanding the area of use to also include specific renovation measures.[111] Approximately 30 credit guarantees are issued per year, with the vast majority going to new production.[112] The Swedish National Board of Housing, Building and Planning has carried out information campaigns in 2016 to raise awareness of credit guarantees and the number of applications has also risen noticeably. Up to 30 September, the number of credit guarantees granted had increased by 56 per cent and advance decisions had increased by 124 per cent compared to the same period of the previous year.

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[111] Report by the Swedish National Board of Housing, Building and Planning and Swedish Energy Agency entitled "*Förslag till utvecklad nationell strategi för energieffektiviserande renovering - Utredning av två styrmedel 2015*" [Proposal for a developed national strategy for energy-efficient renovation – Investigation of two instruments 2015]

[112] This applies to all kinds of credit guarantees for new construction and conversion managed by the Swedish National Board of Housing, Building and Planning. Approximately 150 cases are handled per year in total.

Aid for improvement and increases in energy efficiency of rental accommodation

Aid was introduced on 1 October 2016 with a view to stimulating renovation and greater energy efficiency for rental accommodation in areas with socio-economic challenges.[113] In 2016, the Government allocated SEK 800 million for the aid. In the budget proposals for 2017, the Government has proposed SEK 1 billion annually for the 2017–2020 period.

The aid is intended for buildings containing residential apartments that are let with a right of tenancy and that are located in residential areas where more than 50 per cent of households have low purchasing power. The building must have an energy performance of 130 kWh/m^2 (Atemp) per year or worse to be considered for aid.

The aid consists of two parts – one relating to renovation and one relating to energy efficiency measures. The renovation aid amounts to 20 per cent of the cost of renovation and that part of the aid goes directly to the tenants through a rent reduction over a seven-year period. The aid for energy efficiency measures is calculated on the basis of the energy saving achieved after the renovation. That part of the aid goes to the property owner. To obtain that part of the aid, the renovation must lead to an improvement in the energy performance of at least 20 per cent. The aid is not paid out for just renovation or just energy efficiency measures because that does not meet the purpose of the aid.

Support for improvements to school premises and outdoor environments adjacent to schools

The Government has introduced a subsidy for the 2015–2018 period for improving school premises.[114] The initiative aims to provide pupils with a better learning and working environment while reducing the environmental impact of the premises. Subsidies for improvements to outdoor environments will be provided up to maximum of 50 per cent of the total cost of eligible measures. However, subsidies are not provided for measures that cost less than SEK 50,000 in total.

Since 1 June 2016, a subsidy has also been granted for improvements to outdoor environments adjacent to schools, preschools and after-school recreation centres. The subsidy consists of a maximum of 25 per cent of the total cost of eligible measures. Subsidies are not provided for measures costing less than SEK 100,000 in total.

Applications for both these subsidies are made to the Swedish National Board of Housing, Building and Planning. *Deduction for repair, conversion and extension work*

The deduction for repair, conversion and extension work is a tax reduction on the cost of labour for repairs, maintenance and rebuilding and extension of residential accommodation. The deduction was introduced in 2008 for the purpose of stimulating the labour supply and reducing illegal labour.[115] Some of the

[113] Ordinance (2016:837) on support for renovation and energy efficiency measures in some residential areas
[114] Ordinance (2015:552) on State subsidies for improvement of school premises and outdoor environments adjacent to schools, preschools and after-school recreation centres
[115] Government Bill 2006/07:94, p. 34 ff., and Government Bill 2008/09:97, p. 93

measures included also contribute to more efficient use of energy.[116] One natural effect of the deduction for repair, conversion and extension work is that it provides an incentive for property owners to carry out more renovations. The tax reduction was lowered from 50 per cent to 30 per cent of labour costs on 1 July 2016. The maximum amount of aid is still SEK 50,000 per year. The possibility is offered to owners of houses, apartments and second homes as well as holders of tenant owner apartments.

The EU emissions trading system (EU ETS)[117]

The EU system of emissions trading, the EU ETS (EU Emission Trading System) is an important part of EU efforts to combat climate change. Carbon dioxide emissions from 13,000 facilities in the industrial and energy sectors are included in the scheme, which covers around 45 per cent of total EU greenhouse gas emissions.

Two trading periods have taken place so far – the first between 2005 and 2007 and the second between 2008 and 2012. The third period of the trading scheme began in January 2013 and will continue until 2020. Many Swedish electricity generation and district heating plants are required to participate in the EU ETS scheme and the Swedish industries that are included in the EU ETS scheme do not pay carbon tax.

EU financial aid for energy efficiency in buildings

The EU has for many years promoted the improvement of the energy performance of buildings through a series of programmes for financial aid.

A number of these programmes are implemented in cooperation with international financial institutions. There are three so-called intermediate financial instruments:

- the Energy Efficiency Finance Facility (EEFF)
- the instrument for municipal financing (MFF)
- the Small and Medium-sized Enterprise Finance Facility (SMEFF)

The European Energy Efficiency Fund (EEEF) was set up in 2011 with an amount of EUR 265 million. It provides instruments for loans, equity and guarantees and grants for technical assistance for project development support.

