Strategy for fossil free competitiveness

STRATEGY FOR EFFICIENT USE OF ENERGY AND POWER

Fossil Free Sweden

A strategy by
Fossil Free Sweden

Contents

Foreword

The timing could hardly have been better. Right now, the energy issue and – not least – the price of electricity are on everyone's lips. Suggestions for energy-smart measures is a recurring theme in the headlines and social media, and this spontaneous popular education is bearing fruit. Electricity use has fallen by about 10 per cent compared with previous years. The question is, though, how many of these emergency savings measures will last? Will we stop saving electricity when prices stop being so extreme?

This strategy is not about scrimping and saving. It is about making energy use more efficient with lasting results, without compromising quality of life. It largely concerns use of smarter technology and heightened automation, making us use energy when we actually really need it. Leaving lights on in empty rooms, and having fans running at full power at night in factories when nobody is at work, is of no benefit to anyone.

This is the fifth strategy prepared by Fossil-Free Sweden together with various companies in the value chain, and in dialogue with academia. The 29 entities endorsing this strategy span energy-intensive companies, to energy firms and housing enterprises. Common to all of our strategies is that they show how policies can facilitate and accelerate implementation of the 22 roadmaps for fossil-free competitiveness developed by the business sector within the Fossil-Free Sweden framework. More efficient use of resources is pivotal for competing while making production more sustainable at the same time.

The challenges facing the business sector are immense. Electricity consumption in industry will almost need to double already by 2030 to avoid losing momentum in implementing the roadmaps. This is why all fossil-free energy sources are needed to achieve this, in combination with energy efficiency improvements. Unfortunately, improving energy efficiency plays a minor role in the debate, despite it often being the cheapest, fastest and greenest way of freeing up electricity for the rapid expansion of industry.

However, within the OECD's expert body, the International Energy Agency (IEA), improving energy efficiency plays a prominent role. In their scenario, improving energy efficiency is the single most important measure for limiting the global temperature increase to 1.5 degrees. It is greater than all production from wind power, nuclear power and hydroelectric power combined by 2050.

In our strategy, we have opted to be more cautious to avoid a discussion about various potentials. Rather, we want to focus on the policy instruments that present tremendous opportunities for speeding up energy efficiency improvements in Sweden. Our proposals for policy instruments can, combined, free up about 10 per cent of total energy use by 2030, and around 14 TWh of electricity, which is equal to the annual output of both the Ringhals nuclear reactors, or 300 offshore wind turbines.

We hope this will pique your interest in energy efficiency improvements and that our strategy will provide a better understanding of where and how energy efficiency improvements can be made in Sweden.

Wishing you an energising read,

Svante Axelsson
Nationell samordnare, Fossilfritt Sverige

Companies behind the strategy

Fossil Free Sweden has, in its work on the strategy, been in dialogue with a number of companies and organisations, which support the strategy as a whole, but not necessarily all individual wordings and proposed actions.

Per-Otto Bengtsson, Head of Energy and Environmental Affairs, Victoriahem

Henrik Brodin, Head of Energy, Södra Skogsägarna

Anna Denell, Sustainability Director, Vasakronan

Henric Dernegård, Head of Environmental Affairs, Holmen AB

Anders Egelrud, CEO, Stockholm Exergi

Thomas Erséus, CEO, AMF Fastigheter

Cecilia Fasth, CEO, Stena Fastigheter AB

Erik Florman, Director of Sustainability, Akademiska hus

Anders Fredriksson, CEO, Löfbergs

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Anders Holmestig, CEO, Fastighetsägarna

Sezgin Kadir, Group CEO, Kraftringen

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Victoria Olsson, Senior Sustainability Manager, Arla Sverige

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Niclas Sahlgren, CEO and founder, Eways

Cecilia Svensson, EVP Communications & Sustainable Transformation, Perstorp Holding AB

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Anders Thor, Director of Communications & Public Affairs, Nordics, Northvolt

Louise Wall, Sustainability Manager, HSB

Caroline Ödin, Energy Strategist, Fabege AB

Andreas Örje Wellstam, CEO, Swegon

Roadmaps for fossil free competitiveness

In the roadmaps for fossil-free competitiveness, 22 sectors demonstrate how they contribute to Sweden reaching its climate neutrality target by 2045. Together, they also show the areas in which decisive action is needed for the success of the transformation and to sharpen competitiveness. Fossil Free Sweden is therefore developing horizontal strategies together with actors in relevant value chains to untangle the knots and show the way forward. This strategy for efficient use of energy and power is Fossil Free Sweden's fifth strategy. The previous strategies are the strategy for a sustainable battery value chain, the hydrogen strategy, the bioenergy and bio-based feedstock in industry transition strategy, and the finance strategy.

CONCRETE INDUSTRY	AVIATION INDUSTRY	CEMENT INDUSTRY	AGRICULTURAL SECTOR	MINING AND MINERALS INUSTRY	STEEL INDUSTRY
SKI RESORT SECTOR	DIGITALISATION CONSULTANCY INDUSTRY	FOOD RETAIL SECTOR	HEAVY ROAD HAULAGE	HEATING SECTOR	MARITIME SECTOR
AGGREGATES INDUSTRY	CONSTRUCTION AND CIVIL ENGINEERING SECTOR	ELECTRICITY SECTOR	FAST-MOVING CONSUMER GOODS INDUSTRY	RECYCLING SECTOR	FOREST SECTOR
AUTOMOTIVE INDUSTRY LIGHT VEHICLES	AUTOMOTIVE INDUSTRY HEAVY VEHICLES	PETROLEUM AND BIOFUEL INDUSTRY	GAS SECTOR		

22 roadmaps for fossil-free competitiveness

Summary

The sectors' roadmaps for fossil-free competitiveness describe a way forward for climate transition in Sweden. Many of the industrial processes that have previously needed fossil fuels are now to be made partly or fully climate-neutral through electrification. New industries are also being established in Sweden, often attracted by access to relatively inexpensive and fossil-free electricity. The transport sector is also undergoing electrification at an accelerating pace. All in all, this is positive for Sweden, and the climate transition will mean new jobs, increased competitiveness and a better work environment and health.

The climate transition is largely a transition within energy, and greater access to fossil-free electricity will be needed to secure Sweden's future welfare. Forecasts vary, but many indicate a doubling of current electricity consumption, and an increase in the power need by around 50 percent.

Energy efficiency should be seen as a climate action, even if the efficiency enhancement is within fossil-free energy, because:

1. The fossil-free transition of the industrial and transport sectors will require a great deal of energy, especially electricity, so the energy freed up will in practice contribute to phasing out fossil fuels in the industrial and transport sectors, and
2. fossil-free energy that is not used in Sweden can force out fossil electricity and fuels in neighbouring countries.

Efficient and flexible use of energy thus plays a crucial role both in the climate transition and in the current situation of extreme and unpredictable energy prices.

The purpose of this strategy is to demonstrate how more efficient use of energy contributes to:

- Energy going farther, which means that the transition can go faster than if the higher need for electricity in particular is fulfilled by new generation alone.
- Facilitating implementation of the roadmaps and increasing the competitiveness of industry through the fossil-free transition.
- Curbing energy prices.
- Improving Sweden's self-sufficiency.
- Improving resilience ahead of future crises.

Energy efficiencies are constantly being made and, despite population growth and rising GDP, Sweden has not increased its energy consumption since the 1970s. However, most studies show that there are still tremendous opportunities for profitable investments in energy efficiency. The strategy shows what can be achieved, and what is needed for it to happen. It is quite possible to free up a substantial proportion of today's energy use in just ten years or so, with lower energy prices as a result. However, for this to happen, active efforts are needed to eliminate the market failures that exist in the area.

Efficient use of energy and power

More efficient use of electricity in existing industries and property holdings is the quickest way to free up power to establish new industries and build residential areas. More efficient use of energy can also make us more self-sufficient and less dependent on other countries, reducing the vulnerability of both companies and individual households.

The focus of this strategy is the efficient use of energy and power, which is not the same as energy saving. Rather, it concerns maximising the benefit of energy used (energy efficiency), shifting electrical power in time to reduce bottlenecks in electricity grids and generation (flexibility) and utilisation of residual energy (energy efficiency). Even if there is a good energy supply in the country or the area as a whole, there may still be a power shortfall in some places.

This strategy focuses on the areas of power and flexibility, the housing and services sectors and the industrial sector.

Assessments of potential in the strategy

In the strategy, it is estimated that, at minimum, an efficiency improvement equalling 34 TWh, or 9 percent of energy consumption in 2020, is possible to achieve in Sweden by 2030. Of this, approximately 14.5 TWh is electricity, 9.5 TWh district heating and around 10 TWh efficiency improvements within various fuels. An efficiency improvement of 14.5 TWh of electricity by 2030 could equal just over 30 percent of the estimated need for new electricity by the same year.

In the strategy, aggregated assessments of potential through 2030 are made based on what ought to be feasible to implement at minimum, provided that sufficient policy instruments are introduced. The strategy's assessments are thus relatively cautious and, when drawing up the strategy, the need for relevant policy instruments has been prioritised ahead of precise efficiency potentials. It is probably quite possible to achieve significantly larger efficiency improvements.

Flexibility potential

Sweden has a surplus of electricity on an annual basis and generates more electricity than is used in the country. However, the electricity grids are not capable at all times of transmitting electricity from where it is generated to where it is needed. Actions that shift electricity usage in time, from hours to days, are known as flexibility. Flexibility can free up power, leading to more efficient use of existing grids and a reduced need to expand electricity grids. Electricity grids need to be dimensioned to cope with higher electricity consumption in the future, but they also need to be used smarter and more effectively.

The assessment of flexibility potential made in this strategy should be seen in light of the uncertain and incomplete basis of research currently available. The potential is considerable, however. In Gothenburg alone it is estimated that flexibility can free up 100 MW (=0.1 GW), equalling the need of a small municipality such as Partille or Enkoping. In order to truly harness the potential, clear incentives and greater knowledge are needed.

Flexibility potential 2030 3.5 GW

In the strategy, flexibility potential for electricity through 2030 is estimated to be at least 3.5 GW, of which 1.5 GW in residential buildings, 0.5 GW in premises and service, 1 GW in industry and 0.5 GW in electric vehicles.

It should be possible to free up part of the potential, not least for households, very swiftly through behavioural changes and smart control of equipment. For example, properties act as large heat reservoirs and retain their temperature for some time after active heating has been switched off. Properties with electric heating therefore become flexibility resources in electricity grids. With simple equipment for smart heating system control, this can be solved automatically.

In industry, conditions for flexibility measures vary. Some types of industries are already participating in flexibility measures today, not least the pulp and paper industry. There is also potential in other parts of industry, such as the cement industry and data centres, and eventually with hydrogen storage.

Drawing on lessons learned from other technological shifts and the current direction set by the EU, it is reasonable to assume relatively rapid growth in electric cars' contribution to flexibility potential until 2030. It is estimated that if 60 percent of the car fleet consists of electric cars, there is battery capacity of 14–114 GW, which is four times greater than the highest power need in winter for the whole of Sweden.

Efficiency potential in apartment blocks

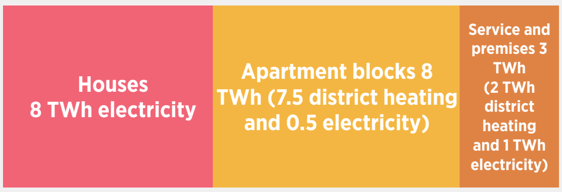
The strategy estimates that apartment blocks should be able to free 7.5 TWh of district heating and 0.5 TWh of electricity by 2030. Actions with high energy efficiency potential for apartment blocks are smarter heating system control, more efficient water taps and nozzles and adjustment of ventilation systems.

A large proportion of the stock of apartment blocks is considered to have extensive renovation needs and a slow renovation rate. In renovations, measures for more efficient energy use are also usually carried out, such as replacing windows and ventilation systems. However, most buildings that are renovated move up only one or a couple of energy classes, which could be remedied with more forceful policy instruments. Renovations need to be carried out with due care so as not to cause rent increases that would force tenants of small means to move out.

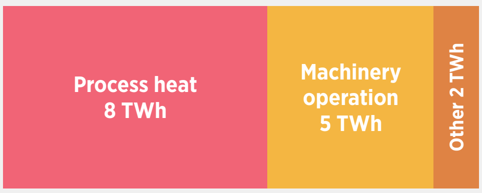
Efficiency potential in houses

There is tremendous energy efficiency potential in Sweden's two million or so houses. With current electricity price levels, it might be reasonable to assume that more measures will be implemented than before, while developments ahead are very uncertain with reduced margins for many households, which affects their ability to invest in profitable efficiency improvements. This strategy therefore makes the relatively cautious estimate that 8 TWh electricity could be released by 2030.

Efficiency potential of homes and premises 19 TWh



Efficiency potential of industry 15 TWh



Measures with the greatest energy efficiency potential in houses are also smarter heating system control, more efficient water taps and nozzles and also extra insulation of attics.

Besides, around 173,000 houses are still heated with direct-acting electric heating, which is very inefficient and expensive. If holiday homes are included, the number is even higher. Installing new hot water central heating systems in an existing house is a costly and sweeping measure. From an energy system perspective, it would be beneficial if this were done, but it is rarely profitable for the individual home owner. Installing air-to-air heat pumps could be a more profitable option.

Efficiency potential in premises

Premises and service are a more heterogeneous group than homes, and include offices, store premises and schools. Knowledge of energy use and efficiency potentials is also lower in this sector. Yet, the strategy nevertheless estimates that efficiencies equalling 3 TWh by 2030 are feasible, of which 2 TWh is district heating and 1 TWh electricity. Energy efficiencies in premises are generally more difficult to implement because they encompass many different types of buildings and operations in which incentives for efficiency improvements are divided between property owners and tenants.

Efficiency potential in industry

More efficient use of energy in industry can often cut emissions immediately, as fossil energy is still used in many processes. However, there data is often lacking and it is therefore difficult to appraise the energy efficiency potential. The European Commission estimated in 2021 the possible profitable efficiency potential of just over 31 TWh for the industrial sector.

In view of the uncertain basis, in this strategy a more cautious assessment is made – that 15 TWh should be possible to free up from the industrial sector by 2030, of which 8 TWh could consist of process heat and 5 TWh of electricity. However, the assessment of the potential does not take account of overarching systemic aspects – measures that look at an entire process and make sweeping efficiency improvements and changes. That area probably holds the greatest potential, but is even more diverse and difficult to assess depending on the industry. Policy instruments should also be designed to take account of these types of measures.

Action plan

Although the high energy prices of late have increased interest in energy efficiency measures, a holistic approach is lacking and knowledge levels are still inadequate. There is therefore a need to review and supplement policy instruments within energy efficiency to accelerate developments.

The assessment in this strategy is that current policy instruments do not provide sufficient incentives for sustainable energy efficiency improvements. The Swedish Energy Agency estimates that Sweden's target of 50 percent more efficient use of energy in 2030 than in 2005 will not be achievable with current policy instruments. The EU is also expected to tighten its energy efficiency targets, which will require further efforts by Sweden.

The most forceful proposal in this strategy that is expected to have a major effect in terms of giving greater impetus to energy efficiency in Sweden is the introduction of a new energy efficiency programme. Previous programmes have been directed at energy-intensive industries, while the proposal in this strategy has a broader scope. Participation in the programme is proposed to be voluntary and include a market-based auction system to reduce electricity use among the affiliated actors and their customers. The energy efficiency programme would help to reduce the use of electricity, reduce the price of electricity and at the same time contribute to achieving the Swedish energy efficiency target by 2030 and expected EU-level targets.

One possibility to finance the energy efficiency programme could be to reserve part of Svenska Kraftnät's surplus from capacity charges. However, before a reasonable assessment of revenues for 2023 has been made, it is difficult to determine the size of the surplus. In the strategy it is nevertheless considered likely that relatively substantial electricity price fluctuations will persist, which will lead to a surplus that could be used to finance energy efficiency measures. This is not possible on the basis of current EU regulations, but in light of the current energy landscape in Europe and Commission communication of 18 May 2022 on short-term energy market interventions and long-term improvements to the electricity market design, in this strategy the conditions are considered to be relatively decent.

In order to facilitate and enable implementation of the roadmaps, Fossil Free Sweden lists below priority proposals from the strategy for more efficient use of energy, electricity and power. An in-depth and complete list of all proposals is presented in Chapter 6.1.

Priority proposals

- The Government should commission the Swedish Energy Agency with designing an energy efficiency programme that also includes a market-based auction system to reduce the use of electricity and power. The programme should run until the end of 2030, and may for example:
  - be open to companies, including property owners, with average annual energy consumption exceeding 28 GWh and which in the proposal to revise the Energy Efficiency Directive shall introduce an energy management system,
  - be open and link to participating property owners within existing networks such as BeLok, BeBo and BeSmå,
  - be open to energy companies and aggregators,
  - exempt participating actors from supervision in terms of the Environmental Code's energy requirements on the rational use of energy,
  - include platforms for networking between the participating actors,
  - include the possibility to apply for planning support for detailed preliminary studies for investments in energy efficiency measures,
  - include reverse auctions for energy efficiency measures in which the repayment period exceeds three years.
  - an initial auction round is proposed to be directed at actors in electricity areas 3 and 4 with the aim of freeing up 5 TWh of electricity. Within the bounds of the Emergency Regulation, Svenska Kraftnät may apply to the Swedish Energy Markets Inspectorate to use part of the surplus from the capacity charges in 2023 to finance this first auction round.

- The Government should commission the Swedish Energy Agency with investigating the possibilities of long-term funding of a new energy efficiency programme. The commission is proposed to include exploring the possibilities of reserving some of Svenska Kraftnät's surplus from capacity charges if these are forecast to be high in the coming years also.
- The Government should include energy efficiency as a climate action and commission relevant agencies with incorporating (more types of) energy efficiencies in existing climate-related support, such as the deduction for green technology, the Climate Leap and the Industry Leap.
- The Government should commission The Swedish Energy Markets Inspectorate and Svenska Kraftnät with reinforcing and developing well-functioning flexibility markets and enabling more types of actors to participate.
- The Government should introduce measures to incentivise property owners into carrying out energy-efficient renovations. Several options are available and are proposed to be implemented in two steps:
  - Step 1: Reintroduce the previous "Aid for energy efficiency in apartment blocks". The aid was granted for additional costs for energy efficiencies that improved the energy performance of a building by at least 20 percent, and was financed with funds from the EU recovery package available between 2021 and 2027. Small enterprises could obtain a maximum of 50 percent of the basis eligible for the aid, medium-sized enterprises up to 40 percent and large enterprises up to 30 percent. The basis for assessing the support must be technology-neutral.
  - Step 2: In order to secure long-term conditions for property owners' work on energy-efficient renovation, the Government should commission the Swedish National Board of Housing, Building and Planning, in consultation with the Swedish Tax Agency, with investigating and submitting proposals regarding how a tax reduction corresponding to the above aid levels could be designed to provide continued incentives for the energy-efficient renovation of apartment blocks after 2027.
- The Government should extend the period during which the tax deduction for home repairs, conversion and extension may be used, for example three years, making the maximum amount of the deduction SEK 150,000. The deduction should also be extended to include deductions for advisory services and energy audits of properties and installing smart control systems.
- The Government should extend the investment grant, announced in the 2023 Budget Bill, for conversion of heating systems and renovation of houses with direct-acting electric heating or gas heating. It should be possible to apply for the aid over a proposed period of five years, and it should also include properties that are still heated by oil-fired boilers.
- The Government should commission the Swedish Agency for Economic and Regional Growth and the Swedish Energy Agency, within the bounds of the European Regional Development Fund (ERDF), with jointly continuing to support small and medium-sized enterprises financially and in terms of know-how with automation and energy efficiency improvements. The Government should also supplement the commission with support for the regions in order to facilitate the co-financing required by ERDF. Lessons drawn from the previous programmes, the Robot Leap and the National Regional Fund Programme, should be put to use in designing the joint commission.

1. Introduction

Sweden and the world at large are in the midst of a dramatic transition. It has long been clear that fossil fuels, which have provided the world with energy, and around which economies and infrastructure are built, need to be phased out to avoid destroying the climate. Dependence on fossil fuel is also a security risk – a fact that has been made clear by Russia's invasion of Ukraine. Europe and the EU must now, in a very short space of time, free themselves of dependence on Russian fossil energy. Rocketing prices of natural gas and other fuels have led to soaring energy prices across Europe, inflation, risk of bankruptcies and fears that people will not be able to afford to heat their homes.

Energy efficiency, energy saving and time-shifting energy use – flexibility – are the fastest and simplest tools for reducing fossil dependence, lowering prices and increasing competitiveness and households' resilience. Even before the price increases, there was a plethora of feasible and profitable measures to improve efficiency in energy use within all sectors in Sweden. At the price levels of the autumn of 2022, significantly more measures will be profitable. At the same time, research clearly shows that profitability is not enough for energy efficiency measures to actually be implemented.

Within the framework of Fossil Free Sweden, 22 industries have developed roadmaps for their fossil-free transition by 2045. When these roadmaps are put beside each other, they provide a plan for Sweden's continuing prosperity, in which green industry generates jobs and tax revenues that finance common welfare.

From the roadmaps, it is clear that many industries are relying on electricity for their fossil-free transition. There are estimates of a doubled electricity and power need by 2045. At the same time, there are already areas in Sweden where the expansion of renewable electricity is being slowed down by difficulties in connecting to electricity grids.

In order to implement the roadmaps for fossil-free competitiveness and hit the climate targets, new electricity generation and new electric power lines are needed. The period of time from the project idea to a completed permit must and can be shortened. Today, the process often takes 10–12 years for a major power line or a wind farm. Several roadmaps show that the time should be halved to obtain more electricity.

At the same time, a lot of electricity is used for aspects that do not generate any added value. Ventilation systems remain switched on in unused premises, heat from industrial processes is cooled instead of being used, and numerous houses are inefficiently heated. Estimates by the European Commission show that Sweden could profitably reduce its energy consumption by 17 percent by 2030, with maintained economic development.[1]

The aim of this strategy is to illuminate how efficient energy usage is an enabler, since it leads to energy going farther and the transition going faster than if the heightened electricity need is met by new generation alone. Energy efficiency is thus a key in the implementation of the roadmaps, for greater resilience and for reduced dependence on energy imports alike. The strategy shows what can be achieved, and what is needed for it to happen. It is perfectly possible to free up at least one tenth of today's energy consumption by 2030, and this can also be done with economic viability, with reduced energy prices as a result. However, it requires active efforts from society to happen.

The strategy for the efficient use of energy and power has been developed on the initiative and under the leadership of Fossil Free Sweden. The work has been performed with the support of the Research Institutes of Sweden (RISE) and is based on retrieval of knowledge from literature, input from and discussions with the appointed reference group and other stakeholders, including from the real estate sector, energy companies, the manufacturing industry, industry associations and government agencies. Most of the companies essentially share the overall direction and conclusions of the strategy, as listed on page 5. The work has obtained valuable assistance from the reference group, which consisted of:
Anders Pousette, Swedish Energy Agency; **Jenny Larsson**,

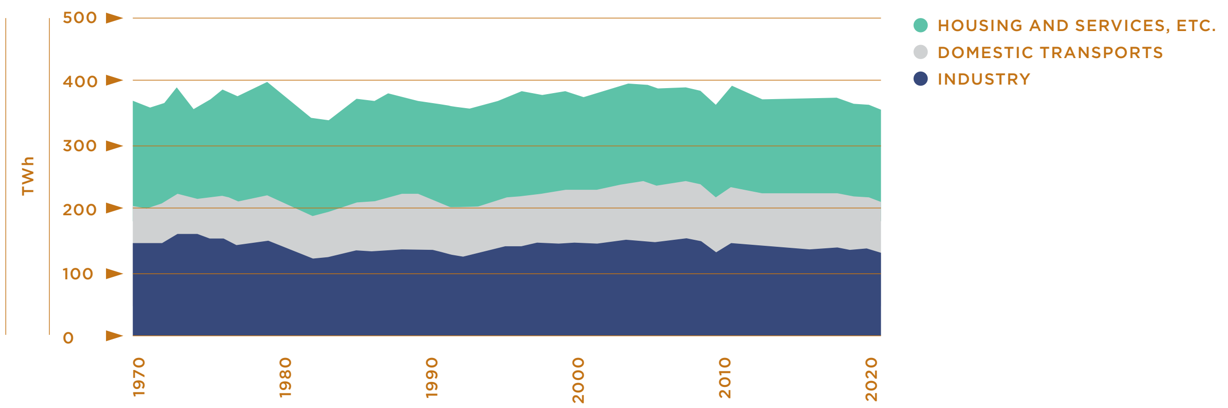
Schneider Electric Sverige AB; **Jenny Palm**, Lund University and **Louise Ödlund**, Linköping University.

1.1. Sweden's energy use and the price of electricity

Energy is a basic resource and is used for cooking, movement, heating (or cooling) homes, communication, entertainment and the production of goods and provision of services.

However, energy use is also the cause of climate impact; many of the energy conversion processes used today give rise to greenhouse gas emissions. Both globally and in Sweden, energy-related processes account for around three quarters of greenhouse gas emissions.[2] In large parts of the world, electricity generation is a major source of emissions through burning fossil fuels. In Sweden, emissions are mainly generated by the industrial and transport sectors, while electricity generation is practically fossil-free.[3]

TOTAL FINAL ENERGY USE PER SECTOR FROM 1970, TWH



ELECTRICITY USE PER SECTOR FROM 1970, TWH

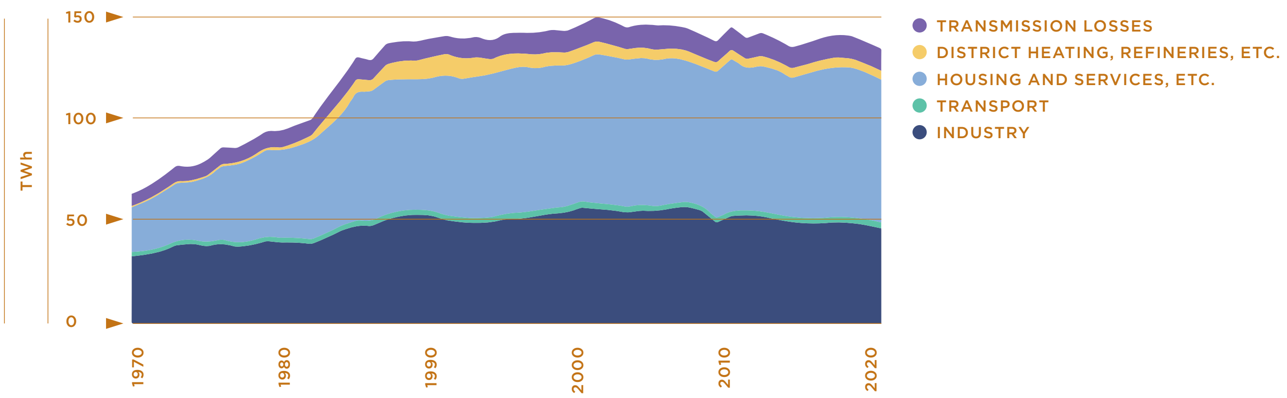


Figure 1 Left-hand panel: Sweden's total energy use since 1970, broken down by sector. Right-hand panel: Sweden's electricity broken down by sector. Housing and services includes, besides housing, also public-sector operations, other service operations, agriculture, forestry, fisheries and construction operations. A more detailed breakdown of energy use in each sector can be found in the relevant chapters further on in the report.

Source: The Swedish Energy Agencyi rapporten.

Energy prices, not least for electricity, are lower in Sweden than in many comparable countries, which is a reason why Sweden has large-scale, energy-intensive industry. Also, fossil-free electricity generation attracts industries, data centres and other investors who are concerned with their carbon footprint.

Even before Russia invaded Ukraine, it began to cut down on gas deliveries to Europe and the price of natural gas rose. In August 2022, Russia completely turned off the gas supply through the Nordstream pipeline, which has led to record-high electricity prices. The situation has been aggravated by factors such as a hot summer, with heightened use of air conditioning, and problems with French nuclear power.

Europe's electricity markets are interconnected both physically and financially, and high prices in one area therefore spread to neighbouring areas. Furthermore, like in many other markets, marginal pricing is used in the electricity market. This means that the most expensive type of power – or the last generated unit for which buyers are willing to pay – determines the price for all electricity generation. When the price of natural gas increases, it is also more expensive to the run gas power plants that generate electricity, and this then determines pricing for the entire electricity market.

Energyforsk commissioned a simulation of the progression of the price of electricity if Europe reduced its electricity consumption by 10 percent. This would, all else equal, halve electricity prices in southern Sweden compared with prices in August 2022.[4] Even if electricity consumption only decreases in southern Sweden and by as little as 5 percent, this would result in a SEK 0.40/kWh lower electricity price in those price areas according to the same analysis. In the autumn of 2022, electricity use in southern Sweden has already declined by around 10 percent. Further analyses commissioned by Energiforsk on behalf of Fossil-Free Sweden show that if electricity use declines by a further 10 percent in southern Sweden, this could give a reduction in the price of electricity of SEK 0.32/kWh in the winter of 2023/24. This is a drop of 38 percent from the expected price level for the period, with electricity use at the same levels as at the turn of 2022/23.

Electricity sport prices on Nordpool (month)

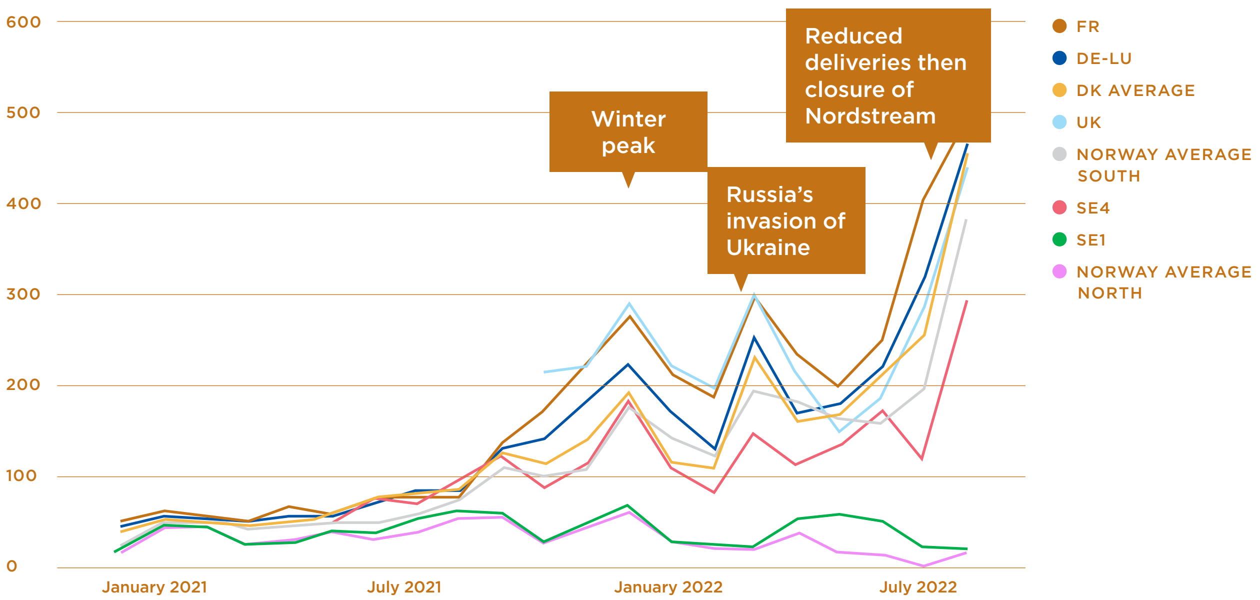


Figure 2 Electricity spot prices on the Nord Pool electricity exchange, monthly average, from November 2020 to August 2022. Note that, as these are spot prices on the exchange, VAT, taxes and fees for the end consumer will be added, which vary from country to country. Northern Sweden and Norway have maintained low prices, while the price increases in all other regions, at most in the UK. **Source:** Nord Pool.

1.2. Market failure – profitable investments fail to transpire

Most studies show tremendous opportunities for profitable investments in energy efficiency in Sweden. Arguments against many policy instruments in this field are therefore that these do not generate any additionality and that the measures would have been implemented even without policy instruments. However, neither businesses nor individuals can carry out everything that is economically profitable – and what is 'profitable' is not always clear, see Chapter 1.4. Numerous studies both in Sweden and internationally show why energy efficiencies that ought to be profitable nevertheless fail to transpire.[5]

As an example, a private individual who owns an unrenovated house from the 1970s can save money by installing extra insulation and replacing windows. However, this requires the owner to seek out measures to improve energy efficiency and read up on insulation materials and u-values. It takes time and requires capital – which might have to be borrowed from the bank.

There are also restrictive factors at industrial companies, in terms knowledge, capabilities and capital, for example. Energy efficiency improvements often require capital and therefore compete with other investments. Required return is often high at companies, and so efficiency improvement measures with a payback period exceeding two to three years are not implemented.

In large-scale production processes, making small, ongoing efficiency improvements is possible, but to make a big difference it might be necessary to replace most of the machinery. This involves production stoppages, a risk of production losses in the running-in process for new equipment, staff training and much more. Such changes are usually only made when the equipment has to be replaced anyway, and sometimes with decades in between.

In other cases, it might be one organisation that has the resourcefulness to carry out energy efficiency measures, but another that benefits from the results.

There are studies clearly showing the link between climate actions and positive health effects, which also reinforces the benefits of energy efficiency measures for society. Burning fossil fuels often generates emissions and air pollution that are harmful to health, causing illness and premature death. Globally, 3.6 million premature deaths per year can be attributed to air pollution caused by fossil fuels.[6] Reducing emissions can thus have a direct impact on human health, with reduced health-care costs as a result. This is often difficult to quantify, however, which is a reason why it is challenging to get efficiency improvements of benefit to society into place. Better ventilation in schools and workplaces can boost learning and productivity, but the effect is difficult to measure. The same applies to benefits such as reduced noise, particulate emissions and so on.

A lack of knowledge about the potential measures and their effects is also a reason why many efficiency improvements are not made. In cases where there are gains for the public economy, but insufficient incentives for the individual, the state should bridge the gap through policy instruments. Numerous energy efficiency measures fail to transpire due to market failures, and in order to free up energy for industrial conversion and improved resilience, policy instruments are needed to remedy this.

1.3. Electrification a key to reducing emissions

Around one third of Sweden's greenhouse gas emissions come from industry, one third from transport and the rest from agriculture, electricity and district heat generation, works machinery and other sources, as illustrated in Figure 33. Since 1990, there has been a substantial reduction, of 35 percent, thanks to efficiency improvements, the transition to renewable energy, expansion of district heating systems and partially halted growth in parts of industry, such as in the pulp and paper sector. Yet, emissions still amount to 46.3 million tonnes of carbon dioxide equivalents annually and much work remains to be done.

In industry, fossil fuels are used to make iron and steel, at refineries, in food production, cement production and so on. Many of these processes can be partly or fully climate-neutral through electrification, as shown in the roadmaps for fossil-free competitiveness. The Hybrit project is aimed at replacing the coke-dependent blast furnace process with direct reduction using hydrogen. The chemicals industry is on the cusp of a similar transition, and one example is Project Air, in which fossil methanol will be made fossil-free using hydrogen and biogas. Fossil-free hydrogen can be produced through electrolysis, which requires large amounts of electricity. The roadmaps for the food industry and agriculture point out that, in numerous heating processes, burning fossil fuels can be replaced by different types of electric heating, which can also contribute to the implementation of the roadmaps of many other industries within, for example, the manufacturing sector. In the sawmill, pulp and paper industry, a large volume of biofuels are burned. Through efficiency enhancements, the bio-based raw material could instead be made available to replace fossil carbon atoms in more advanced biofuels, textiles, steel products and plastics, and so on.

The transition of the transport sector is in full swing, and developments in electric cars have gone faster than most predicted a few years ago. Many heavier transports and works machinery are also expected to be electrified, as are parts of the aviation sector.

Electrification can provide jobs and opportunities for people to live and work across the entire country. Electricity instead of fossil fuels often provides a better work environment for employees, more consistent product quality and better control of processes. Electric cars reduce travel expenses and improve comfort. The climate transition is an energy transition in many respects, and greater access to sustainable electricity will be needed to secure Sweden's future welfare. Forecasts vary, but many indicate a doubling of current electricity consumption, and an increase in the power need of 40–100 percent.[7]

Energy efficiency can be seen as a climate action, even if the efficiency enhancement is within fossil-free energy, for two main reasons: The fossil-free transition of the industrial and transport sectors requires a lot of energy and, above all, a lot of electricity. This means that energy made available in one place will in practice help to phase out fossil fuels in the industrial and transport sectors. Also, electricity and energy can be exported. Fossil-free energy that is not used in Sweden can force out fossil electricity and fuels in the common European energy market and reduce climate emissions there.

1.4. Definitions, terms and limitations

Efficient use of energy

Energy is a commodity which, according to the laws

SWEDEN›S TERRITORIAL EMISSIONS 2020: 46.3 MILLION TON CO_2-EKV.

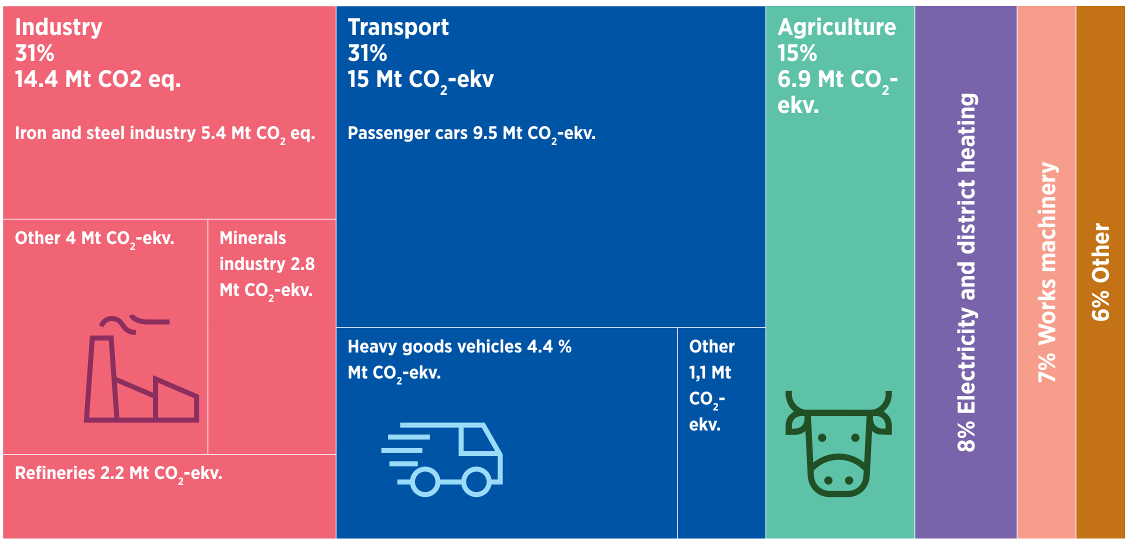


Figure 3 Breakdown of emissions in Sweden **Source:** The Swedish Environmental Protection Agency.

of physics, cannot be destroyed but only converted between different forms. The term 'energy loss' therefore refers to energy that does not have any benefit in a certain process, usually in the form of residual heat. Electricity is a high-grade form of energy that can be converted with great efficiency into other useful forms of energy, such as movement.