Aid for energy audits in small and medium-sized enterprises The Agency provides financial aid for small and medium-sized enterprises to conduct energy audits[118].[119]The aid covers 50 per cent of the cost of an energy audit with proposed measures and an associated

[116] House owners are granted a right to a tax reduction for work such as drilling and installation of geothermal heating as well as replacement of windows, doors and taps, additional insulation and assembly and replacement of ventilation. For a single holder of a tenant owner apartment, only repair, conversion and extension work carried out in the apartment confers a right to a tax reduction, for example replacement of taps but not replacement of windows.
[117] This entire section is from Swedish Energy Agency (2015), *Energiläget 2015* [The Energy Situation in 2015]
[118] An energy survey shows how the energy is distributed in different parts of a company's operations and what energy costs the company has. The survey contains proposals on how the company can make processes and auxiliary equipment more energy-efficient so that they use less energy.
[119] Ordinance (2009:1577) on State aid for energy audits

energy plan. A maximum of SEK 50,000 in aid may be received. The aid is aimed at small and medium-sized enterprises with energy consumption over 300 MWh per year. An application for aid is submitted to the Swedish Energy Agency.

Administrative instruments

The Swedish National Board of Housing, Building and Planning Building Regulations (BBR)

Requirements for buildings are set out in the Planning and Building Act.[120] The regulations apply to both new construction and to alteration of buildings. The Swedish National Board of Housing, Building and Planning building regulations contain regulations for application of the Planning and Building Act in the form of regulations for residential design, accessibility and usability, load capacity, fire protection, hygiene, health, environment, water and waste management, noise protection, safety of use and energy conservation.

Section 9 of the building regulations[121] contains requirements for energy conservation that specify the limits for maximum permitted energy consumption in buildings. The limits indicate how much energy, measured per square metre of floor area, a building may use per year. Energy consumption includes the energy consumed in one year for heating, comfort cooling, hot water and property energy. The rules relate to actual energy consumption when the building is in use.

There are requirements other than requirements on energy consumption that the building must meet, for example requirements on heating insulation, heating, cooling and air management installations, efficient use of electricity and metering systems for energy consumption. For buildings heated by electricity, there is also a maximum installed electric power for heating.

When it comes to building modification, the basic premise is that, in principle, the requirements applying to construction of new buildings also apply to modification and renovation of buildings. In the case of modification, however, the requirements must be adapted and any departure from the requirements must take account of the extent of the modification, the conditions of the building, the precautionary requirement and the prohibition on distortion. In the case of modification, the requirements may be imposed on the modified part of the building.

If, after the building envelope has been changed, a building fails to meet the requirements imposed on new buildings, the rules specify the U values for ceilings, walls, floors, windows and exterior doors that the work must attempt to achieve. If a change is made in a ventilation system or a ventilation unit, the rules specify the SFP[122] values and SFPv[123] values that the work must attempt not to exceed.

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[120] Planning and Building Act (2010:900)
[121] BFS 2011:6
[122] Specific fan power (SFP), The sum of the power rating for all fans included in the ventilation system, divided by the maximum flow of supply air, kW/(m^3/s).
[123] SFP_v, Specific fan power for a unit.

System for establishing rent.

Sweden's administrative system for establishing rents is unique by international standards. Rents for residential apartments are established through a combination of various regulations, the Rent Act (Code of Land Laws)[124] and the Rent Negotiation Act (1978:304). The system for establishing rents is also referred to as the utility value system and its purpose is to imitate a market system, yet at the same time form a barrier against unfair rents and secure right of occupation.[125] The rent for a residential apartment is established according to local negotiations between the property owner and the tenants' association. The property owner is not free to establish the level of rents in its stock of apartments, but must apply utility value rents and negotiate with the tenants. The utility value system is based on the fact that rent is established on the basis of the standard of the apartment and the property, the proximity to services and the attractiveness of the area.

The landlord's obligations towards tenants when a renovation is to be carried out is regulated by the Code of Land Laws[126]. If the initiatives relate to raising the apartments to the lowest acceptable standard or carrying out maintenance, the landlord does not need to have the tenants' consent but, in the case of more extensive work, the landlord needs the tenants' consent before the measures can be implemented. One important principle in the system for establishing rents is that regular maintenance is normally included in the rent and does not increase the utility value, whereas, on the other hand, measures that raise the standard justify rent increases. The system for establishing rent therefore plays an important part in renovations.[127]

The Ecodesign Directive

The Ecodesign Directive[128] is an administrative instrument that aims to develop product requirements for energy-related products that are to be released on the EU internal market. Ecodesign requirements mean that products must meet minimum energy-efficiency and resource-efficiency requirements in order to be released on the market or enter service in the EU. One consequence of the minimum requirements is that the most energy-intensive and resource-intensive products will be phased out of the market.

Requirement for energy audits for large companies

Since June 2014, Sweden has established a requirement for large companies to conduct energy audits. The energy audit[129] is an administrative and informative instrument that must provide answers as to how much energy is supplied and consumed in running the business each year. The audits also put forward proposals for cost-effective measures that the company can adopt in order to reduce costs, reduce energy consumption and thereby increase energy efficiency. Large companies are

[124] Chapter 12 *Jordabalken*, JB [Code of Land Laws]
[125] Swedish National Board of Housing, Building and Planning, 2014. The Swedish system for establishing rents.
[126] Code of Land Laws (1970:994) Chapter 12, section 18 Rent
[127] For more information, see the Swedish National Board of Housing, Building and Planning, 2014 The Swedish system for establishing rents, pages 27–28
[128] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products;
[129] Act (2014:266) on energy audits at large companies

required to conduct quality-assured energy audits at least every four years. The obligation to issued energy declarations on properties also remains for large property owners that are required to conduct energy audits under the Act. Approximately 1,500 companies are covered by the Act in Sweden.

Informative instruments

Energy declarations

The Energy Declarations Act entered into force in 2006 and regulates the use of energy declarations in Sweden[130]. The Swedish National Board of Housing, Building and Planning issues regulations for application and is responsible for supervision of energy declarations and energy experts' independence.

An energy declaration contains information about the building's energy consumption and is aimed at prospective house buyers or tenants. Energy declarations, through the information they contain, will make buyers aware of the energy consumption so that it is taken into account at the time of purchase. An energy declaration must be drawn up for a building at the moment of sale, rental and new construction as well as for larger buildings frequently visited by the public. The energy declaration is issued by an independent expert commissioned by the owner and is valid for ten years.

The declarations have now existed for ten years and there are a total of approximately 632,000 energy-declared buildings registered in the Swedish National Board of Housing, Building and Planning database. One of the most important changes to have been made in recent times has been the strengthening of the function of the declarations to enable them to provide consumer information. This has been done by making the declarations clearer. Previously, the focus was on proposed measures, but now the focus is more on the A–G rating. The rating looks the same as the energy label for products such as refrigerators and washing machines. To ensure that the buyer has received the declaration prior to the purchase, a requirement was introduced in 2014 that the label with the rating must be included in any advertisement for the property.

Energilyftet and other training in low energy building

The Swedish Energy Agency, along with other operators, has several initiatives for enhancing skills in low-energy building that cater for different target groups. These initiatives are new from 2016.

Energilyftet is the Swedish Energy Agency's on-line training course to enhance basic skills in low-energy building among operators in the construction industry. The training is aimed at clients, architects, engineers, construction project managers, managers and technicians and will run until 2018 with the possibility of an extension.

Beställarkompetens [Client Skills] is a collaboration project involving *Byggherrarna* [Swedish Construction Clients], SABO [*Sveriges Allmännyttiga Bostadsföretag* – the Swedish Association of Public Housing Companies], *Fastighetsägarna Sverige* [the Swedish Property Federation], SKL [*Sveriges Kommuner och Landsting* – the Swedish Association of Local Authorities and Regions] and EMTF [*Energi- och Miljötekniska Föreningen* – the Society of Energy and Environmental Technology] that is financed by the Swedish Energy Agency. *Beställarkompetens* is aimed partly at providing more detail on the knowledge in the Swedish Energy Agency's *Energilyften* training initiative. *Beställarkompetens* is intended for property developers,

[130] Act (2006:985) on the energy certification of buildings.

property owners and managers and the training provides more detailed knowledge of the tools available in Sveby [*Standardisera och verifiera energiprestanda i byggnader* – Standardise and verify the energy performance of buildings], BeBo [Beställargruppen Bostäder – Client Group Housing], BELOK [*Beställargruppen Lokaler* – Client Group Premises] and *Gröna Hyresavtal* [Green Leases].

Nya Glasögon[New Glasses] is a cross-industry project involving the Swedish Energy Agency and industries in the construction sector. *Nya Glasögon* is aimed at sixth-form teachers on construction programmes. They will in turn teach the labour force of the future how low-energy buildings are to be built and renovated.

Energibyggare [Energy Builders] is a skills-enhancing training programme intended for building workers, installation engineers, supervisors and site managers. The project forms part of the EU BUILD UP Skills initiative and is financed by the European Commission and the Swedish Energy Agency.

The Energy Labelling Directive

The Energy Labelling Directive[131] is an informative instrument intended to highlight products' energy consumption and make it easier for consumers who want to make energy-efficient choices. Energy labelling is compulsory for the product groups regulated and is common to all the EU Member States.

Both the Ecodesign and Energy Labelling Directives are framework directives, which means that the directives set the parameters for how requirements must be produced and what can be regulated. Specific requirements for different products are then established in the product regulations that apply directly in the Member States. The directives can include all energy-related products such as windows, lights and car tyres. Vehicles are excluded from both directives.

Municipal energy and climate advice

Municipal energy and climate advice aims to provide impartial, locally-orientated information and advice on how to make energy consumption more efficient or increase the use of renewable energy. The advice is aimed at private individuals, small and medium-sized enterprises, tenant housing associations, private apartment building owners and associations and organisations. The energy and climate advisors play a central role, including in the fulfilment of Articles 14 and 15 of the Energy Performance Directive.

The Swedish National Board of Housing, Building and Planning guidance on tenant consultation in the case of conversion

Digital guidance on the Swedish National Board of Housing, Building and Planning's website, Guidance for property owners on tenant consultation in the case of conversion, was opened in 2014. It compiles experiences and good examples of renovations carried out with tenant consultation in the case of conversion and development of residential areas.

The main message in the guidance is that the process should start in time before positions have been adopted and it should make use of the tenants' experience, clearly state what might be affected and ensure that the consultation is a dialogue and not

[131] DIRECTIVE 2010/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products

just a question of providing information. Several good examples are included in the guidance on tenant consultation.