Efficient energy use can lead to increased energy use, for example, if production of a particular product increases even more. A production line with an output of 1,000 products per hour is often more energy-efficient per unit produced than one with an output of 10 products, but switching to the larger line will of course increase the company's energy use. In this strategy, the term 'efficiency' also includes utilisation of conversion losses, such as residual heat.

Electrification often leads to an increase in the efficiency of a process. For example, an electric engine is much more efficient than an internal combustion engine; about 90 percent of the energy is usually converted into movement in an electric engine compared with 25–35 percent in an internal combustion engine. In other words, electrification of a previously combustion-run process thus often means improved efficiency, in terms of total energy use, even if it increases electricity use.

It might also be effective to increase the whole of Sweden's energy use if this reduces the need for (fossil) energy elsewhere in the world. For example, there are plans to set up battery plants in Sweden, which could increase energy use within the country but contribute to cleaner transport systems around the world. The space and time aspect is important in this context. In the short term, there might be greater marginal benefit in exporting fossil-free electricity rather than processing it further in Sweden. However, in order to achieve a long-term transition and at the same time increase the value added of Swedish exports, batteries are needed for the fossil-free operation of the transport sector.

Energy efficiency is therefore not the same as energy savings. The complete closure of a production line gives an energy saving, but no efficiency. However, switching to more energy-efficient production equipment is both a saving and an efficiency. Switching to mass production of a product could be an efficiency if less energy is needed per unit produced, but involves increased energy use overall, rather than a saving.

Efficiency, power and flexibility

Power is defined as transmitted energy per unit of time. So, the term 'power shortfall' means that not enough electricity can be obtained during a certain period of time. Charging electric cars can provide an illustration: If all electric car owners in an area wish to charge their vehicles at the same time, it is usually the power rather than the energy that does not suffice. The capacity of electric power lines to the area does not suffice to transmit enough energy in a sufficiently short space of time. Capacity shortages in electricity grids can occur when new operations wish to connect to grid areas that are already operating at almost maximum capacity. It is often a case of occasional hours during the day or even the year when grids are at risk of overload. If a business is able to time-shift its electricity use – that is, the possibility of flexibility – power peaks can be avoided and the grid will not become overloaded.

Power shortfall thus occurs in geographically distinct areas. There may be good energy supply in the country or the area at large, yet there may nevertheless be a power shortfall in some localities.

Fact box: Energy and power

Energy is often measured in kilowatt-hours, kWh. The energy consumption of the whole of Sweden is usually measured in terawatt-hours, TWh. 1 TWh = 1,000 GWh = 1,000,000 MWh = 1,000,000,000 kWh.

Power is energy per unit of time. Power is measured in kilowatts, kW. Power is usually mentioned in relation to electricity. If an electrical appliance consumes 1 kW, after one hour of use it has consumed 1 kilowatt-hour, 1 kWh. The whole of Sweden's power need is usually measured in gigawatts, GW. 1 GW = 1,000 MW = 1,000,000 kW.

A comparison can be made with water coming out of a tap. Energy corresponds to the volume of water coming out of the tap, while power corresponds to the flow out of the tap.

Fact box: A few reference numbers

Sweden's electricity use in 2021: 140 TWh

Electricity use in an electricity-heated detached house: 20,000 kWh per year

Sweden's highest electricity power extraction in the winter of 2021/2022: 25,600 MW

(7 December 2021, 17–18).

Power, old light bulb 0.1 kW

Power, new LED light bulb: 0.016 kW

Efficient energy use is about both how much energy is used, and when and where it is used.

About the term 'potential'

There are different types of 'potential' to take into account when it comes to energy and power efficiency. Common concepts are technical potential and economic potential, but what is considered technically feasible can vary, as can the definition and calculation of economic potential. All potentials are estimates based on a number of assumptions and, depending on the definition and assumptions, different experts end up with different results.

In this strategy, aggregated assessments of potential are performed concerning the energy efficiency potential that ought to be possible, at minimum, by 2030. The estimates are based on reasonable magnitudes rather than detailed appraisals of different measures. Account has been taken of finances, technical and practical conditions and behaviour both in the areas where measures are needed and among those implementing them, and assuming that policy instruments are introduced that stimulate implementation of such measures.

When developing the strategy, the need for and development of relevant policy instruments have been prioritised ahead of exact efficiency potentials. The strategy's assessments are therefore relatively cautious. With forceful policy instruments, much greater efficiency improvements are possible.

It makes no sense to use the potentials as exact predictions, but they should be used as indicators of what is reasonable to achieve. In general, it can be ascertained that the potential for energy efficiency in Sweden is very high, and it is more important to find measures that realise the potential, than to determine the exact size of the potential.

Cost efficiency and profitability

There are different ways of calculating what a 'profitable investment' is. The calculations themselves can vary, and also the input parameters can vary between different

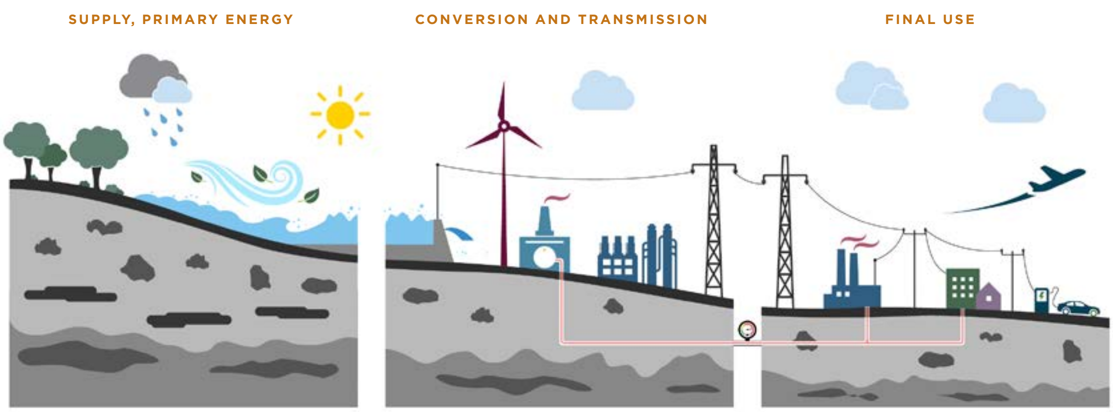
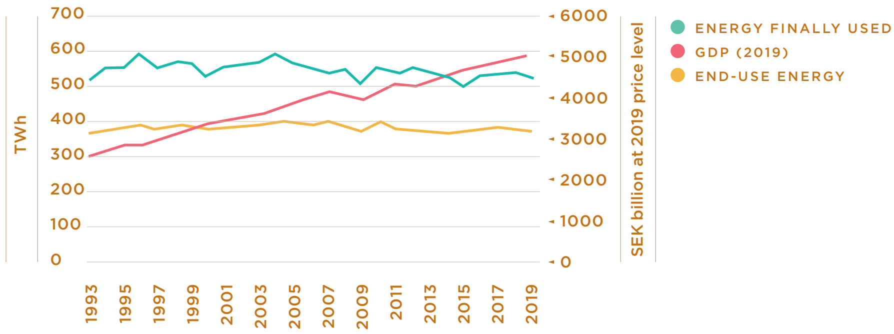


Figure 4 Schematic illustration of the energy system. **Image:** The Swedish Energy Agency.

calculations, and different actors also have varying requirements for what is profitable or not. Finally, does it matter for whom profitability is calculated – for an individual actor, or for society at large? It is therefore not possible to unequivocally define what is profitable or cost-efficient. Profitability calculations are based on the cost of a measure and its energy saving. In addition, the energy price over the coming years is estimated to convert the energy saving into money. A calculation interest rate is needed, to translate future saving into a present value. The lifetime of the measure can be significant. Many measures will also be much cheaper if they are done at the same time as others. For example, if the façade of a building has to be repaired anyway, the additional cost of extra insulation is lower than if insulation alone were done. There are frequently other benefits in a measure, which are often difficult to put a price on. For example, if the measure provides a better indoor environment for residents or employees, or improves the organisation's resilience and ability to withstand crises. At the same time, some efficiency measures, particularly in industry, may be associated with new risks, which might be difficult to price.

A measure is defined as gainful for the public economy if the benefit to society is greater than the cost to society. However, performing precise calculations to this end

GROSS INLAND ENERGY CONSUMPTION



NORMAL-YEAR-ADJUSTED ENERGY INTENSITY IN RELATION TO BASE YEARS 2005 AND 2008 IN FIXED PRICES, 1993–2020, PERCENT

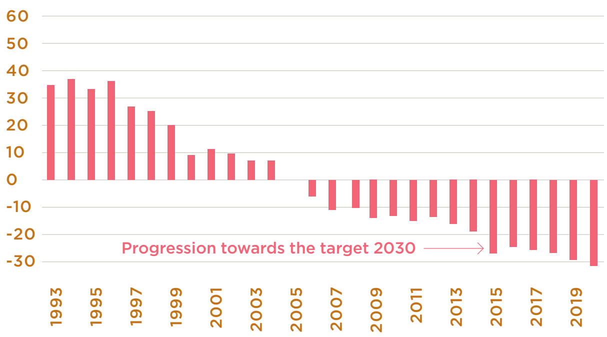


Figure 5 Sweden's energy use in relation to GDP (left) and illustration of Sweden's road towards the 2030 energy efficiency target. **Source:** The Swedish Energy Agency

quickly becomes very complex indeed, because numerous factors that must be included that are often very difficult to price, such as the value of a less vulnerable society. At the same time, it is often the society-wide perspective that is most relevant in terms of energy efficiency and, not least, in terms of flexibility measures.

Limitations of the strategy

The energy system is often divided into supply (or primary energy), conversion and transmission, and use, as in Figure 7. This strategy focuses on the efficient use of energy, and to some extent also efficient transmission.

Energy is used in all parts of society. This strategy focuses on the industrial sector as well as housing and services, which have several common denominators, both in terms of actions and actors.

The efficiency of core industrial processes is only addressed at an overarching level, since they are often unique with completely different conditions between them. Core processes should however be included when policy instruments are designed because, here too, there is tremendous potential for efficiency.

1.5. Energy efficiency targets: Sweden and the EU

The Riksdag has decided on a target for efficient energy use stipulating that Sweden shall have 50 percent more efficient energy use in 2030 than in 2005. The target is measured as energy intensity; that is, the ratio between gross inland energy consumption (GIEC) and gross domestic product (GDP).[8] The Swedish Energy Agency estimates that the target will not be reached, given that no policy instruments other than the current ones are introduced.

Figure 5 shows gross inland energy consumption, final energy consumption and GDP in Sweden since the 1990s. As shown, both gross inland energy consumption and final energy consumption have fluctuated relatively little over the years, while GDP has risen. Sweden has thus reduced its energy intensity without notably reducing its energy use. In the 2021 follow-up, which concerned 2020, Sweden had 29 percent lower energy intensity than in 2005.

There are also energy efficiency targets in the EU, adopted in the Energy Efficiency Directive.[9, 10] In the development of this strategy, negotiations are under way on new targets and directives – a raised ambition level is expected, initially in the light of increased climate ambitions. In 2022, however, there have been demands for even more stringent targets as part of the EU's independence from Russian energy. The current EU targets are measured as efficiency improvements compared with prepared energy use scenarios in 2030. The existing EU target in November 2022 is a 32.5 percent energy efficiency improvement compared with a 2030 scenario that was prepared in 2007.

The current Energy Efficiency Directive also requires each country to save 0.8 percent of its final energy consumption annually from 2021.[11] Here too, higher levels are now being negotiated; at the time of writing, the European Parliament has proposed a 2 percent annual energy efficiency improvement.

2. Power and flexibility

Sweden has historically had electricity grids with excess capacity and new incoming operations have enjoyed swift and straightforward access to electricity and power. However, for some years now, population growth and industrial growth have caused greater congestion in electricity grids. In parallel, planned improvement initiatives have been delayed, while regional and local electricity generation from both cogeneration and nuclear power in the south have been shut down. On an annual basis, Sweden generates more electricity than it uses. However, the electricity grids are not capable at all times of transmitting electricity from where it is generated to where it is needed. This has been a cause of fluctuations in the price of electricity between Sweden's four electricity price areas.

Sweden has a number of grid connections with other countries, and the electricity market is pan-Nordic with connections into Europe. Through connections with other countries, Sweden can both import and export electricity, which increases the stability of the electricity system. In recent years, electricity exports have increased sharply. In 2021 Sweden had net exports of 25 TWh[12] and net imports of electricity of 375 hours, which can be compared with the period 2007–2011, when Sweden had net imports of 2,400–5,800 hours annually.[13] The connections to other countries have also been a factor in the differences between price areas in Sweden. During the wet spring of 2020, for example, northern Sweden was flooded with inexpensive Norwegian hydroelectric power, resulting in very low prices there. In 2022, southern Sweden in particular was heavily impacted by high gas prices. Gas power is the most expensive form of electricity generation in Germany and, because of marginal pricing, gas power sets the pricing level of the entire market. With the increased price of gas, the price of electricity in Germany has therefore soared to record highs, which has also raised the price in neighbouring electricity price area 4 in southern Sweden.

With the major industrial investments announced in northern Sweden, electricity consumption looks set to rise sharply in the north. At the same time, most forecasts indicate increased electricity consumption in the south as well, from population growth, electrification in the transport sector and growth in old and new industries.

There are also problems in the local and regional electricity grids, making it difficult to supply electricity for new residential areas or industries. The causes vary; in some areas, local and regional grids have not been extended quickly enough, in some places generation capacity has been shut down, and sometimes there are bottlenecks higher up in the system.

The question of capacity and power also concerns when electricity is used. At night, electricity use is low, and peak use occurs in the morning and evening, when lots of people shower, cook, do laundry and so on at the same time. Electricity trading contracts with a floating hourly price can help to time-shift electricity use to parts of the day when usage is otherwise low, helping to attain more efficient energy use, see Figure 6. There is also a great difference in electricity use between summer and winter, which is largely due to the need for heating in winter.

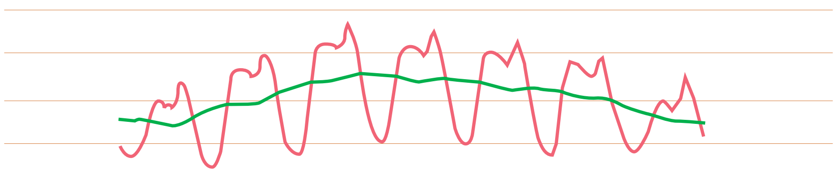


Figure 6 Electricity use in Stockholm during a week. The black line is actual use and the red line illustrates how the need might look if a certain amount of usage were moved from daytime to night. **Source:** Stockholm Exergi.

In a pilot project, Mälarenergi has been able to test an alternative tariff design with a significantly lower cost at night. This has enabled charging electric buses in a garage where there is twice as much power available at night than during the day.

New electricity grids need to be rolled out faster in parallel with measures to improve efficiency in the use of existing grids. Electricity grids need to be dimensioned to cope with peaks in electricity demand, although several grids are heavily loaded only for a very limited part of the year, usually only for a few hours at a time. By reducing the power peaks, either by completely removing power or by time-shifting it (flexibility), existing grids are used more efficiently.

In order to tackle local capacity challenges, trading venues for flexibility have been created. Examples are Switch and Sthlmflex. Here, actors can trade in flexibility at a local level to mitigate challenges for the grid owner. Such markets are a faster solution than large-scale grid expansion and have proven to work relatively well.

Göteborg Energi estimates that flexibility can cut the power peaks in Gothenburg by 100 MW (=0.1 GW), which could free up space in the grid corresponding to the need of a small municipality such as Partille or Enköping.

Variable renewable electricity generation such as solar and wind power is another driver for heightened flexibility. In order to maximise the benefits of renewable generation, operations need to improve at adapting their electricity use to available generation. Wind power already has a major impact on the price of electricity, and operations that can increase electricity use when it is windy and the price is low, and reduce it when the price is high, can save money and at the same time help to stabilise the electricity system.

Possibilities of flexibility will be crucial for efficient energy use across the whole of Sweden – to enable maximising use of existing infrastructure, keeping electricity prices down, connecting new operations swiftly and optimising use of variable electricity generation.

2.1. Measures in buildings

In practice, buildings act as large heat reservoirs; their insulation causes heat to remain in a building for some after active heating has been switched off. The better the insulation of a building, the better it serves as a heat reservoir. The same goes for buildings made from heavier heat-retaining materials. Buildings with electric heating therefore serve as flexibility resources in electricity grids. It is possible to switch off or turn down the heating when electricity consumption in society is at its highest without compromising comfort. In many buildings, the heat could be switched off during the high-load morning hours without having to turn up the heating afterwards, as sunlight penetration contributes heat. With simple equipment for smart heating system control, this can be solved automatically. Such systems are usually a relatively inexpensive investment. Both heating the building and hot water can be controlled in this way.

For larger buildings and apartment blocks, it might be worth having more extensive building automation systems, and using machine learning to control the energy use of buildings as efficiently as possible. The digitalisation of buildings offers greater opportunities to compile, analyse and act on data from a wide range of sources, which in turn enables self-learning systems that can predict the energy use of a building depending on the weather, electricity price and/or power balance in the grid. It is chiefly heating and ventilation systems that are controlled and regulated. More buildings could also be connected and controlled more collectively with respect to power balance in the area, for example. This type of digitalisation of buildings can reduce energy use and thus reduce energy costs. Also, maintenance costs can be cut by automating the monitoring of a building's functions. For example, the Sara Cultural Centre in Skellefteå can switch between energy carriers to minimise emissions and temporarily lower its electricity consumption to allow an electric bus to charge outside.[14]

Measures in individual buildings are often profitable for the property owner. If several property owners take action, the impact on the electricity system could also be appreciable. Aggregators, which are now starting to appear on the market, can gather power from several small-scale property owners and trade in it on a market, which can increase both profitability for the individual and benefit for society.

Reducing the peak power extraction of a building can have positive effects both from a systemic angle and for the property owner. Electrical equipment should therefore have low peak power as a rule. If a property owner can sufficiently reduce their overall peak power, this could open up the possibility of switching to a cheaper fuse plan with the grid owner. This also frees up power for other users in the same grid area. Especially in areas with power shortfall, a review of the power use of buildings can be of great importance. Municipalities that own their own properties or real estate companies in such areas have the resources to take actions that free up power themselves.

It is also possible for buildings to contribute to the stability of the electricity system by participating in support services markets. AMF's properties are taking part in the frequency containment reserve (FCR), which is a system at Svenska Kraftnät to ensure that electricity generation and electricity use in Sweden are constantly in balance. At critical times, the properties can reduce their electricity consumption and thus offload the electricity grid. The measure will be implemented in five buildings with a capacity of 1.5 MW.[15]

Flexibility potential in buildings

Numerous factors affect flexibility potential, which varies during the year and day. The potential in buildings is greater in the winter when heating is greatest. Different loads can be moved or reduced for different periods of time; heating can often be reduced for periods of around several hours (longer for heavy and well-insulated buildings). Some flexibility can cause new peaks at other times, for example if all heat pumps react in the same way and start operating simultaneously but at a different time. Also, if a building has been cooled too much, total electricity consumption might increase if substantial reheating is needed. Assessing realistic flexibility potential for heating in buildings is thus complex, and the research basis is incomplete as few studies have been conducted.