Property owners facing conversion of a rental building have much to gain by giving residents the opportunity to have their say early in the process. When the residents are given the opportunity to express their wishes and can feel respected and listened to, it often increase their comfort and well-being. It can also reduce stress and anxiety among the tenants in advance of the conversion. Tenant consultation can also contribute to increasing the attractiveness and status of the residential area, which in turn results in lower relocation, fewer vacant apartments and reduced loss of rental income. However, a poorly executed process can lead to the case having to be dealt with in the rent tribunal, with the cost that entails.

The National Regional Fund

The National Regional Fund Programme is part of the European Structural Fund Programme for Sweden and is implemented in the 2014–2020 period. The Swedish Energy Agency receives a total of SEK 80 million per year for investments to increase energy efficiency in small and medium-sized enterprises during the period. The purpose of the Swedish Energy Agency's work in the National Regional Fund Programme is to support the transition to a low-carbon economy and increase the share of renewable energy and promote energy efficiency in enterprises.

Energy efficiency in small and medium-sized enterprises should be promoted in all sectors. This takes place by means of financial aid for enterprises and by forming networks and facilitating exchange of experience and dissemination of information. For most projects, the aid goes through various partners such as *Energikontoren* [Energy Agencies of Sweden], the county administrative boards, the municipalities and *Energieffektiviseringsföretagen* [Energy Efficiency Companies]. For aid for environmental studies and energy survey aid, small and medium-sized enterprises can apply for money directly from the Swedish Energy Agency. Research and innovation

Innovation clusters

There are several so-called innovation clusters in the construction and property sector. These were formerly known as networks or client groups. The purpose of the clusters is to create a platform for close collaboration between industry operators, academia and the State. The clusters place the emphasis on innovation and on implementing and monitoring demonstration projects to develop energy-efficient methods, procure new technology and promote good practice.

Industry operators, along with the Swedish Energy Agency, run a series of innovation clusters: LÅGAN is for buildings with very low energy consumption; BELOK is a cluster for non-residential premises; BeBo is an innovation cluster for owners and managers of apartment buildings; BeLivs is an innovation cluster of grocery premises; and BeSmå groups together house builders. Two new innovation clusters began operating in 2016. They are *Innovationskluster för energieffektiv sjukvård* [Innovation Cluster for Energy-Efficient Medical Care] and *Innovationskluster Hållbart samhälle* [Innovation Cluster Sustainable Society].

The innovation clusters have mainly affected the energy efficiency of the building stock by promoting the development of new solutions and applying and demonstrating new knowledge and technology. Experience and expertise is disseminated by bringing together industry operators in the clusters.

The technology procurement/innovation procurement method exists to promote the development of new technologies and bring about the introduction of energy-efficient technologies in the market. It is a process that involves a number of different phases or activities and several different operators. The different phases are: preliminary study, client group, specification of requirements, tendering procedure, evaluation, dissemination and further development. The aim of technology procurement is to promote and accelerate the development of new technologies. The objective of technology procurement is to develop new products, systems or processes that meet purchasers' requirements better than the products already on the market. Technology procurement is currently carried out in close cooperation with fixed client groups for housing, non-residential premises and grocery establishments. Technology procurement is also carried out with networks in the public sector, villa owners, trade associations and others.

Research

As a public authority in the sector, the Swedish Energy Agency has a primary responsibility and coordinating responsibility for energy-related building research. In addition to the Swedish Energy Agency, Formas and Vinnova also finance projects in this sphere. *Konsumentverket* [the Swedish Consumer Agency], the Swedish National Board of Housing, Building and Planning and the Swedish Environmental Protection Agency also have energy-related commitments in the area of construction.

Energy-related research and innovation activities are characterised by a systemic vision. That vision is to achieve resource- and energy-efficient building. Cooperation is a keyword for the achievement of that vision. The Swedish Energy Agency's investment in research in the field of buildings in the energy system is divided into a number of programmes.

- Research and innovation for energy-efficient building and housing
- Heat pump research in the EFFSYS EXPAND collaboration programme
- District heating research in the Fjärrsyn cooperation programme
- The *Energieffektivt byggande och boende* (E2B2) [Energy-efficient building and housing] cooperation programme
- Energy, IT and Design
- Improvements in energy efficiency in buildings of cultural and historical value, *Spara och bevara* [Save and Preserve]
- The programme for energy efficiency in the area of lighting

These include a number of research projects conducted at universities, university colleges, institutes and companies. The Swedish Energy Agency has a project database[132] in which all projects are recorded.

Proposal for instruments in alternative 1

This section describes in more detail the amendments to instruments that we propose in alternative 1.

Information Centre for renovation to improve energy efficiency

The purpose of the information centre is to provide better information on what energy efficiency measures can be carried out when renovating, which means that it mainly helps increase the standard of energy efficiency improvement, but can also affect the scope of the renovations. A description of how the centre can be organised and managed is contained in the Swedish National Board of Housing, Building and Planning and Swedish Energy Agency report, Bov. 2015: 47.

The Government has allocated 10 million in the autumn budget for 2017 to the Swedish National Board of Housing, Building and Planning to appoint one or more operators for a centre for sustainable building.