The certification company DNV has, on behalf of the Swedish Energy Markets Inspectorate (SEMI),[16] calculated the technical potential for houses at 7 GW in winter, which is a sizeable part of Sweden's maximum peak power in winter, which usually ranges from 23 to 27 GW. DNV's figure is based on all electricity-heated houses completely turning off their heating at the same time. This is hardly realistic, and other studies rather indicate 1–2 GW[17] as the flexibility potential of household heating.

The flexibility potential in the services sector is given in DNV's and SEMI's report at 0.5–1.7 GW, with account taken of heating and ventilation. The flexibility potential for operational electricity in premises is largely uninvestigated.

2.2. Managing power in relation to district heating

For district heating too, there are high-load hours, and fossil auxiliary back-up heating is often fired when there is a shortfall in regular capacity. Power control that reduces the need for auxiliary back-up heating has an immediate emissions-curbing effect.

Heat reservoirs could reduce or eliminate the need for auxiliary back-up heating. For this reason, Mälarenergi is converting a former emergency oil reservoir into a hot water reservoir. This also enables increased electricity generation. Otherwise, at cogeneration plants, electricity generation often takes a back seat to heat production on the coldest days of the year, despite this being when electrical power is needed most. The rock chamber can store the equivalent of 13 GWh of hot water, which suffices to supply district heating to Vasterås and nearby localities for two to four weeks depending on outdoor temperature.

A preliminary study has been conducted within residential property owners' network BeBo, on heat output in apartment blocks.[18] A conclusion is that the area is quite undeveloped. Only one of the participating property owners had implemented power management measures for heat, and had reduced their power extraction by 20–30 percent and total energy use by 0–3 percent.

2.3. Measures in industry

Industry is a broad and heterogeneous group when it comes to flexibility measures. Some are already participating in flexibility measures today, not least the pulp and paper industry. Mechanical pulp mills are often able to change when in time they manufacture pulp, and the pulp can be stored for a period of time (occasional hours), freeing up flexibility potential.

Holmen's sawmill at Braviken is adapted for flexible electricity consumption.[19] The plant is taking part in the frequency containment reserve (FCR), which is a system at Svenska Kraftnät to ensure that electricity generation and electricity use in Sweden are constantly in balance. By switching off electricity consumption in the drying process in return for remuneration, the sawmill can reduce the load on the grid when needed.

In the ironworks industry, twin power induction furnaces present opportunities for flexibility, with one furnace smelting and the other one holding the material. This enables running the electricity-intensive smelting process mainly at times when electricity prices are lower.[20] These opportunities are not necessarily suitable for all operations, as there may be risks and challenges in implementation. There is also flexibility potential in the cement industry, server rooms and many other industries.

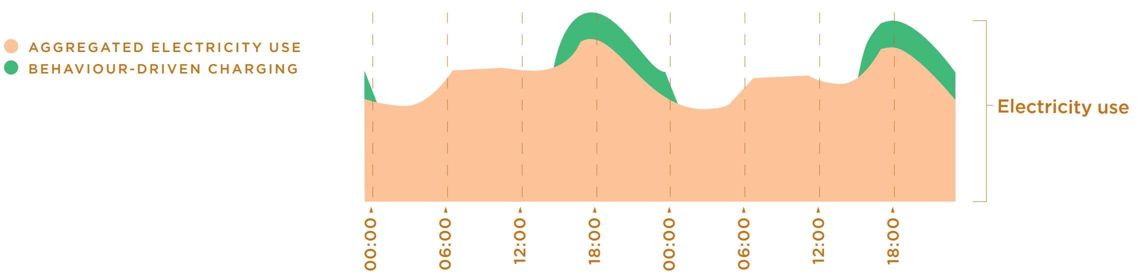
Other industries are more dependent on a steady supply of electricity and the steel industry for example has greater difficulty in adapting its current processes to a varying electricity supply.

Industries can also participate in local flexibility markets, or engage an aggregator to manage their flexibility. These measures are rarely done today and many are not even aware that the possibility exists.

When there is an extensive transition to hydrogen, flexibility resources could increase sharply. Hydrogen production through electrolysis can be better adapted to electricity supply, provided there is sufficient storage capacity for the gas. DNV estimates that Hybrit will give flexibility potential of 0.3–1.2 GW by 2045. Current flexibility potential in the industrial sector in Sweden is estimated at around 1.3 GW,[21] but further research and development is needed, not least in the field of hydrogen.

2.4. Charging electric vehicles

Today's electric cars already have a battery capacity that can store as much electricity as the whole of Sweden uses in 45 minutes.[22] According to a forecast from Power Circle, the number of chargeable passenger cars could reach 2.5 million by 2030.[23] More and more heavy transport vehicles are also running on electricity. While this shift significantly reduces emissions, it also increases the power need with the risk of intensifying power peaks in the evening. With smart charging, prima-



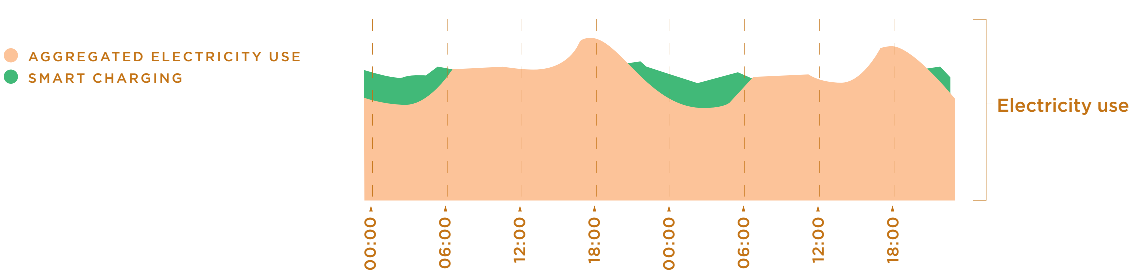


Figure 7 Schematic illustration of how electric car charging can intensify or level out power peaks. The grey field shows power use without electric car charging. The yellow fields are the charging. In the upper picture, cars are charged when people arrive home from work, which intensifies the afternoon peak. In the lower picture, cars are instead charged when power use is lowest, which levels out total power use. **Source:** Sweco

rily at night, power peaks can be levelled out, as illustrated schematically in Figure 7.

SWECO has estimated how growth in electric cars in Sweden could affect the electricity and power need up to 2045[24]. The study shows that, in the event of rapid growth in electric cars, evening peak loads could increase by 2 GW by 2030 and almost 6 GW by 2045, if nothing is done to steer charging. Smart charging can halve the new power peaks.

So far, electric cars are few in number and the Swedish Energy Markets Inspectorate estimates current technical flexibility potential at only 0.02 GW.[21]

The average passenger car is stationary for around 95 percent of the time.[25] The capacity of electric car batteries thus presents tremendous potential to charge electricity back to the grid (known as vehicle-to-grid – V2G) or to provide other support services.

At present, few electric cars and electric car chargers support V2G, but studies and trials are under way, indicating that electric car batteries will have an important role as suppliers of energy and other grid support services. NEPP estimates that, with 3.8 million passenger cars (60 percent of the passenger car fleet), there is battery capacity of 14–114 GW.[26] The high figure is four times greater than the peak wintertime power need for the whole of Sweden. Even if only a small proportion of this capacity were available at any given moment, there is tremendous potential to support the grid.

DNV has estimated flexibility potential for electric car charging in 2045 at 3–4 GW in a scenario with a high proportion of electric cars.[16] This includes both the vehicle charging its battery, and it charging back to the grid (V2G).

2.5. Assessment of potential for flexibility

The strategy's assessment is flexibility potential of at least 3.5 GW by 2030.

The assessment of flexibility potential should be seen in light of the incomplete basis of research. It is estimated that the potential is 1.5 GW for households, 1 GW for industry and 0.5 GW for services. Combined actual potential is not necessarily equal to the sum of these, partly because the peaks of households and industry do not coincide and the potentials are not available at all times of the day.

Most of the potential can be freed up rapidly through behavioural changes and smart control of equipment. The European Commission has issued a package to help Member States reduce their electricity consumption by 5 percent during peak load hours. During the highest peak load hour in the winter of 2021/2022, this would mean a reduction of 1.3 GW. A relatively large proportion of available flexibility resources would thus need to be utilised to achieve this. During most hours of the year, the peak load is much lower.

Drawing on lessons learned from other technological shifts and the current direction set by the EU, it is reasonable to assume relatively rapid growth in electric cars and also V2G. Electric cars could therefore account for significant flexibility potential of 0.5 GW by 2030.

On the whole, this strategy's assessment of flexibility potential by 2030 is 3.5 GW. In order to truly harness the potential, clear incentives and greater knowledge are needed.

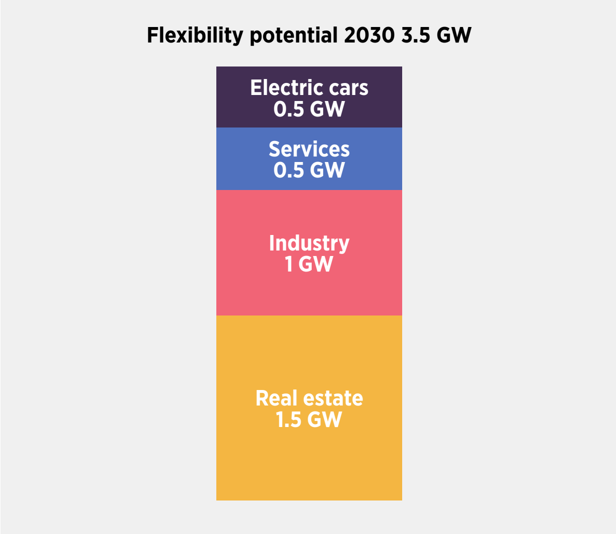


Figure 8 Flexibility potential by 2030 according to the assessment of this strategy.

3. Energy use in the housing and services sector

There are 4.8 million households in Sweden.[27] More than half of Sweden's 10.5 million inhabitants live in individual houses, and 43 percent in apartment blocks. Others live in special residences, such as retirement homes. The housing and services sector accounts for around 40 percent of Sweden's total energy use and about half of its electricity use. Besides housing, the sector also includes public-sector operations, other service operations, agriculture, forestry, fisheries and construction operations, and their respective energy use is shown in Figure 9. Greenhouse gas emissions from heating homes and premises have fallen considerably in the past 30 years, from 9.3 million tonnes of CO_2 equivalents in 1990 to 0.6 million tonnes in 2021[3]. This is largely due to a reduction in the use of oil-fired boilers.

Figure 9 shows the breakdown of energy carriers in the housing and services sector. Petroleum products are chiefly used for works machinery within agriculture and forestry as well as fisheries and construction, but also for heating buildings to a limited extent. 23,000 houses in Sweden still have oil-fired boilers as their main form of heating.[28]

Total electricity consumption in the housing and services sector has been relatively constant since 1990, as shown in Figure 1012. Electricity use for heating has decreased somewhat since the peak in the mid-1980s, thanks to the expansion of district heating networks and the introduction of heat pumps. Use of household electricity has increased due to population growth and a

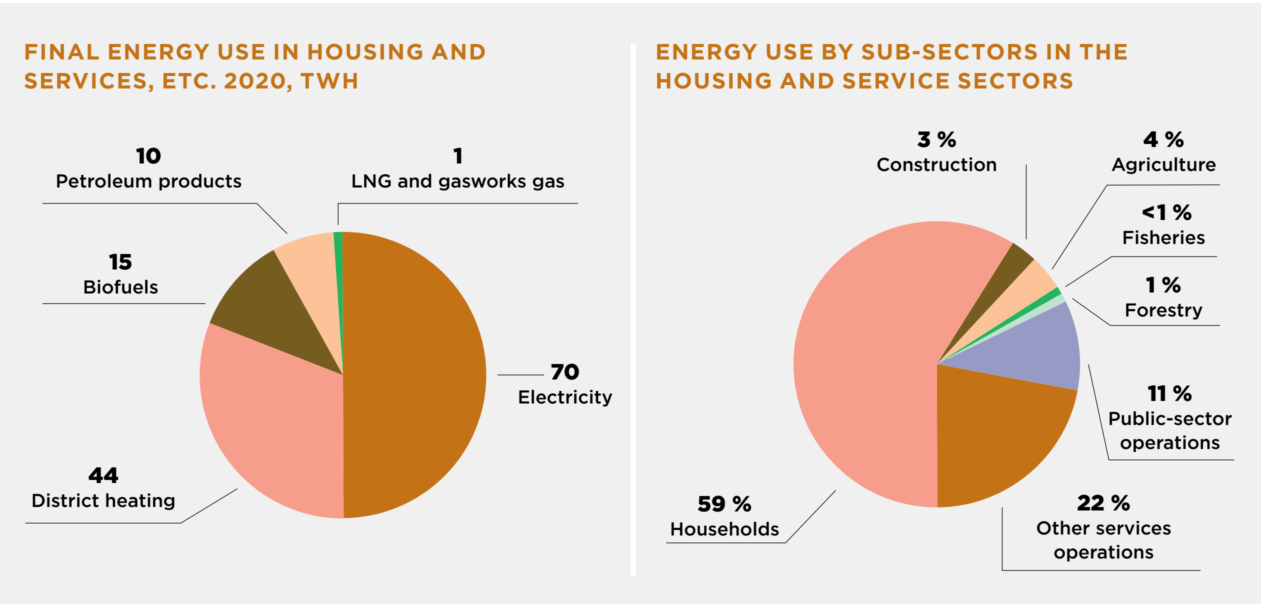


Figure 9 Final energy use in housing and services 2019, and breakdown between different sub-sectors.

Source: The Swedish Energy Agency

greater number of electrical appliances in homes. Operational electricity is a mixture of property electricity (fixed installations in buildings such as lifts, ventilation, etc.) and the electricity that is used in premises, and this has increased due to growth and expansion of the surface area of premises.

Newly built houses generally have a good energy performance, and well-insulated houses that are equipped with solar panels or solar heat systems can even serve as excess energy units and deliver more energy than they use on an annual basis. However, newly built houses only account for a slight proportion of the housing stock. The vast majority of buildings are older. Figure 11 shows the breakdown of Swedish buildings based on energy classes, where A has the best energy performance and

ELECTRICITY USE IN HOUSING AND SERVICES, ETC. FROM 1970, TWH

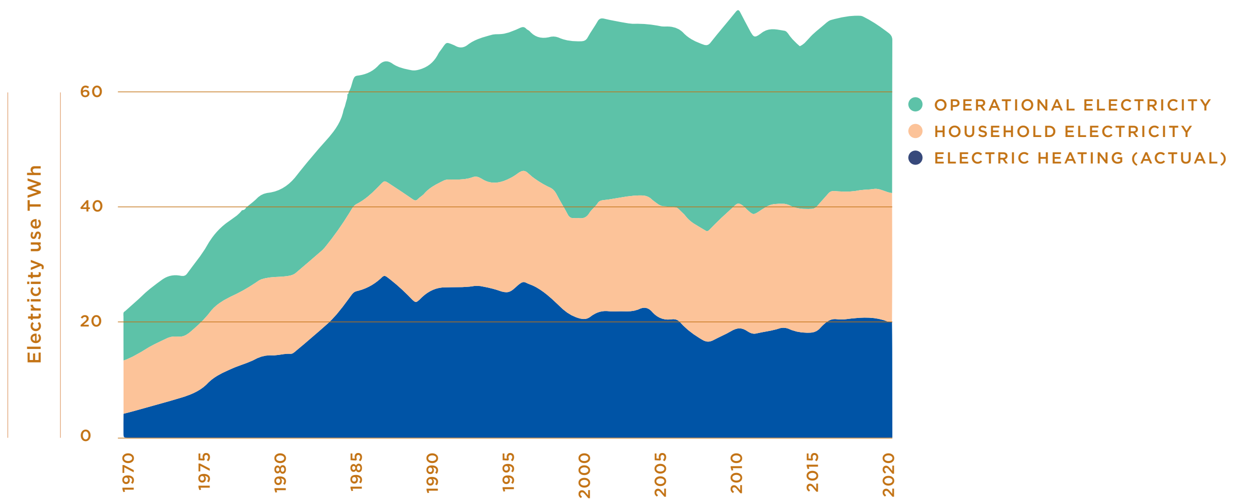


Figure 10 Electricity use in the housing and services sector over time. **Source:** The Swedish Energy Agency

ENERGY CLASS BREAKDOWN FOR INDIVIDUAL HOUSES, APARTMENT BLOCKS AND PREMISES. SWEDISH REQUIREMENTS FOR NEWBUILDS AND REQUIREMENTS FOR NEAR-ZERO ENERGY BUILDINGS ARE CLASS C.

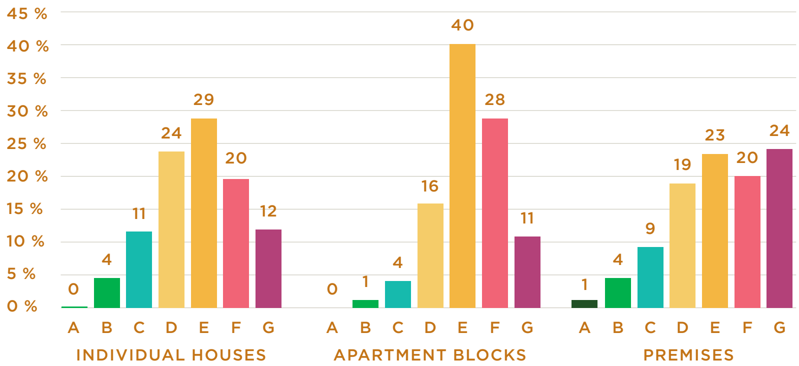


Figure 11 Energy class breakdown. As an energy declaration is only needed when houses are sold, much of the stock lacks an energy declaration. For apartment blocks and premises too, there are a number of buildings that lack declarations. **Source:** The Swedish National Board of Housing, Building and Planning and the Swedish Energy Agency.

G the worst. New buildings must have class C or better. Class A buildings have an energy performance that is 50 percent better than that of C buildings, and the worst class G buildings have an energy performance that is 235 percent that of a C building.

3.1. Comment on different forms of heating

In Sweden's cold climate, heating and hot water represent more than half of energy use in the housing and services sector, and amounted to 74 TWh in 2020[12]. The most common forms of heating for homes and premises are district heating or different types of electric heating, see Figure 12.

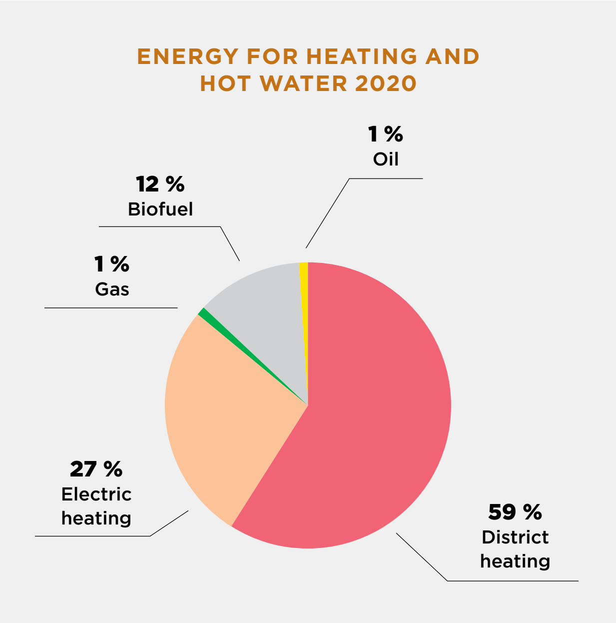


Figure 12 Energy for heating and hot water by energy type. **Source:** The Swedish Energy Agency

District heating is usually produced by the combustion of bio-based residual products or waste, some of which have fossil origin. A small proportion of district heating is recovered from other activities. In 2021 the share of coal, oil and fossil gas in district heating was 2.2 percent.[29]

District heating systems are local and pay off in densely populated areas. Since the deregulation of energy markets in the 1990s, there has been free price formation for district heating, and prices vary according to local conditions.

At cogeneration plants, both heat and electricity are produced. As a rule, the boilers are dimensioned according to the heat need and electricity generation is seen as a secondary product. Within certain limits, it is possible to control the degree of heat, or electricity, a cogeneration plant produces at any given time. When demand for heat peaks, heat production is often maximised, resulting in a reduced exchange of electricity at the very time when electricity is needed most. For much of the 2010s, electricity prices were so low that building cogeneration plants was not considered viable; rather, investments in pure boilers were made instead. Local cogeneration of heat and electricity has also been shut down in many places, which has contributed to a power shortfall in some towns. In Sweden there are about 500 district heating systems, but only around 100 of these have combined heat and power production.[30] Burning fuel without simultaneously converting part of the heat to high-grade electricity is not optimal from an energy system angle.

A district heating system with cogeneration, heat pumps, electric boilers and heat reservoirs can add considerable flexibility to the electricity system.[31] By producing more heat in heat pumps and/or electric boilers, more electricity can be consumed when, for example, there is overproduction from wind power. Conversely, heat reservoirs can be used to enable continuing electricity generation at the cogeneration plant even when the heat need is higher. Dimensioning district heating systems based on maximum capacity to provide the electricity system with flexibility could have a considerable impact at the national level. For example, cogeneration could give three times the capacity for electricity generation in the peak load hour compared with currently, and twice the electricity generation on an annual basis. However, it is important that this does not lead to increased fossil back-up production or adverse effects on the local heating system and related buildings. The Swedish Energy Agency has been commissioned with identifying measures to promote the contribution of district heating and cogeneration to electricity supply, particularly during periods when the electricity system is under the greatest strain. The report of the commission will be presented in December 2023.

Projects are under way in many parts of Sweden with low-temperature district heating. Lower temperatures mean lower losses and also residual heat from more sources can be reused.

Electric heating can be direct-acting, whereby a certain energy amount of electricity is converted into the same energy amount of heat, directly in electric radiators or through a waterborne system. Heat pumps also count as electric heating; they use the heat that is naturally present in the air, ground or water and, using a small amount of electricity, upgrade the heat to the desired temperature. That way, heat energy equalling three to four times more than the electricity supplied is obtained. Heat pumps have lower efficiency the greater the difference between the desired temperature and the temperature of the ground/water/air from which the heat is extracted. Air-to-air and air-to-water heat pumps extract a particularly large amount of electricity at very cold outdoor temperatures and a few older versions completely switch over to direct-acting electricity in such conditions. Newer heat pumps are still around twice as good as direct-acting electricity at an outdoor temperature of -15 degrees. Geothermal and ground source heat pumps are not affected as much by outdoor temperature as the ground temperature changes significantly less and more slowly than the air temperature.

Other forms of heating include pellets-fired stoves and boilers, as well as oil-fired and gas boilers.

3.2. Apartment blocks

In 2019, apartment blocks used around 26 TWh for heating and hot water, of which district heating represented over 90 percent. Apartment blocks are 27 percent owned by the public housing sector, 41 percent by tenant-owner associations and 32 percent by other private owners.[32]

70 percent of apartment blocks in Sweden could halve their energy use, according to the Third National Strategy for Energy Efficient Renovation.[32] The Swedish National Board of Housing, Building and Planning estimates that only 15–25 percent of buildings constructed before 1981 have been renovated despite extensive needs. Only 2.3 percent of the surface area of apartment blocks has been renovated annually in the past ten years.[33] During the course of renovations, energy efficiency improvements are also usually made. However, the rules on rent-setting, with the 'utility value principle', give property owners strong incentives to prioritise measures that improve standards, since this enables rent increases.

Research shows that most buildings that are renovated

INVESTMENT/ENERGY SAVING

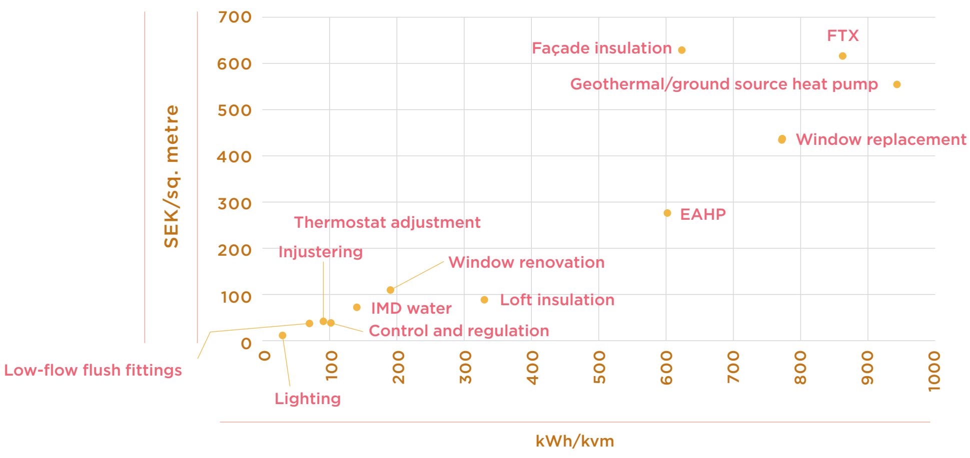


Figure 13 Investment cost in relation to saving for a number of energy efficiency measures in apartment blocks. The figure is from 2017 and prices prevailing at the time or before. The energy saving is calculated based on the building's new energy performance, which means that it includes adjustment factors for different energy carriers.
Source: BeBo

only move up one or two energy classes. Also, there is a correlation between income and energy class, with a higher income level among those living in homes with a better energy class, with poorer energy classes among those with a lower income level.[34]

Measures in apartment blocks

Within residential property owners' network BeBo, the 'Halve more' initiative has shown that 70 percent of participating properties could halve their energy use through cost-effective measures; for one property, use was cut by as much as 85 percent.[35]

Figure 13 shows energy efficiency measures for apartment blocks based on cost and energy saving. The figures are, however, from 2017 or earlier.

Sweden has a major renovation debt. 70 percent of apartment blocks could halve their energy use through cost-effective measures. Each area from the 'Million Programme' public housing initiative of the 1960s–70s could thus supply energy to one more area of equal size.

Ventilation is a major drain on energy in numerous buildings and heating equalling 9 TWh (including houses) is ventilated out of buildings annually.[36] Switching to ventilation systems with heat recovery is an expensive measure but can save a lot of energy, around 6.5 TWh annually according to preliminary data for the White Certificates Inquiry.[37] Correcting the balancing of existing ventilation systems could save 1 TWh/year. Ventilation systems should always be connected to an efficient control system and preferably sensors for measuring current air quality, so that the ventilation system only runs when necessary.

Window and façade procedures can be relatively expensive but effective on the right building. In older buildings, implementing energy efficiency measures without destroying cultural values can be a challenge, but many measures are nevertheless feasible.[38]

As slight a detail as replacing thermostatic valves, which control flows in radiators, and setting them correctly, can save 2.7 TWh annually.[37] More efficient taps and nozzles also have high profitability potential as they can save a lot of hot water – 1.3 TWh.

As previously noted, all profitability calculations must be assessed on the basis of the different conditions of the properties. Also, there may be aspects to consider other than energy use during the operational phase alone – such as materials processing, environmental impact and energy consumption for the manufacture and assembly of the materials used in the renovation.

ENERGY EFFICIENCY MEASURES WITH THE GREATEST POTENTIAL IN APARTMENT BLOCKS

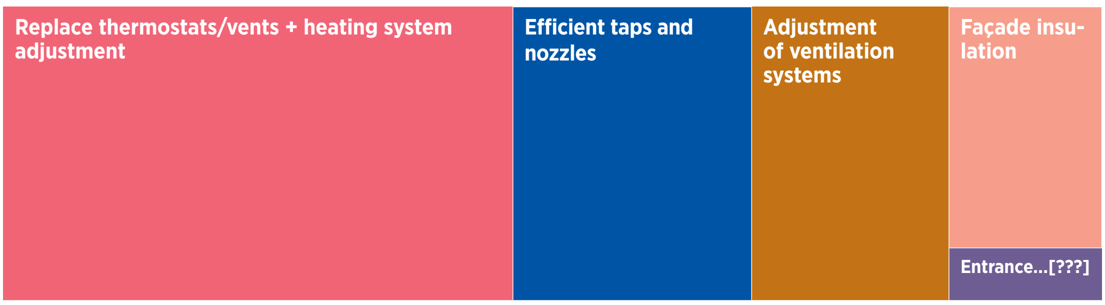


Figure 14 The figure shows the approximate breakdown of energy efficiency potential in apartment blocks by measure, for the measures with the greatest potential. **Source:** Preliminary data for the White Certificates Inquiry.

* In the data, measures have been considered profitable if the gain on the saving over the lifetime of the measure exceeds the investment cost, using an 8 percent calculation interest rate and energy costs for 2021.

Assessment of potential for apartment blocks

The strategy's assessment is that energy efficiency potential by 2030 for apartment blocks is at least 8 TWh, 7.5 TWh of which consists of district heating and 0.5 TWh of electricity

For apartment blocks, the preliminary data for the White Certificates Inquiry indicates profitable* saving potential of just over 6 TWh by 2030. No household electricity is included in this figure. In view of the renovation debt in Sweden's apartment blocks, the potential can be viewed in other ways. The Third National Strategy for Energy Efficient Renovation finds that 70 percent could halve their energy use through profitable measures. If 70 percent of apartment blocks constructed during 1941–1980 halved their energy use, this would save almost 12 TWh. The overall assessment made in this strategy is that the apartment blocks could free up around 8 TWh. Swedish apartment blocks are 90 percent heated with district heating, and it is thus assumed that 7.5 TWh of the potential consists of district heating savings. It is also assumed that 0.5 TWh of electricity could be freed up, which is both property electricity and household electricity, as well as some electricity for heating.

3.3. Houses

There are just over two million houses used as homes in Sweden, and they represent around 41 TWh, or 12 percent, of energy use28. For household electricity, around 9.5 TWh is used, and electricity for heating is approximately 16 TWh. In total, houses use 25.5 TWh of electricity, which is almost one fifth of Sweden's total electricity use. Oil-heated houses have accounted for quite some emissions in the past, and today there are still around 23,000 houses that are mainly heated with oil. This figure has remained stable since 2016.

Electricity is the largest single energy carrier for heating in houses, see Figure 15. Out of households heated by electricity, 1,215,000 houses have some kind of heat pump and 173,000 houses are heated by direct-acting electric heating**. Assuming that an electricity-heated detached house uses 20,000 kWh for heating a year, electricity use from houses with direct-acting electricity will be 3.5 TWh annually***.

Measures in houses

It would be technically feasible to make virtually all houses net-zero energy buildings on an annual basis, if they

ENERGY USE FOR HEATING AND HOT WATER IN INDIVIDUAL HOUSES, FROM 1983, TWH

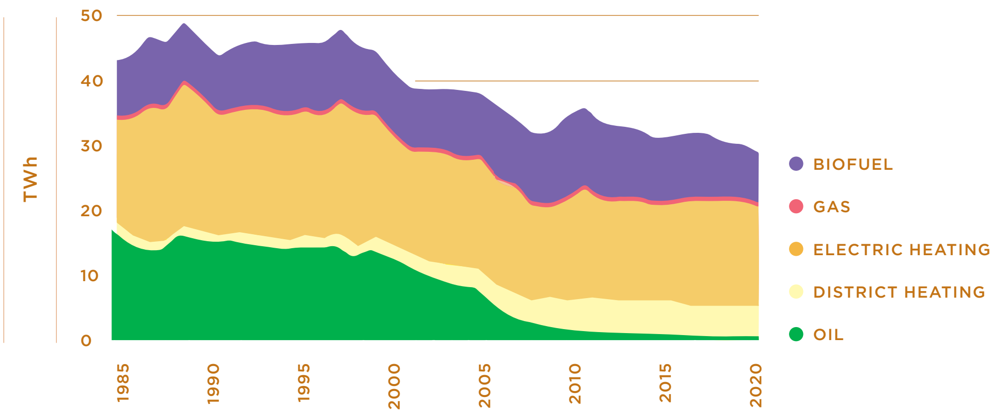


Figure 15 Energy use for heating in houses. "Free" heat supplied by heat pumps is not included in the diagram.
Source: The Swedish Energy Agency

** By 'direct-acting electricity' we mean here 'electric heating without a heat pump', which is what is used in everyday terms. This includes both direct-to-air electric heating, and waterborne electric heating. In the statistics on houses, these are usually divided into two groups.
*** This is a rough calculation. The energy statistics currently bundle together electricity use from direct-acting electricity with heat pumps.

ESTIMATED INVESTMENT COSTS PER SAVED KWH FOR CERTAIN TECHNICAL ELECTRICITY EFFICIENCY MEASURES IN TWO HOUSES

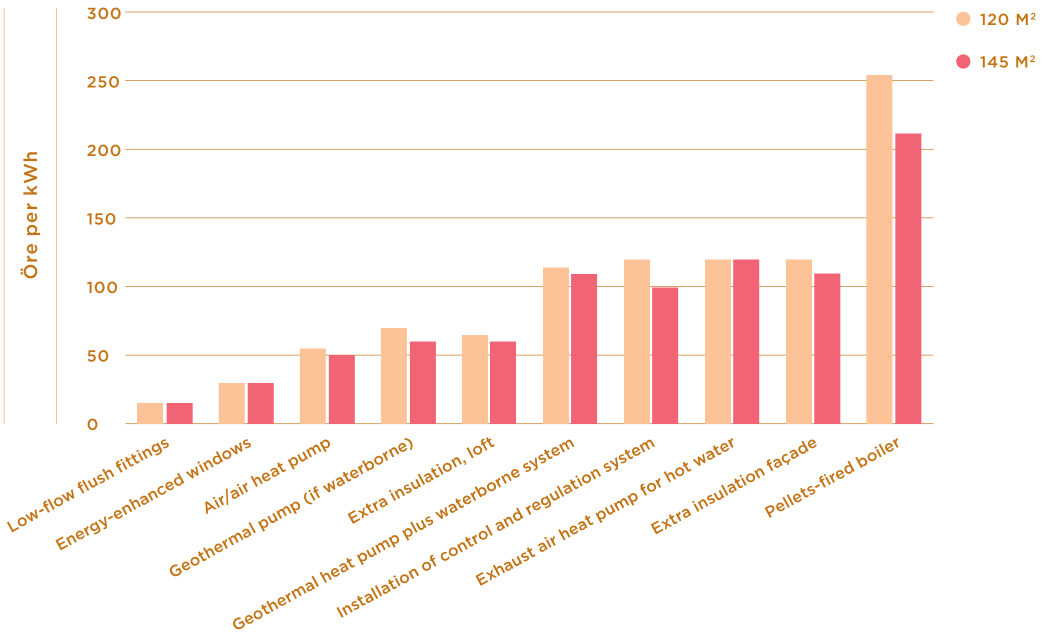


Figure 16 Estimated investment costs per kWh saved for certain electricity efficiency measures in two types of houses. **Source:** Swedish government official reports SOU 2018:76.

ENERGY EFFICIENCY MEASURES WITH THE GREATEST POTENTIAL IN INDIVIDUAL HOUSES

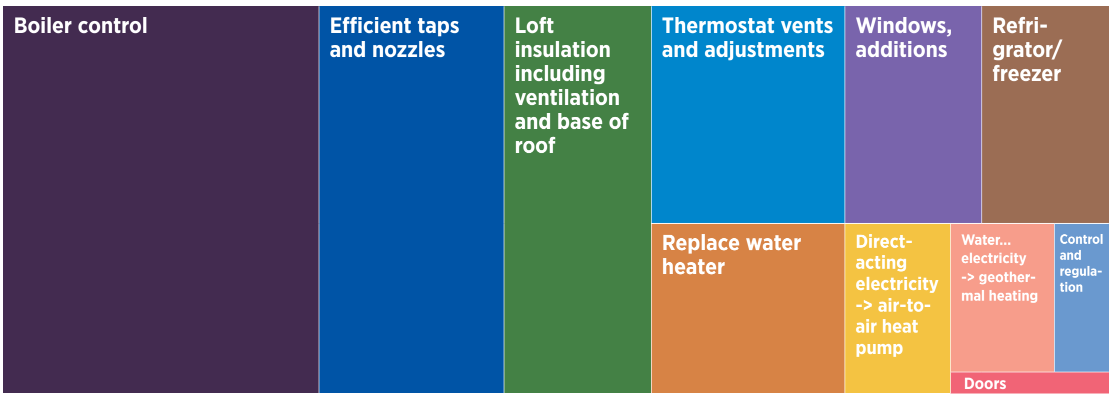


Figure 17 The figure shows the approximate distribution of energy efficiency potential in houses from various measures. **Source:** Preliminary data for the White Certificates Inquiry.

made energy efficiency improvements and installed solar panels and/or solar heating systems.[39] An example of profitable efficiency potential from the data for the White Certificates Inquiry adds up to 15 TWh, all of which is electricity.[37] Since studies show that many houses do not meet standard ventilation requirements, the data includes an upgrade of the ventilation systems of houses, which is assumed to increase electricity use by 5 TWh. As with apartment blocks, there is tremendous potential in heating system control, over 3 TWh in total. Efficient water taps and nozzles also have considerable potential – 1.6 TWh.

Virtually anyone who uses direct-acting electricity can save power, energy and money on replacing heating systems. Houses that already have a waterborne heating system can cost-effectively switch to a geothermal heat pump, and for the few houses that are within district heating networks this is an option. Installing new waterborne heating systems in existing houses would be beneficial from an energy system angle, but is rarely profitable for the individual homeowner. In that case, air-to-air heat pumps are more cost-efficient.

Assessment of potential for houses

The strategy's assessment is that the energy efficiency potential by 2030 for houses is at least 8 TWh of electricity.

Sweden's houses present tremendous energy efficiency potential. In the preliminary data for the White Certificates Inquiry, it is assessed that there is profitable efficiency potential of 15 TWh by 2030.[37] BeSmå finds in a "reasonable implementation" scenario that the potential by 2030 is 11.6 TWh (starting from 2016). The different results are due to varying assumptions about electricity prices, calculation interest rates and so on, and possible implementation rate.

At current electricity price levels, it might be reasonable to assume that more measures will be implemented than before, while future developments are highly uncertain with reduced margins for many households, thus affecting their ability to invest in profitable efficiency improvements. This strategy therefore makes a relatively cautious assessment of the efficiency potential in houses, at around 8 TWh of electricity by 2030, which is on average approximately 3,800 kWh per house.

3.4. Premises and services

Premises span everything from offices, service premises such as hairdressers and shops, and public premises such as swimming pools and schools. In premises, 19.5 TWh was used for heating and hot water in 2020.[12] District heating represented 77 percent of this energy, electric heating including heat pumps represented 17 percent, biofuels 2 percent and oil and gas combined approximately 3 percent.