- Based on the fact that the problem of low knowledge can lead to profitable renovation alternatives not being fully considered, our opinion is that an information centre can help to marginally increase the number of renovations by helping to remove the knowledge barriers and thus provide: Incentives for renovation: more guidance can mean that more renovations are carried out, but it mainly means that the renovations that are carried out are carried out correctly and do not have an adverse effect on other technical functional requirements.

- Incentives for energy efficiency: greater impact on energy efficiency measures than on renovation because the purpose itself is to increase knowledge about energy efficiency.

More marketing of the Swedish National Board of Housing, Building and Planning guidance on tenant consultation in the case of conversion

Digital guidance on the Swedish National Board of Housing, Building and Planning's website, Guidance for property owners on tenant consultation in the case of conversion, was opened in 2014. It compiles experiences and good examples of renovations carried out with tenant consultation in the case of conversion and development of residential areas.

The reference group for the study stressed that a model for dialogue with residents before a renovation is a success factor because a successful dialogue with residents can resolve something that can actually be categorised as a knowledge problem. The Swedish National Board of Housing, Building and Planning intends to carry out more work on increasing knowledge about resident discussions.

- Incentive for renovation: more guidance for resident dialogues can lead to more renovations being carried out – it is possible to find solutions that

[132] http://www.energimyndigheten.se/forskning-och-innovation/forskning/projektdatabas/ Go to "*Avancerad sökning*" [Advanced search], enter "*Bebyggelse*" [Building] in the area and then search all projects.

pave the way for renovations that would not otherwise be carried out or that can increase the number of renovations at the margin for renovations that have not been carried out due to the knowledge barrier. The study takes the view that this has a small or marginal effect on the renovation rate.

- Incentives for energy efficiency: more guidance for resident dialogue can have a greater effect on energy efficiency measures than on renovation since the resident dialogue can mean that planned renovations become more less ambitious in their energy efficiency measures depending on what the residents want. Please note that it may also reduce the level of ambition in energy efficiency measures.

Knowledge of the impact of energy efficiency measures on the indoor environment and the utility value

In the consultation responses to our first basic premises for the renovation strategy, a number of consultation bodies pointed out that if measures that provide customer benefits in terms of improved comfort due to better insulation, replacement of windows, improved ventilation, etc. could generate an increase in rents, it would make it easier for managers that want to implement measures to increase energy efficiency. While working on this assignment, the matter was discussed again in the external reference group as a barrier relating to the fact that there is too little knowledge about what energy measures can be carried out that can mean rent increases.

We therefore propose that a knowledge base regarding establishment of rents be created in order to increase the profitability of measures to increase energy efficiency that also provide benefits for customers. Profitability can be improved through the property owner receiving rental income in addition to the energy saving if the energy efficiency measures also provide benefits for customers. Then there is the possibility of charging higher rents, which increases profitability. That possibility exists in the Rent Act today, but our view is that rent negotiations require more of a knowledge base that shows that energy efficiency measures can also affect the utility value and therefore form the basis for rent.

The knowledge base can be built up, for example, where local agreements and standards have already been developed. It is also possible that the issue can be woven into guidance for resident dialogues.

- Incentives for renovations: more guidance can lead to more renovations being carried out, but it will be a question of renovations at the margin

- Incentives for energy efficiency: the instrument is expected to have a greater impact on energy efficiency than on renovation because its very purpose is to increase awareness of energy efficiency.

Credit guarantees for renovation and energy efficiency measures

The purpose of expanding the scope of credit guarantees is to persuade banks and property owners to make more use of this possibility. The instrument is proposed as a reinforcement of the instruments that can stimulate renovations and increase the pace of energy efficiency measures. One powerful reason for proposing an extension of credit guarantees is the fact that it is a system that has already been built up and that does not require major initiatives in order to change. A description of how this can be done is contained in the Swedish National Board of Housing, Building and Planning and Swedish Energy Agency report ET 2015:47 Bov. 2015:47. A need for information regarding credit guarantees has been identified and information initiatives are being carried out during 2016, though a widening of the area of application needs to be followed up by more information initiatives.

- Incentives for renovations: some impact

- Incentives for energy efficiency: some impact

Improvements in energy declarations

Continuing work on change is about further strengthening the information components so that energy performance is included in a building's market value and can thus have an impact on the property market.

Future work should focus on the design of the entire declaration and ensure that there is enough digital information that supports the use of the declarations that can easily be linked to renovation questions at the information centre and through continued contacts and information initiatives aimed at the banking sector. [133] This work is part of the Swedish National Board of Housing, Building and Planning's management and development work on energy declarations.

- Incentives for renovations: Improved energy declarations are not expected to have more than a marginal effect on the incentive to renovate.

- Incentive for energy efficiency: It increases the incentives for carrying out energy efficiency measures.

The PBA Knowledge Bank

The PBA Knowledge Bank[134] is the Swedish National Board of Housing, Building and Planning digital manual intended for municipalities, authorities, industry and the general public for better and more uniform application of the PBA and the BBR. It is absolutely essential that operators who have an influence on the process and the results possess good knowledge and a guide to the energy conservation requirement will therefore be produced. The aim is to obtain satisfactory application of the energy requirements and the focus will be on

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[133] Inspiration for how digital information concerning energy declarations can be presented is available on the website of the Danish Energy Agency, http://sparenergi.dk/forbruger/boligen/energimaerkning-boliger

[134] The PBA Knowledge Bank is a Government assignment that is being carried out in order to bring about uniform application of the Planning and Building Act throughout Sweden. It consists of support for national development projects, PBL training and a component concerned with arranging and further developing a PBL network. Within the framework of PBL *Kompetens* [Skills], there are great opportunities for raising knowledge levels and providing specific guidance for municipal administrators. The assignment is implemented in the 2014–2016 period.

the energy conservation requirement, rather than energy declarations or other matters relating to them. The work will be carried out at the Swedish National Board of Housing, Building and Planning.

- Incentives for renovations: Better guidance on the energy conservation requirement does not affect the incentives to renovate.

- Incentive for energy efficiency: Guidance on energy requirements will make it easier for those who are renovating to meet the energy requirements. It will also be easier to carry out supervision and monitoring and provide advice (municipalities).

The section on energy conservation includes all buildings. When the rules become clearer and easier to apply, it will affect all building categories.

Ideas for instruments for renovation and reasons for assessment of further investigation

A number of instruments have been discussed in our reference group meetings. We have received help from Mats Björs, *Byggmaterialindustrierna* [the Swedish Construction Federation], Lotta Bångens, *Energieffektiviseringsföretagen* [Energy Agencies of Sweden], Bengt Wånggren, Sweden Green Building Council, Kristina Mjörnell, Renoveringscentrum, Veronica Eade, *Fastighetsägarna* [Swedish Property Federation], Per Holm, SABO [*Sveriges Allmännyttiga Bostadsföretag* – the Swedish Association of Public Housing Companies], Jennie Wiederholm, *Hyresgästföreningen* [the Swedish Union of Tenants], Maria Brogren, *Sveriges Byggindustrier* [the Swedish Construction Federation] and Hans Lind, KTH [*Kungliga tekniska högskolan* – Royal Institute of Technology]. In Table 50, we present the reasons why we are not proposing these instruments.

Table 50 Proposed instruments discussed during reference group meetings.

Instrument	What will it remedy?	The committee's comments on further work
Rent subsidies	Improve profitability. Residents have moderate or low ability to pay, which limits the necessary rent increases	Relevant for further investigation.
Greater tenant consultation	Improve profitability The residents have moderate or low ability to pay, which limits the necessary rent increases	Proposal for promotion through the Information Centre and by other means, as stated in alternative 1.
Lower VAT on rent	Improve profitability The residents have moderate or low ability to pay, which limits the necessary rent increases	Requires negotiations within the EU VAT Directive.
Subsidies for property owners	Improve profitability The residents have moderate or low ability to pay, which limits the necessary rent increases	The Government has introduced a number of subsidies for renovation.
Changes in the system for establishing rents	Improve profitability The system for establishing rents provides incentives for "wrong" renovations	Relevant for further investigation.
Technology procurement	The development of productivity on the part of entrepreneurs is too low	Technology procurement is already supported through the Swedish Energy Agency.
More competition	Competition in the construction market is too low.	Essential for the housing market and not just for renovations. SOU 2015:105 Space for more who build more leads to more proposals.
Reduced VAT on capital brought into a business	Taxes and fees on materials and labour are too high	Requires negotiations within the EU VAT Directive.
Higher deduction for repair, conversion and extension work for houses	Taxes and charges on	The deduction for repair, conversion and extension work was lowered recently

Instrument	What will it remedy?	The committee's comments on further work
and tenant owner associations	materials and labour are too high.	and it is still too early to say whether it is appropriate to increase the deduction again. An evaluation should be carried out first.
Deduction for repair, conversion and extension work for rental accommodation	Taxes and fees on materials and labour are too high	Included in SOU 2014:1 and was deemed difficult to implement in view of how the instrument is formulated. Evaluations of previous versions of repair, conversion and extension work show that it helped to bring forward renovations. [135]
"Renovate right dialogue"	Increase knowledge among property owners.	The Swedish Energy Agency has just launched its large-scale skills initiative. The proposal could be included in future knowledge initiatives.
Good examples	Increase knowledge among property owners.	Expected to be disseminated through the information centre
Requirement for a maintenance plan	Increase knowledge among property owners.	A maintenance plan is something that a property owner can be expected to produce alone. If good examples are needed, that is a task for the information centre.
Preliminary studies for sustainable renovations	Increase knowledge among property owners.	Disseminating good examples of preliminary studies can also be an appropriate task for the information centre

[135] https://www.google.se/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=ROT-avdragets+effekter+riksdagens+reviso

Annex 4 Calculation methods

Data from the real estate assessment register and need for renovation

Section *7.3.4 The number of renovations can be monitored via property tax assessments* and section *9.2 Scenarios* present results based on results from the real estate assessment register.

Data from the real estate assessment register

Each building, when it is new, is given a year of construction and a value year. The building's value year is initially the same as the year of construction, but that can change when major investments are made when renovations are carried out. The size of the renovation cost in relation to the new construction cost established by SCB each year determines how much the value year changes. Example 1 contains an example of how the value year is calculated after renovation.