Incentives for energy efficiency improvements in premises sometimes fail because it is the property owner who is responsible for the building, while the business operator controls and pays for the energy. This is a reason why the energy classification for buildings containing premises is generally poorer than for residential buildings. At the same time, pressure from tenants on property owners appears to be on the rise. Companies that measure and report their energy usage and emissions need to know and be able to control their energy usage, prompting them to place demands on the property owner. The saving potential for premises is considerable, but the basis of data is deficient. Premises encompass many different types of buildings and operations, which also makes it more difficult to generalise solutions.

The energy saving potential for offices has been estimated at 0.5 TWh.[37] Here it is mainly ventilation control that presents major potential, and also optimised cooling to some extent. Other measures such as upgrading ventilation systems, windows and lighting could generate savings but it is more difficult to attain profitability for such measures.

Schools have significant potential for efficiency improvements that can also improve the teaching and working environment for pupils and teachers. The preliminary data for the White Certificates Investigation gives profitable efficiency potential of nearly 1 TWh by 2030. Most schools in Sweden are owned by municipalities, so there are also direct public resources to renovate them. Within trade, there is saving potential of at least 1 TWh.

A concrete example is doors on refrigerated display cabinets in supermarkets.[40] The doors have halved the cooling need in just ten years, and such doors have become the industry standard. The previous concern among store operators about the doors causing reduced sales could be addressed through studies of customer experience, behaviour and comfort. The doors also allow for new measures in a long chain, which could in total save more than 75 percent of food-cooling energy. Other measures in the trade sector concern ventilation, district heating measures and lighting.

The statistics on the service sector also include agriculture, forestry, fisheries and construction, which represent just shy of 9 percent of energy use in the sector, see Figure 9. Due to lack of data, no efficiency potential estimates are made for these sectors.

Assessment of potential for premises and services

The strategy's assessment is that energy efficiency potential by 2030 for premises and services is at least 3 TWh, of which just over 2 TWh consists of district heating and just under 1 TWh electricity.

Knowledge of energy use and efficiency potentials for premises and services is incomplete. For some premises types – mainly schools, offices and commercial premises – there are estimates that indicate potential of 2.5 TWh by 2030. Potential for office premises is estimated at 0.5 TWh.[37] The European Commission estimates potential at 4.7 TWh for the entire premises and services sector. Premises generally have a relatively low energy class, see Figure 11, which underpins assumptions concerning high efficiency potential.

Despite considerable uncertainties, the overall assessment is that efficiency improvements equalling at least 3 TWh by 2030 are feasible. Premises are largely heated by district heating, so almost three-quarters of the potential is assumed to be found there. There are also efficiency improvements to be made within operational electricity, and a small proportion relates to other energy carriers.

3.5. Energy communities

Energy communities are about sharing energy between operations located closely to each other in order to create environmental benefits and empower the position of consumers. In its simplest form, it could be a solar-powered building that shares any electricity surplus with its neighbours. More complex communities for instance can control energy use across multiple operations, so that they never collectively exceed a certain peak power level, which can reduce load on the grid. It is possible to share residual heat or jointly use storage facilities. In some cases, it has been shown that energy communities have been able to save 30 percent of energy among participants and halve the power need.[41] However, the extent to which this figure can be generalised is uncertain.

Since the turn of 2021/2022, electricity sharing between adjacent buildings has been permitted, which facilitates the formation of energy communities. However, the changes have been criticised for not being sufficiently far-reaching.[42]

3.6. Measurement and control

Digitalisation, coupled with the development of inexpensive and small sensors as well as artificial intelligence (AI), provides new opportunities for smart and advanced control of energy use in properties. However, many properties can save energy with relatively simple control measures, such as ensuring that cooling and heating systems are not running at the same time.

A study of a number of district heating plants showed that three-quarters of the plants had incorrect settings, leading to unnecessarily high energy use.[43] Lighting and ventilation should also be controlled, for optimal performance in combination with sensors that enable adaptation to the actual situation.

Adequate measurement combined with self-learning systems (machine learning) can save energy and improve indoor climate a notch. An example can be found in Eslöv, where AI and smart control of the municipal company's homes will enable shutting down the auxiliary back-up boiler in the district heating system.[44]

Energy use is currently measured per (heated) square metre. An additional measure could be to look at energy usage per person using a building. This could provide new insights into efficient use of buildings. Occupancy sensors can be used to measure how effectively spaces are used as a basis for space optimisation and sometimes also to avoid or reduce new construction.

3.7. Cooling

Comfort cooling consumes a great deal of electricity in warmer parts of the world, but is still a small area in Sweden. Today, the cooling requirement is estimated at 5–7 TWh. An increase of 1.3 TWh is forecast for the next few decades,[45] driven mainly by climate change.

For numerous premises, cooling needs can be reduced by harnessing residual heat produced in server rooms or by other equipment. It should also be evaluated which cooling is actually desirable. Some buildings are so cool in summer that workers complain about the cold.

4. Energy use in the industrial sector

Industry represents almost 40 percent of Sweden's energy use, a good third of electricity use, and causes a third of greenhouse gas emissions. Energy efficiency in operations with fossil energy use has a direct impact on emissions. However, energy efficiency in other parts of industry is also important, as it frees up energy for other users. Modern solutions can also contribute to a better working environment, higher production and more consistent quality for many products.

Industrial operations are not as homogeneous as the housing sector, which means that statistics, compilations of knowledge, good examples, requirements, product tests and so on do not exist to the same extent or quality. Different industrial sectors have different points of departure and conditions.

A report from the European Commission[1, 46] shows considerable energy efficiency potential in Swedish industry, see Table 1. The results are based on prices prior to Russia's invasion of Ukraine. The report shows that just over a fifth of energy consumption – almost 31 TWh – in industry is both technically and economically feasible to free up. The estimate includes continued growth but not new industries.

	2019 Energy use (TWh)	2030 "Business as usual" forecast, energy use (TWh)	Technical saving potential 2030 (TWh/year)	% of BAU	Economic saving potential 2030 (TWh/year)	% of BAU
Industry	142	144	31,7	22	30,7	21

Tabell 1 1 Energy saving potential in industry in Sweden. **Source:** European Commission.

According to the report, process heat represents the single largest potential, see Figure 19. Within process heat, one third of the potential is steering and control systems, and other measures include recovery of residual heat, preventive maintenance and insulation. The second largest potential is related to machinery operation, such as more efficient motors, ventilation systems and speed control. However, there is much to indicate that

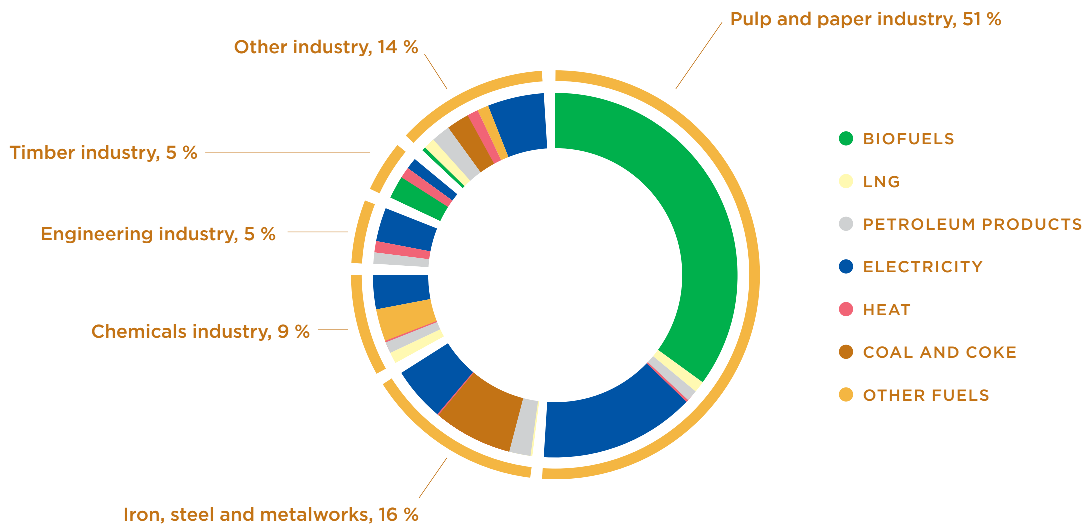


Figure 18 Energy use in industry in 2018, broken down by sector and by energy carrier. **Source:** The Swedish Energy Agency

the greatest potential is released when there is optimisation in a broader systemic perspective, see Chapter 4.1.

4.1. Improving efficiency at different levels

Efficiency improvements in industry can be described based on a hierarchy of increasingly complex systems, in which efficiency improvements can be made at each level, but the greatest effect is achieved if account is taken of the highest systemic level.[47] Some examples are provided below. At the lowest level there are individual components, such as electric motors. These components are often covered by the EU Ecodesign Directive, see Chapter 5.5.

At the next level there are composite appliances, such as fans and pumps, which consist of an electric motor, drive shaft and a fan wheel or impeller, and any speed control. Already at this level, society's demands and knowledge concerning the systems fade.

Another level up, a ventilation system, consisting of a fan, duct system and control system, can serve as an example. Many systems at this level were designed during a time of low energy prices, which means they are overdimensioned. Because replacing duct systems is expensive and cumbersome, the systems often remain in place.

The ventilation system ducts can be leak-tight to varying degrees, which affects efficiency. It is also important that the system is correctly dimensioned in relation to the ventilated space. An encapsulated process can reduce the ventilation need and also simplify recovery of residual heat.

Higher up, the hierarchy follows process integration and then industrial symbiosis, which involves several companies cooperating. One company's residual product can be the raw material of another. Industrial symbiosis makes use of geographical proximity. At Örtofta outside Lund, a steam pipeline is being built from the biofuel-fired cogeneration plant to the sugar mill, which covers 25 percent of the mill's energy need and reduces emissions by 17,000 tonnes of carbon dioxide annually.[48] Industrial symbiosis can generate considerable energy efficiency, but it is difficult to derive total potential, as it is based on local and unique conditions.

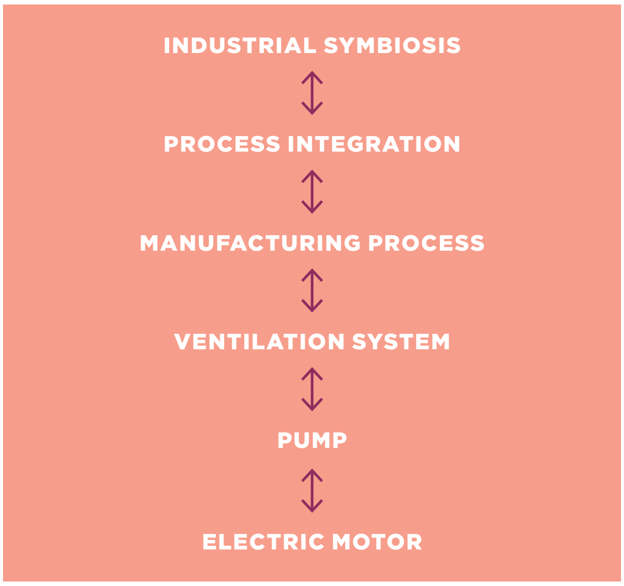


Figure 20 Energy efficiency hierarchies.

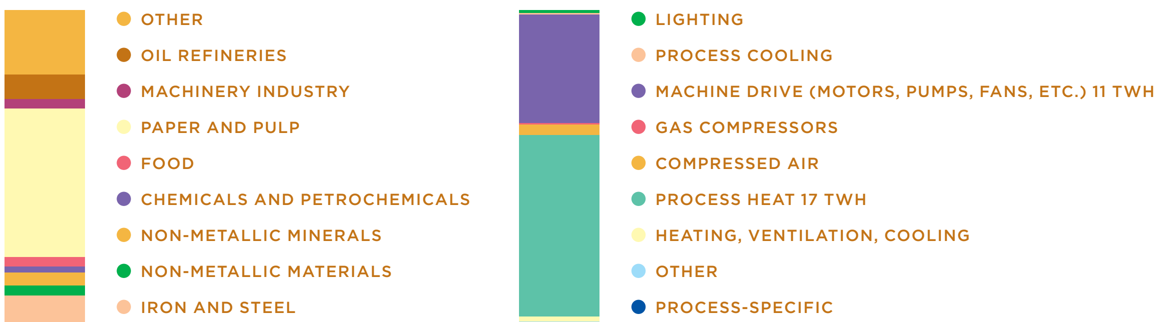


Figure 19 Distribution of energy saving potential, 31 TWh by 2030, in industry, by sector and by area of measure.

Source: European Commission.

4.2. Organisation, management and knowledge

Energy efficiency very much concerns organisation, knowledge and behaviour. To enable efficiency improvements, energy use should first be measured and relevant key indicators developed, which are followed up in the same way as other indicators of the company's performance. Old rules of thumb need to be reviewed to avoid overdimensioning. A person or function should have designated responsibility for energy use.

Introducing an energy management system provides the organisation with a functional framework to take control of its energy use. Studies from major companies in Austria showed that the implementation of energy efficiency measures was 165 percent higher in companies with a certified energy management system compared to those without.[49]

Energy management systems involve working systematically according to a cyclical model: Planning, implementation, follow-up, improvement. Even simple models lead to benefits at small companies.[50] Major energy users often benefit from certified energy management systems, which ensure that issues are addressed professionally and systematically.

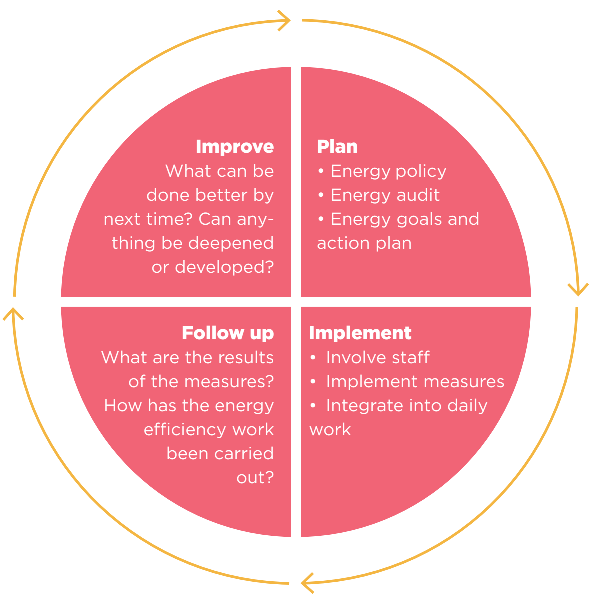


Figure 21 Illustration of the principle of an energy management system. **Source:** The Swedish Energy Agency.

A review of the previous support programme, PFE, see Chapter 5.3, shows that measures at systemic level, including management, control and knowledge development, generated the greatest actual energy saving.[47] New research from Linköping University also shows that theoretical and practical knowledge, leadership and cooperation between these aspects is needed to attain greater energy efficiencies and system optimisation.[51] This cooperation is also becoming increasingly important with the digitalisation of industry.

4.3. Support processes

It is estimated that various kinds of electric motors account for 40 percent of Sweden's total electricity consumption[52] and 65 percent of electricity consumption in industry. Electric motors drive pumps, fans, lifts and an array of other systems. Because they are subject to ecodesign requirements, the motors coming onto the market are becoming increasingly efficient. Electric motors generally have a long service life, so there are many older inefficient electric motors in operation. Also, many are insufficiently serviced or overdimensioned in relation to their task. They are often controlled by an on-off principle, whereby they are either completely switched off or on at full speed. Pumps used to pump liquids or air are also often overdimensioned and lack speed control.

Electric motors account for about 40 percent of Sweden's electricity use and 65 percent of electricity use in industry. At least 5 TWh could be freed up by 2030. The long-term potential is three times greater.

Heat exchangers are another important cooling and heating component in many industrial processes, opening up opportunities for energy reuse. Modern plate heat exchangers are often 25 percent more efficient in heat transfer than older tubular heat exchangers, and often have a short payback time. Incorrect dimensioning and lack of heat exchanger maintenance affect heat transfer capacity and thus reduce the amount of reusable energy. It is also a reason for heightened energy use in connecting equipment.

A general measure is to shut down systems when they are not in use. This should be done automatically to avoid dependence on the human factor.

Ongoing maintenance is important for all types of support processes. Dirt, leaks and incorrect settings can cause a great deal of unnecessary energy consumption.

It is estimated that 30 percent of energy use in industrial pumps could be saved through correct dimensioning, maintenance measures and speed control.[53] More efficient electric motors in the EU can save the electricity consumption of Sweden as a whole; that is, 135 TWh.[52] ABB, which itself manufactures electric motors and electronic frequency converters, believes that, in an optimistic scenario, 7–10 TWh of electricity could be saved in Sweden through more efficient and correctly dimensioned electric motors and greater implementation of speed control. That is almost one tenth of Sweden's electricity use.

4.4. Small and medium-sized enterprises

Small and medium-sized enterprises (SMEs)* account for 17 percent of the energy use of industry and often have high energy saving potential, because for instance the energy issue is rarely prioritised, and because savings can be made in easily and cost-effectively corrected support processes. Researchers at Linköping University[54, 55] have studied the energy efficiency potential for various sub-processes at SMEs. The results are shown in e 22. The companies in the study had performed energy audits and implemented around half of the proposed measures. On average, companies saved around 6 percent of their energy use, while the potential is estimated at 20 percent by researchers.

4.5. Measures in premises – heating, ventilation and lighting

Industrial premises can, like other premises, save a lot of energy by optimising their heating, cooling, ventilation and lighting.

There are numerous industrial premises that have active heating, which could instead have used residual heat from their own industrial processes. By putting residual heat to use in other ways rather than releasing it into the premises, the need for cooling in the summer is also reduced.

Progress within energy-efficient lamps and fittings has been significant since the light bulb was phased out, but this has not yet taken full effect in society. As much as

ENERGY SAVING POTENTIAL FOR DIFFERENT SUB-PROCESSES

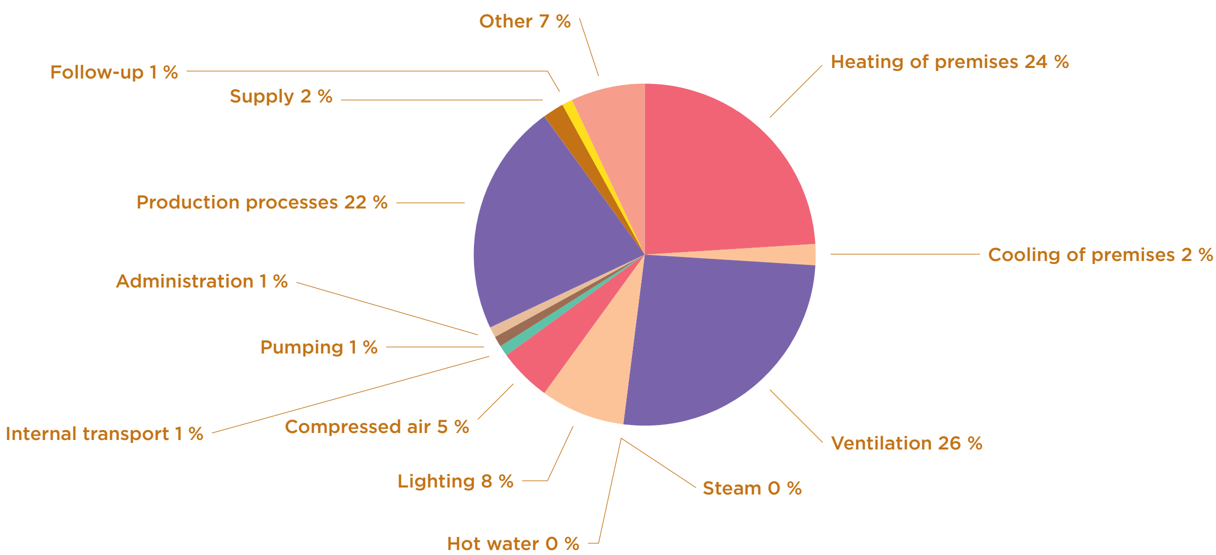


Figure 22 Energy saving potential for different sub-processes at small and medium-sized enterprises.
Source: Paramonova, Thollander (2015)

* Up to 250 employees and with a turnover and balance sheet total of a maximum of EUR 10 million.