Example 1 A description of how a building's value year changes in connection with a renovation

The example refers to a conversion in 1996.
Year of new construction: 1960
Last established value year: 1970
Renovation year: 1996
Conversion cost: 4,600 SEK/m2
New construction cost according to the table: 9,200 SEK/m2

Conversion Cost 1996 / New construction cost 1996 = 4,600/9,200 = 50 per cent

The conversion cost is 50 per cent of the estimated new construction cost. The adjustment of the value year is calculated as follows:
Adjusted value year = 1970   (1996 – 1970) x 0.5 = 1983

A building's value year is normally equal to the buildings year of new construction. If substantial conversion or extension has been carried out, the value year will be changed. When the value year changes, the conversion and extension cost is compared to a calculated new building cost at the time of the conversion. The change is made according to one of the following alternatives:

- Group 1. The conversion and extension cost is more than 70 per cent of the estimated new construction cost. Value year = the conversion or extension year.

- Group 2. The conversion and extension cost is 20–70 per cent of the estimated new construction cost. Value year = the last established value year plus a conversion supplement.

- Group 3. The conversion and extension cost is less than 20 per cent of the calculated new construction cost. Value year = last established value year.

- Group 4. Valuation units where there is no new construction year and the conversion year is later than the value year. Valuation units where only the conversion year is available. Valuation units where the value year is later than the new construction year and there is no conversion year. These were probably converted before 1988, which is the first year for conversion years contained in the register.

- The "Not converted" group includes those not included in the above groups, valuation units where the new construction year is the same as the value year and there is no conversion year. Valuation units where there is no new construction, value year or conversion year. Valuation units where the new construction year is later than the value year (40 incorrect).

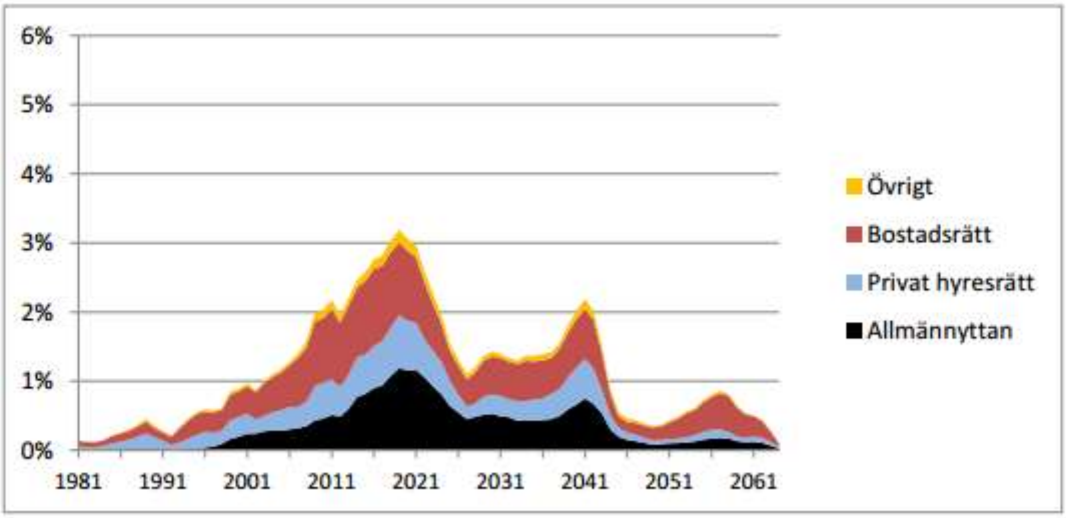
Need for renovation

The results presented in section *7.3.4 The number of renovations can be monitored via property tax assessment* are based on a complex combination of data and calculations and the results should therefore be interpreted with caution. The supporting data contains no information on what kind of renovation measures have been carried out. In addition, a building can have been renovated on more than one occasion but it is only the last occasion that is reported. This means that buildings that have been subject to continuous maintenance work without renovation are placed in the groups that have not undergone major renovations.

Annual need for renovation in the apartment building stock

The information in the real estate assessment register makes it possible to roughly estimate the annual need for renovation. The need for renovation is based on the assumption that if the building's value year is older than 50 years, the building is considered to be in need of renovation measures. This means that a building with the value year 1950 is assumed to need renovation in 2000, while a building with the value year 1964 is assumed to need renovation in 2014. Figure 39 shows the remaining need for renovations calculated from 2014 and future needs. A remaining need means, for example, that in 2010 there was an area of approximately 2 per cent that "should" have been renovated considering that the buildings were 50 years old. The results in Figure 39 show that in the coming years approximately 3 per cent of the area in apartment buildings will need renovation. At the same time, there are deferred renovations from previous years remaining, which means that a much larger area would need to be renovated each year.