90 percent of energy use from lighting could be saved in some operations.[56] In offices, lighting could be the single largest user of electricity, with figures such as 50 percent emerging.[56]

Numerous measures within heating, cooling and ventilation are common to the real estate sector and are described in more detail there. Correct measurement and control can save a lot of energy in the industrial sector too, where not least sensors and control systems can serve an important purpose.

4.6. Core processes in energy-intensive industry

Energy-intensive industry could free up 3 TWh of electricity through ongoing efficiency improvements by 2030.

Major system changes that require greater investment could free up much more.

Companies operating in energy-intensive industry often have dedicated energy managers because energy is both a critical commodity and a high cost for them. Nevertheless, there is potential for savings here too. For example, within the previous support programme, PFE, see Chapter 5.3, 3 TWh of electricity was freed up over a ten-year period, which represents 10 percent of the electricity use of participating companies. Also, almost 1 TWh of other energy was saved as a result of further measures implemented.

4.7. Heat recovery

In many industrial processes, heat is generated which is cooled, known as residual, waste or surplus heat. The temperature varies but generally the higher the temperature, the more valuable the heat. By recirculating heat in the processes or recovering heat in other ways, a lot of energy can be saved.

Residual heat also occurs outside of industry, such as in hospitals, underground transport systems and sewage systems. The total amount of residual heat in the EU is estimated to be as much as the heat used by the EU's entire stock of buildings.[57] While not everything is recoverable, the untapped potential is considerable.

In many places, district heating networks offer an appropriate outlet for residual heat. Out of Sweden's 60 TWh of district heating, nearly 5 TWh comes from residual heat.[12] It is usually large industries that are connected to district heating networks, but there is also potential to connect more, smaller entities, such as supermarkets and smaller-scale industries. It is also possible to use the return from district heating; that is, cooled district heating water that is channelled back after use.

An example of reuse of residual heat can be found in Lund, where the research facilities ESS and MAX IV provide a surplus of energy of 200 GWh. The energy is put to use and channelled out into a newly built low-temperature district heating network to heat homes, provide hot water, snow-free roads and so on. More areas of use are being developed as the neighbourhood emerges, which is planned to be home to 30,000 new Lund residents in future.

Many industries are too far away from a district heating network to make it economically viable to use residual heat, but there are many other possibilities even for low-grade heat. One example is food production. Industrial symbiosis consisting of systems with greenhouses and fish or shrimp farms presents an opportunity, which is for example being explored at BillerudKorsnäs Frövi, in cooperation with the company WA3RM.

A tremendous untapped possibility is to upgrade high-grade residual heat to process heat using high-temperature heat pumps. Also, surplus heat can be used to produce electricity. In general, however, the efficiency ratio is low, so inexpensive residual heat is needed for it to be profitable. Alternatively, there is an outlet for the heat and cold that become "residual products" in the process. In recent years, technology has developed and, with continued enhancement, this could make a significant contribution to the energy system in future.

The untapped potential for recovering residual heat for district heating has been estimated at 3 TWh annually.[56] In view of the new industrial activities planned in Sweden, this potential is likely to grow strongly. There is also tremendous potential for using residual heat in ways other than in district heating, although there are currently no estimates of total potential.

4.8. Electrification

Heating and drying are common industrial processes that often run on fossil fuels and cause emissions. Depending on the application, there is a vast array of electrified technologies in various stages of development that could replace fossil fuels. Microwave heating and induction are used in many households, but are relatively rare in industry.

Besides saving energy, electrification often has other desirable 'side effects' such as an improved working environment, process control and product quality. However, it can also present new risks, such as bacterial growth. To obtain a well-functioning new process, a holistic approach is needed, and often the entire existing process must be reviewed, including sub-processes and residual flows.

In the pulp and paper industry, a considerable proportion of biofuels are burned, which could be put to better use elsewhere. New research shows that electrified methods can make certain processes at biorefineries highly efficient, such that virtually all carbon atoms in bioenergy are converted into bio-electrofuels.[58] If the residual heat is also harnessed, the process can be both energy- and cost-effective. In theory, such 'bio-electrofuels' could supply the non-electrified parts of the transport sector with domestically produced fuels.

Some processes run 24 hours a day, 365 days a year, stopping only for maintenance once every ten years or even more seldom. Planning such maintenance stoppages takes many years and when the stoppage is a few years ahead in time, it is too late to make any major changes. The next opportunity might therefore be in twenty years' time.

4.9. Assessment of potential for the industrial sector

The strategy's assessment is that energy efficiency potential for the entire industrial sector by 2030 is at least 15 TWh. About 5 TWh consists of electricity while the rest is mainly made up of various fuels.

For industry, it is difficult to perform an independent assessment from a bottom-up perspective due to a lack of data. The European Commission's report proceeds on the basis of individual industries and technologies and their potential for savings, yet how the assessments are made is not transparent. The profitable potential derived by the report for 2030 is significant, at 31 TWh or approximately 20 percent. However, the assessment does not include overall systemic aspects, where the absolute greatest potential can be found. These are difficult to assess and it might therefore be reasonable to exclude them. Research from Linkoping University and international comparisons also indicate that 20 percent is a possible profitable efficiency potential for the industrial sector.

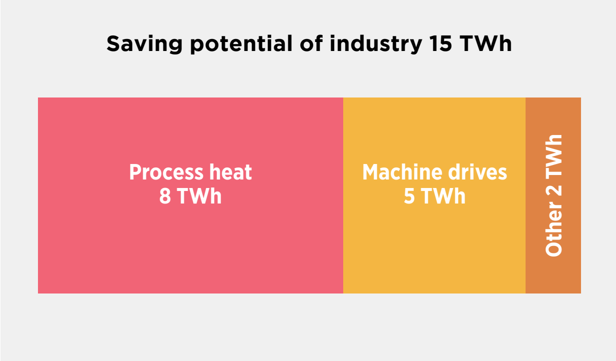


Figure 23 Energy effeciency potential by 2030 in the industrial sector according to the assessment of this strategy.

Whether implementing these measures by 2030 is actually feasible is difficult to judge due to a lack of data, and different industry representatives make very different assessments. A more cautious assessment would be that at least half of this potential could be freed up by 2030; that is, 15 TWh. It ought to be possible for at least 5 TWh of this to be electricity.

5. Present and past policy instruments for efficient energy use

Even if efficiency improvements are made, more can be done to free up more energy and electricity for the industrial transition, while keeping prices down at the same time. A number of policy instruments in Sweden have an impact on the volume of energy efficiencies that are made, although not all of them have energy efficiency as an explicit goal. Very few present and past policy instruments have an impact on power use and flexibility.

This chapter briefly discusses the policy instruments that are most important for efficient energy use.

5.1. Overarching policy instruments

Tax on electrical energy. This is an excise duty on electricity use and the level in 2022 was 36 öre, excluding VAT, per kWh of electricity consumed.[59] The tax makes up a relatively large proportion of the total energy price charged to the end consumer. One reason for this is that the tax is to steer towards reduced electricity use.

Some activities such as energy-intensive industries and ships in ports pay a reduced electrical energy tax of only 0.6 öre per kWh, compared to the 36 öre per kWh paid by others. In municipalities in northern Sweden, the tax rate is lower, 26 öre per kWh. There is a risk of the lower energy tax counteracting energy efficiencies as energy costs are an important driver of efficiency improvements.

5.2. Policy instruments aimed at residential properties and premises

Construction rules of the Swedish National Board of Housing, Building and Planning. The most detailed requirements for newbuilds and major conversion projects are found in the construction rules of the Swedish National Board of Housing, Building and Planning. They stipulate minimum energy performance requirements for a building (supplied energy measured as a primary energy ratio), building envelope requirements, and maximum installed electrical power for heating and domestic hot water.

The construction rules do not currently contain any requirement concerning maximum power utilisation on the whole, or flexibility requirements. Commissioned by the Government, in 2021 the Swedish National Board of Housing, Building and Planning delivered an inquiry on possible additions to the construction rules.[60] It was proposed that, if the construction rules are to be supplemented with additional requirements, such a requirement should be designed as a maximum heat loss ratio, which is defined as the heat output emitted by a building on the coldest winter day in a normal year, divided by the heated area of the building. In the long run, imposing requirements for a low heat loss ratio could help to keep down the power need in Sweden on cold winter days, according to the Swedish Energy Agency. The Swedish National Board of Housing, Building and Planning considers that the current requirements suffice to attain a decent level of rational energy use.

The agency is working on a major overhaul of the construction rules with preliminary launch in 2024, with a view to simplifying and clarifying them. The overhaul is intended to include requirements from new EU directives (see further down). Because buildings remain in place for a very long time, a change in the construction rules will have a limited impact on total energy use in the near future.

The Energy Declaration for Buildings Act. New houses, most apartment blocks, numerous public premises and houses that are to be sold, shall have valid energy declarations. The energy declaration shall include aspects such as the building's energy performance, proposals for cost-effective measures to improve the building's energy performance, and benchmarks to help consumers compare the building's energy performance. The energy declaration must be performed by a certified expert and is collected by the Swedish National Board of Housing, Building and Planning.

Tax deduction for home repairs, conversion and extension, and deductions for green technology. The tax deduction for home repairs, conversion and extension, and the deduction for green technology are both aimed at private individuals and designed as tax reductions. Tax deductions for home repairs, conversion and extension can grant a deduction for 30 percent of the labour cost for a number of energy efficiency measures in homes, although to a maximum of SEK 50,000 annually.

The deduction for green technology includes the cost for both labour and materials, but it is also capped at SEK 50,000 annually. Technologies covered by the deduction are solar panel systems (tax reduction of 15 percent), systems for storing energy produced by private generators (tax reduction of 50 percent) and installation of charging points for electric vehicles (tax reduction of 50 percent).

5.3. Policy instruments aimed at the industrial sector

The Environmental Code. In the opening section of the Environmental Code, it is clarified that energy must be used rationally and recycled and operations that are granted a permit under the Environmental Code must be energy-efficient. The Climate Law Inquiry (Klimaträttsutredningen, SOU 2022:21) determines[61] that the possibility of imposing requirements on rational energy use is not applied sufficiently consistently in permit-granting and supervision, and proposes changes to clarify that it is possible to impose binding conditions concerning aspects such as energy efficiency. The Environmental Code is mainly directed at industrial operations.

The Energy Audits at Large Enterprises Act. Since 2014, large companies have been required to perform energy audits every four years at minimum. The audit shall include an in-depth review of energy use and proposals for cost-effective measures to reduce energy use or improve energy efficiency. The Act does not contain any requirements concerning measures to be taken, although according to the Swedish Energy Agency, which is the supervisory authority, measures in the areas of heat recovery, ventilation, control systems, process or system efficiency improvements and lighting are common.

The Industry Leap ('Industriklivet') is a long-term initiative totalling around SEK 900 million annually that can be granted for preliminary studies, research, pilot and demonstration projects and investments to reduce the greenhouse gas emissions of the processing industry or help to curb emissions in the rest of society and to attain negative emissions. The aid covers only new untested (innovative) technologies.

Although energy efficiency is not the main focus of the aid, many measures that reduce industrial emissions generate energy efficiencies. Initiatives leading to energy efficiencies, but in which the energy is renewable, are not included in the Industry Leap as they are not considered to result in a direct reduction in emissions.

The Climate Leap ('Klimatklivet') can provide support for local and regional investments with a high climate benefit and may include measures within transport, charging infrastructure, energy, industry, agriculture, real estate, recycling and so on. Energy efficiency is not a focal point but can be included. Applications are evaluated according to the level of climate benefit they generate per invested cost, which rewards investments that improve efficiency in the use of fossil energy or entail replacing fossil energy with renewable energy.

Previous policy instruments aimed at the industrial sector

The Energy Step Programme ('Energisteget') was run during 2018–2020 and included support for the planning and implementation of energy efficiency measures. The aid targeted companies in the mining and manufacturing industry that had performed an energy audit. The evaluation shows that the programme produced energy efficiency improvements equalling just over 0.5 TWh[62] and that the programme has been successful and generated additionality.

Programme for energy efficiencies in energy-intensive industry (PFE). PFE was run during 2004–2014 and practically all companies in Sweden with annual electricity use exceeding 100 GWh took part. The companies were given tax relief in return for implementing a certified energy management system, performing energy audits and implementing efficiency measures. During the programme period, non-financial corporations' electricity consumption decreased by 10 percent – a total of 3 TWh – of which approximately 1 TWh would, according to follow-on studies, probably have occurred even without the programme.[63] The programme was terminated as it was considered inconsistent with EU law.

5.4. Policy instruments with an impact on power and flexibility

Tariff design. The Swedish Energy Markets Inspectorate is preparing regulations on how grid companies may design their tariffs. New regulations were published in 2022, with the aim of stimulating better grid utilisation and better reflecting the costs of a grid company. The new regulations entail a high fixed share, which reflects the fact that the grid owner's cost for the grid is affected relatively little by high or low use of the grid at any given moment.

Some of the policy instruments mentioned previously have an impact on maximum power need and flexibility.

- The construction rules of the Swedish National Board of Housing, Building and Planning prescribe a maximum power level for electric heating in new buildings, which helps to reduce the electrical power need.
- The deduction for green technology covers systems for storing electrical energy produced by private generators. When used correctly, this can contribute to flexibility and reduced power extraction.

There is currently no policy instrument that takes a holistic approach to power and flexibility. White certificates, which are under investigation, can be designed to contribute to flexibility and reduced power extraction. This has also been proposed in a previous inquiry.[64]

5.5. EU regulations

In the field of energy, there are a number of EU directives that Sweden must follow, and it must produce legislation that ensures compliance with them.

The Energy Efficiency Directive. The current Energy Efficiency Directive[65] contains energy efficiency targets that all EU countries are obliged to comply with (Chapter 1.5). The directive also contains other requirements, including requirements for energy audits at large companies, energy requirements for products, and requirements concerning measuring and charging for heating in apartment blocks.

With the new EU Green Deal,[66] which aims to make the EU carbon-neutral by 2050 and cut net emissions by 55 percent by 2030, new directives have been proposed. In the wake of Russia's invasion of Ukraine, these have been further tightened with the REPowerEU[67] package. A new proposal for an energy efficiency directive includes binding requirements for greater energy efficiency and requirements for the public sector to renovate 3 percent of the stock annually. The European Parliament's negotiating offer contains binding requirements for annual energy efficiency improvements of 2 percent in each country.[68] It also encourages behavioural changes and national energy saving campaigns, reducing VAT on energy-efficient heating systems and building insulation, and encouraging public bodies to perform energy audits.

The Energy Performance of Buildings Directive[69] (EPBD) contains regulations to ensure that the European building stock contributes to attaining the EU's net zero goal for 2050.

The EPBD stipulates that Member States must set minimum energy performance requirements for new buildings and that, from 2021, they must be near zero energy buildings (energy class A–C). The directive also stipulates that buildings for sale or rental shall have energy declarations and that all Member States must have a renovation strategy to make the existing building stock more efficient. 3 percent of the floor area in public premises shall also to be renovated energy-wise each year.

With the Green Deal, an amendment to the EPBD[70] was proposed, which is being negotiated in 2022/2023. Following agreement by the Council of Ministers, the proposal includes the requirement for all new buildings from 2030 to be zero emission buildings (2028 for new public buildings) and that existing homes shall be renovated such that the average energy performance for each country attains energy class D at minimum by 2033. Also, it is proposed that the obligation for valid energy declarations be extended to buildings undergoing major renovations, buildings in which rental contracts are renewed and all public buildings. It is also proposed that the declarations be supplemented with information on the production of renewable energy and operation-driven greenhouse gas emissions.

Energy labelling and ecodesign. The Ecodesign Directive covers a number of products such as refrigerators and electric motors and sets limits for minimum energy performance to enable the sale of such appliances. The Energy Labelling Directive stipulates that the products sold must have an energy label which, with clear categories, shall help consumers to understand how much energy a given product uses. The directives are pushing for more and more energy-efficient products and will, according to the EU, have resulted in cumulative energy savings of a full 2,600 TWh in the EU by 2030.

The Commission has also proposed an amendment to the Ecodesign Directive that includes stricter requirements for product recyclability and repairability.[71]

Crisis intervention to address high energy prices. On 14 September 2022, the European Commission launched a crisis package to curb the high electricity and energy price.[72] Member States have subsequently agreed on a voluntary 10 percent reduction in electricity use, as well as a requirement for the countries to reduce their electricity use during peak load hours by 5 percent.

The EU Green Taxonomy will help actors in the financial market to easily assess the sustainability of their investments. Companies with a large proportion of taxonomy-green projects or properties are considered to make an active contribution to the climate transition and can therefore be deemed an attractive investment. That way, green companies will have better access to capital and investing in sustainability will be more profitable.[73]

The taxonomy sets requirements criteria for classifying property construction and management as an activity that contributes to climate transition. To be classified as an environmentally sustainable investment according to the taxonomy, buildings constructed before 31 December 2020 must be among the 15 percent most energy-efficient in the national stock. Renovating buildings is also taxonomy-green if it reduces the energy need by 30 percent.[74]

5.6. Policy instruments in other countries

White certificates have never been used in Sweden. A special investigator has been commissioned with proposing a quota obligation system (white certificates). The final report of the inquiry will be presented on 31 March 2023. White certificates are a market-based policy instrument designed according to the same principle as the electricity certificate system and do not affect the Government budget as costs are scattered among market actors. Actors bound by a quota obligation – the energy companies, in many proposals – are required to report a certain number of white certificates annually, which are obtained by implementing energy efficiency measures among consumers. By setting a certain quota, the state can thus "order" a certain energy efficiency, the implementation of which will be ensured by the quota-bound actors.

White certificates are mentioned in the Energy Efficiency Directive as a main alternative for enabling Member States to attain the energy efficiency targets. However, Member States are not obliged to introduce it, but may use other policy instruments. White certificates are used or have been used in a number of countries worldwide, including in Denmark, France, the UK and the United States.

Auctions are another way for the Government to procure energy efficiencies. Auctions have been successfully used for renewable energy in several countries, and will be used for negative emissions in Sweden. There are also countries, such as Switzerland and Portugal, that have longstanding experience of auctions or procurements for energy efficiency. The companies may submit tenders to implement the energy efficiency improvement requested by the Government, and the proposal with the lowest cost wins. The design of the system can either be a quantitative goal for the desired efficiency improvement for a certain period of time, or there may be a predetermined budget for the auctions. For example, by holding auctions in different categories, broader dissemination in completed projects and between different sectors can be achieved.

Auctions too can be carried out in a market-based way by charging a uniform fee to market actors. Otherwise, they can be paid out of the Government budget. Auctions have been investigated for Swedish conditions at an overarching level.