Figure 39 Deferred and remaining need for renovation in apartment buildings, proportion of total area in apartment buildings



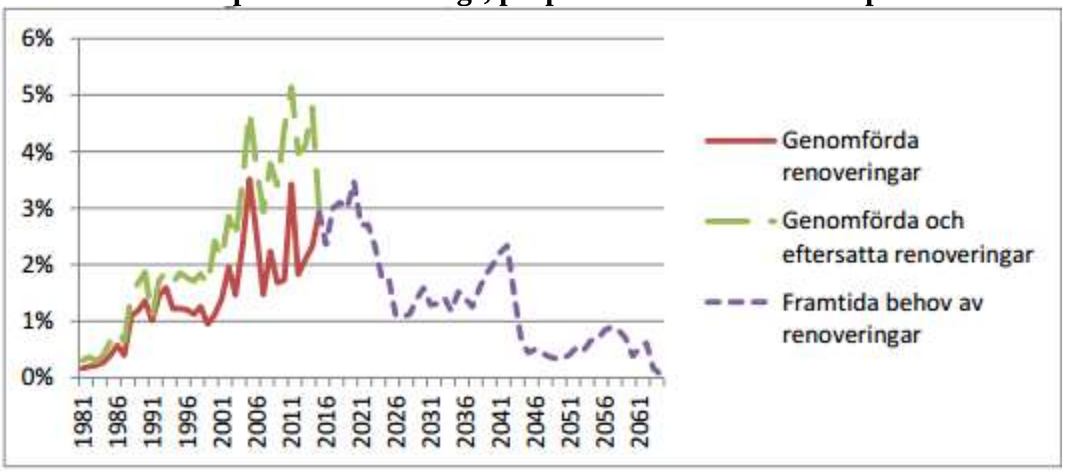
Source: Johansson and Mangold (2016) with data from the real estate assessment register.

Key:

Övrigt = Other
Bostadsrätt = Tenant owner apartments
Privat hyresrätt = Private rental accommodation
Allmännyttan = Public benefit

The red line in Figure 40 shows the renovations that were registered in the real estate assessment register in 1981–2014, whereas the green dotted line adds the renovations assumed to be deferred in the same period. The registered renovations varied between approximately 1 and 3 per cent per year during the 1990–2014 period. Had the deferred renovations also been included as carried out during the period, the renovated area would instead have been 1–5 per cent. The purple dotted line shows the future need for renovations based on the assumption that the renovations should be carried out when the buildings' value year is 50 years.

Figure 40 Renovations carried out, assumed deferred renovations and assuming future need for renovation in apartment buildings, proportion of total area in apartment buildings



Source: Johansson and Mangold (2016) with data from the real estate assessment register. Processed by the Swedish National Board of Housing, Building and Planning & the Swedish Energy Agency

Key:
Genomförda renoveringar = Renovations carried out
Genomförda och eftersatta renoveringar = Renovations carried out and deferred
Framtida behov av renoveringar = Future need for renovations

Scenarios

To produce a reference alternative and different scenarios in section *9.2 Scenarios* , we have made assumptions about what renovation measures are being implemented and their cost. To help to produce supporting data, we have spoken to external operators.

Estimate of costs for renovation measures

A workshop was arranged to produce a renovation package and estimate costs for it. The starting point for the workshop was the SABO report entitled "Home to millions" from 2009. The workshop was attended by:
Jan Johansson, Energy Planner, Municipality of Växjö
Mari Broman, IQ Samhällsbyggnad
Dahn Gidstedt
Katarina Westerbjörk, WSP
Johan Holmgren, SABO

The results were used as a basis for the interview studies that were carried out to produce estimates of what renovation measures are expected to be implemented in the reference alternative.

Description of method for interview studies

The description and the results of the measures implemented in the reference alternative are based on an interview study with property owners. The purpose of the interview study was to find out what percentage of property owners' building stock they planned to renovate, the extent of the renovations, what energy efficiency measures they will carry out and the cost of carrying out a renovation. The results were used to carry out a calculation using the HEFTIG simulation tool[136].

The selection of property owners for the interview study was based on criteria including companies with a large managed area, obtaining a spread of companies in Sweden and capturing companies that are carrying out renovations. Table 51 shows the number of companies interviewed for the various building categories. The interviews were conducted through physical meetings with operational and administrative managers, CEOs, environment managers and construction and project managers.

[136] HEFTIG is an abbreviation of "*Husens EnergiFramTid I Genomlysning*" [the Building's Energy Future I Analysis] and is a tool that can be used to simulate the effects of energy efficiency measures in the building stock. For more information see http://belok.se/forstudie-heftig/.

Table 51 Number of companies interviewed by building category.

	Private	Public	Tenant owner apartments
Apartment buildings	4	2	2
Offices	5	3	
Schools		6	

Error! Reference source not found. presents a detailed description of the various renovation levels 1–3.

Table 52 Packaged measures for the various levels of renovation in apartment buildings

	Continuous maintenance	Level 1	Level 2	Level 3
Painting + sealing windows/doors	Yes	Yes	Yes	-
Replacement of windows, U<1	-	-	-	Yes
Attic Insulation 300 mm short fibre	-	-	Yes	Yes
Façade insulation 100 mm	-	-	-	Yes
New entrance/cellar doors	-	-	Yes	Yes
Change to low-energy bulbs	Yes	Yes	-	-
LED with presence detector	-	-	Yes	Yes
New fans	Yes	Yes	-	-
Replacement of thermostats/valves	-	Yes	Yes	Yes
Balance heating	Yes	Yes	Yes	Yes
FVP 3.0	-	-	Yes	-
FTX n85%	-	-	-	Yes
Balance ventilation system	Yes	Yes	Yes	Yes
Low-flush fittings	-	Yes	Yes	Yes
Energy efficient laundry facilities	-	Yes	Yes	Yes
IMD VV	-	-	-	Yes
Sewage HVAC	-	-	-	Yes
Total energy saving:	**4%**	**10%**	**30%**	**50%**