6. How the potential can be realised – action plan for more efficient energy use

Efficient and flexible use of energy plays a crucial role both in the climate transition and in the current situation of high energy prices. The focus of this strategy is to demonstrate how more efficient use of energy enables it to go farther, and the transition to go faster than if the heightened need for electricity in particular required by the transition is met by new production alone. The strategy's proposals are therefore primarily aimed at creating permanent energy efficiency improvements, and not savings or cutbacks that could lead to lower energy use and prices in the short term, but that do not enhance competitiveness.

Large quantities of energy can be freed up or moved without compromising productivity, comfort and quality. More efficient use of energy also has many positive effects. For example, a 10 percent reduction in electricity use in Europe, based on 2022 price levels, could halve the price of electricity in southern Sweden. Energy efficiencies also reduce the need to import Russian energy, resulting in better resilience and power of resistance. Companies and households that have made energy efficiency improvements will be less sensitive to fluctuations in energy prices, and competitiveness is strengthened.

To facilitate and enable the implementation of the roadmaps, this chapter presents challenges and proposals for more efficient use of energy, electricity and power in the area of power and flexibility, the housing and services sector and the industrial sector.

The strategy makes assessments of the potentials in energy efficiency and flexibility until 2030 based on what ought to be feasible to implement at minimum. When developing the strategy, the need for relevant policy instruments has been prioritised ahead of precise efficiency potentials. The strategy's assessments are therefore relatively cautious and achieving far greater efficiency improvements is quite possible.

	Estimated potential, housing and services (TWh)			Estimated potential, industry (TWh)
	Apartment blocks	Houses	Premises	
Electricity	0,5	8	1	5
District heating	7,5	0	2	
Other	0	0	0	10
Total	8	8	3	15
	19			

Tabell 2 Estimated efficiency potentials by 2030, based on minimum feasibility level.

It is estimated that housing and services could free up a total of 19 TWh by 2030, equalling 13 percent of the sector's current energy use. It is estimated that the industrial sector could free up a total of 15 TWh by 2030, equalling 11 percent of the sector's current energy use*, see Table 2. This means an efficiency improvement of 34 TWh, or 9 percent of energy use in 2020. In terms of improving the efficiency of electricity use alone, the strategy estimates that a total of 14.5 TWh could be freed up by 2030, which could correspond to just over 30 percent of the estimated need for new electricity by 2030.[75]

	Estimated potential (GW)
Residential properties	1,5
Premises and services	0,5
Industry	1
Electric vehicles	0,5
Total	3,5

Tabell 3 Estimated flexibility potential by 2030, based on minimum feasibility level.

6.1. Proposals for policy instruments

There are currently a number of policy instruments steering towards energy efficiency, see Chapter 5. However, even if energy efficiency measures are profitable, in the past they have not been made to the extent that would be effective for the public economy. It is a matter of market failures, such as return on investments for private individuals being lower than the gain for the public economy, information failures in that private individuals are unaware of the possible measures they could implement, or the gain that such measures would generate. Although the high energy prices of late have increased interest in energy efficiency measures, a holistic approach to the issue is lacking and the knowledge level is still insufficient. There is therefore a need to review and supplement policy instruments for energy efficiency to accelerate developments in the areas of energy, electricity and power.

In the EU, negotiations are currently under way on the Energy Efficiency Directive, for example, with the proposals entailing relatively substantially raised ambitions, see Chapter 5.5. If the current proposals are implemented, greater efforts will be required on the part of Sweden than today. It is also considered that Sweden's domestic target of 50 percent more efficient energy use in 2030 compared with 2005 will not to be achievable with current policy instruments in the area alone.

What the longer-term impact will be of the current circumstances, with the exceptional increase in energy prices in 2022, remains to be seen. It is clear, however, that measures to reduce energy use in Sweden are the fastest way to reduce electricity costs for households and companies. Energy savings are crucial to solving the most pressing problems ahead, but more permanent changes in energy use require energy efficiency measures.

Overarching proposals

An energy efficiency programme

Svenska Kraftnät has been commissioned by the Government[76, 77] with applying to the Swedish Energy Markets Inspectorate to use unutilised revenues, from overloading (bottleneck revenues or capacity charges) due to price differences between the Swedish electricity areas, for emergency measures that may benefit consumers and businesses in the short term. The final report of the commission has been presented and approximately SEK 60 billion will be disbursed in cash support to electricity users in electricity areas 3 and 4. In total, Svenska Kraftnät estimates revenues for 2022 at approximately SEK 97 billion. For 2023, Svenska Kraftnät states that the uncertainty in the forecasts of the inflow of capacity revenues is too great to enable them to propose measures.[78]

In order to attain a robust energy system in the longer term, it is important that measures do not only compensate households and companies for high electricity costs – which risks having the opposite effect and increasing demand for electricity. Measures are also needed to reduce demand for electricity in order to curb prices and the load on electricity supply. In a communication from 20 July 2022[79], the European Commission recommended that Member States introduce national or common auction or tendering systems to reduce gas consumption. Member States have also agreed on a voluntary overall reduction target of 10 percent of gross electricity use and a mandatory reduction target of 5 percent of electricity consumption during high-load hours.[80] Both goals apply to the period 1 December 2022 to 31 March 2023.

The assessment in this strategy is that current policy instruments do not provide sufficient incentives for sustainable energy efficiency improvements. The most forceful proposal in the strategy that is expected to have a major effect in terms of giving greater impetus to energy efficiency in Sweden is the introduction of a new energy efficiency programme. The previous programme was directed at energy-intensive industry (PFE), while the scope of the proposal for a new programme is broader. Participation in the programme is proposed to be voluntary and is aimed at companies which, in the proposal to revise the Energy Efficiency Directive, are subject to the requirement to introduce an energy management system, property owners as well as energy companies and aggregators.

The programme is also proposed to include a market-based auction system to reduce electricity and power use among affiliated actors and their customers. In the auction system, the affiliated actors/companies may submit tenders to implement the energy efficiency improvement requested by the Government, and the proposal with the lowest cost wins. In order to attain the desired volume, either a quantitative goal is set for the desired efficiency improvement for a certain period of time, or there is a predetermined budget for the auctions.

Auctions can be held in different categories to ensure broader dissemination in executed projects and between different sectors. For example, auctions can be directed specifically at energy efficiency solutions in industry or real estate companies, industrial partnerships for energy integration or at property owners who can join forces to reduce the electricity use of a whole district.

Including energy companies and aggregators in the programme provides greater opportunities for implementing measures among their customers, such as SMEs and house owners. Another important part of the programme is to create or use existing networks to exchange experiences, raise the level of knowledge and initiate cooperation within energy efficiencies.

The energy efficiency programme would help to reduce demand for electricity and power, reduce the price of electricity and at the same time contribute towards achieving the Swedish energy efficiency target by 2030 and expected EU-level targets.

One possibility for long-term funding of the programme, including the reverse auction system, could be to reserve part of Svenska Kraftnät's surplus from the capacity charges for 2023. Such a solution has the advantage of not burdening the Government budget. The revenues from the capacity charges are for the implementation of measures aimed at eliminating the transfer restrictions between electricity price areas, and until there is a reasonable assessment of 2023 revenue, it is difficult to determine the size of the surplus. The strategy nevertheless finds it likely that electricity prices will remain relatively high in combination with electricity demand in southern Sweden exceeding generation, which will lead to a surplus that could be used to fund energy efficiency measures. This is not possible on the basis of current EU regulations, but in light of the current energy landscape in Europe and Commission communication of 18 May 2022 on short-term energy market interventions and long-term improvements to the electricity market design, in this strategy the conditions are considered to be relatively good. Alternative ways to fund the energy efficiency programme could be within the bounds of the Government budget, like the existing auctioning system for negative carbon emissions, or to earmark a certain share of Government revenue, such as tax on electrical energy.

Proposal:

1. The Government should commission the Swedish Energy Agency with designing an energy efficiency programme that also includes a market-based auction system to reduce the use of electricity and power. The programme should run until the end of 2030, and may for example:
   - be open to companies, including property owners, with average annual energy consumption exceeding 28 GWh and which in the proposal to revise the Energy Efficiency Directive shall introduce an energy management system,
   - be open and link to participating property owners within existing networks such as BeLok, BeBo and BeSmå,

- be open to energy companies and aggregators,
- exempt participating actors from supervision in terms of the Environmental Code's energy requirements on the rational use of energy,
- include platforms for networking between the participating actors,
- include the possibility to apply for planning support for detailed preliminary studies for investments in energy efficiency measures,
- include reverse auctions for energy efficiency measures in which the repayment period exceeds three years.
- an initial auction round is proposed to be directed at actors in electricity areas 3 and 4 with the aim of freeing up 5 TWh of electricity. Within the bounds of the Emergency Regulation, Svenska Kraftnät may apply to the Swedish Energy Markets Inspectorate to use part of the surplus from the capacity charges in 2023 to finance this first auction round.

2. The Government should commission the Swedish Energy Agency with investigating the possibilities of long-term funding of a new energy efficiency programme. The commission is proposed to include exploring the possibilities of reserving some of Svenska Kraftnät's surplus from capacity charges if these are forecast to be high in the coming years also.

Energy efficiency – a climate action

Energy efficiency can help to reduce emissions, in part directly, by reducing use of fossil fuels. Indirectly, efficiency improvements in the electricity system can have a climate impact by freeing up electricity needed for the transition in the transport and industrial sectors. Finally, freed-up electricity that is not used in Sweden can be exported to neighbouring countries and help to force out fossil electricity generation there. Therefore, energy efficiency measures should be seen as a climate action to a greater extent than currently.

On cold days in winter, heat production takes priority over electricity generation at cogeneration plants, despite this being when electrical power is also needed most. By running a top-up boiler, more electricity generation can be freed up. However, this is expensive and also they are often run on fossil fuels. Heat reservoirs enable more electricity to be generated without needing to use top-up boilers. Heat from the reservoirs then fulfil part of the district heating need on the coldest days of the year and enable high electricity generation even in winter. Incentives for a greater degree of heat storage than today would enable higher electricity generation even in winter, hence reducing local and regional power challenges.

It is difficult for initiatives that make fossil-free energy more efficient, or efficiency improvements that do not sufficiently reduce fossil emissions, to benefit from the Industry Leap and the Climate Leap, which are chiefly aimed at a direct reduction in carbon emissions. It may for instance be a case of investing in heat reservoirs or measures to harness or improve efficiency in use of residual heat.

By reviewing how energy efficiency can be included in more of the climate aid already in place, such as the Climate Leap and Industry Leap, it is considered that opportunities for investment in energy efficiencies and heat reservoirs will improve.

Proposal:

3. The Government should include energy efficiency as a climate action and commission relevant agencies with incorporating (more types of) energy efficiencies in existing climate-related aid, such as the deduction for green technology, the Climate Leap and the Industry Leap.

Power and flexibility

Sweden has a surplus of electricity on an annual basis and produces more electricity than is used in the country. However, there are local and regional challenges, in that the expansion of electricity grids and electricity generation have not kept up with electricity use. Consequently, electricity grids are now congested in many places.

Measures that shift electricity use in time by means of smart control can free up power to establish new industries and build residential areas. Cities currently struggling with grid capacity can benefit from flexibility markets and other measures to enable sustained growth without waiting for grid expansion. Policy instruments introduced in the area should therefore be long-term to enable investment decisions and potential start-ups. Electricity grids need to be dimensioned to cope with higher electricity consumption in the future, but they also need to be used smarter and more effectively through reduced power peaks and flexibility. In this strategy, it is assessed that the potential for flexibility measures could free up flexibility of at least 3.5 GW in the areas of housing and services, industry and through smart charging of electric vehicles. In a government commission from September 2022, Svenska Kraftnät will counteract power peaks and reduce prices in southern Sweden through measures such as devising procurements in a way that encourages actors that use a lot of electricity to adapt or reduce their electricity use.

Electricity trading contracts with a floating hourly price can help to shift electricity use to hours of the day when usage is otherwise low. By supporting technical equipment that helps consumers to steer electricity consumption towards times of lower demand for electricity, more might consider an electricity contract based on an hourly rate.

Grid tariffs that steer more clearly towards flexibility

Grid companies have a monopoly on grids in their respective areas, and for this reason the maximum income they may charge to their customers (revenue frame) and how the fees are devised (tariff design) are regulated through the Energy Markets Inspectorate. In 2022, the Energy Markets Inspectorate updated its regulations on tariff design, which has led to a higher proportion of fixed fees. The reason for this is that tariffs should reflect the breakdown of grid costs, and most of the costs are fixed. This does not steer towards more efficient use of grids, as low variable use gives little incentive for grid users to shift their use in time.
The revenue frame governs the maximum revenue that grid companies are permitted to charge to their customers. The revenue frame is intended to ensure that grid companies obtain coverage for the investments they make. At present, the revenue frame is geared to pure investments, such as new power lines, rather than service-based solutions such as flexibility markets. This is because the revenue frame increases if the company can demonstrate costs for investments, but not if it increases its operating expenses by purchasing services. However, in order to make grid use resource-efficient, it is important to stimulate both the rollout of new grids and more service-based solutions and dynamic tariffs so as to ensure effective use of the grids once they are actually built.

Proposal:

4. The Government should commission the Energy Markets Inspectorate with creating stronger incentives in the revenue regulations to maximise efficiency governance, without undermining cost coverage.

Opportunities for flexibility solutions

Insulation ensures that heat stays in a building for a certain period of time even without active heating. Buildings with electric heating can therefore serve as a flexibility resource in grids by switching off or reducing heating when electricity consumption in society peaks. The prospect of property owners doing this manually is improbable; rather, more buildings need to be equipped with smart control that automatically regulates the heating of the building depending on the price of electricity and grid capacity. That way, properties could help to reduce power peaks throughout the day on a large scale.

Aggregators can gather flexible resources, both from generation and use, and package them to trade on the electricity market, bid on various support services or on a local flexibility market. Local flexibility markets, on which actors trade in flexibility, currently exist only in a few places in Sweden. These markets lack uniform regulation, which needs to be developed to facilitate and provide incentives for more actors to participate and to create more local markets with a similar structure that can help address grid challenges. As demand for flexible resources increases, so too does the value of flexibility. Participation in flexibility markets is entirely voluntary and should remain so, as the conditions of different actors vary so much.

The growing share of electric cars in the fleet also affects grid power peaks. In 2021, Mobility Sweden estimated that 80 percent of new car sales will consist of electric cars in 2030,[81] and Power Circle estimates that the number of chargeable passenger cars in 2030 could be 2.5 million. The large electric car fleet will mean that smart control of electric car charging will be crucial to the functioning of the electricity system. At the same time, the potential to use the capacity of electric car batteries to curb power peaks is considerable. NEPP estimates that if 60 percent of the passenger car fleet were electrified, there would be battery capacity of 14–114 GW. Even if only a small part of this capacity were available, there is tremendous potential to support the grid.

Proposal:

5. The Government should commission The Swedish Energy Markets Inspectorate and Svenska Kraftnät with reinforcing and developing well-functioning flexibility markets and enabling more types of actors to participate.
6. The Government should work towards the EU introducing requirements for car manufacturers for the approval of electric car batteries for flexibility services. Charging points too should support V2G (vehicle-to-grid).
7. The Government should supplement the tax reduction for green technology and commission the Swedish Environmental Protection Agency to supplement the Climate Leap with conditions for smart charging technology, which could help to level off power peaks, as part of the support for installing charging points.

Housing and services sector

The housing and services sector is a disparate group encompassing more than just properties, for example agriculture, forestry and construction. The breakdown makes the statistics difficult to interpret and, at worst, misleading if used incorrectly.

The potential to use energy more efficiently in the housing and services sector is considerable. In this strategy, it is estimated that a potential that could be achieved by 2030 is at least around 16 TWh in housing, of which 8.5 TWh is electricity. For schools, offices and the trade sector, the potential is estimated at around 3 TWh for total energy use, of which 2 TWh is district heating and 1 TWh is electricity..

Construction rules of the Swedish National Board of Housing, Building and Planning

The construction rules of the Swedish National Board of Housing, Building and Planning place demands on new construction projects and major conversion projects, see Chapter 5.2. However, the practical use is broader than this and the rules are used both by the Government and voluntary certification systems as an energy performance metric. According to the construction rules of the Swedish National Board of Housing, Building and Planning, purchased energy is currently reported when the energy performance of a building is to be calculated. This means that energy generated in the building or on its plot and that is subsequently used by the building is not included in the building's energy use.

In order to ensure technology neutrality between different heating solutions, such as district heating or heat pumps, weighting factors are used. It is, however, debated how effectively these work when other types of requirements are imposed, for example that a building must be a certain percentage better than the requirements of the construction rules of the Swedish National Board of Housing, Building and Planning. Since the use of district heating can free up electricity use for other needs, requirements should not be set that reward heat pumps above district heating, irrespective of energy performance.

The Swedish National Board of Housing, Building and Planning, in cooperation with the Swedish Energy Agency, has investigated supplementary requirements in the construction rules for the energy performance of buildings.[60] The inquiry proposed that, if the construction rules are to be supplemented with additional requirements, such a requirement should be designed as a maximum heat loss ratio, which is defined as the heat output emitted by a building on the coldest winter day in a normal year, divided by the heated area of the building. In this strategy, it is estimated that low heat loss ratio requirements could help to keep the power need in Sweden on cold winter days down, and should therefore be introduced.

Proposal:

8. The Government should implement the proposal for a maximum heat loss ratio in the joint commission of the Swedish National Board of Housing, Building and Planning and the Swedish Energy Agency concerning supplementary requirements in the construction rules for the energy performance of buildings.

Energy-efficient renovation of apartment blocks

The vast majority buildings are older; new construction projects account for a very small proportion of the total building stock. Buildings that are 40 years or older are considered to have an extensive renovation need and most of the buildings that are renovated only move up one or two energy classes. A faster renovation rate, in which energy efficiency improvements are rewarded, could free up a lot of energy and indeed power. The cities where there is a capacity shortage in grids today could thus reduce the problems through energy and power renovations in the property stock. However, special consideration must be given to renovations not leading to excessive rent increases.

The current rent-setting rules do not allow rent increases to fund energy efficiency measures in the property. However, it may be difficult to carry out major investments such as extra insulation or more efficient heating and ventilation systems without funding the measures with increased rents. There is therefore a need for incentives and support for energy-efficient renovation of apartment blocks that does not lead to high rent increases that could lead to residents being unable to afford to stay. Policy instruments need to lay down long-term conditions for property owners to make energy efficiency improvements and they must also have a technology-neutral design. The strategy proposes several supplementary policy instruments in which the real estate sector can participate, both an auction-based system (proposal 1) and, below, targeted aid for apartment blocks only.

The EU Green Taxonomy sets out that the 15 percent most energy-efficient buildings in the national stock can be classified as an environmentally sustainable investment. Renovations that reduce the building's energy requirements by at least 30 percent are also included.[74] Banks and financial firms are required to report according to the taxonomy, which gives property owners incentives to demonstrate that they fulfil the requirements to obtain green funding. The majority of banks' lending consists of collateral in different types of properties and homes (houses, apartment blocks and commercial properties). One challenge, however, is that only about 20 percent of houses have valid energy declarations.[82] Several banks currently offer 'green mortgages', which grant a discount on the mortgage if the home meets certain environmental requirements. The definitions of the taxonomy will most likely be used for both green mortgages and green bonds.

Proposal:

9. The Government should introduce measures to incentivise property owners into carrying out energy-efficient renovations. Several options are available and are proposed to be implemented in two steps:
   - Step 1: Reintroduce the previous "Aid for energy efficiency in apartment blocks". The aid was granted for additional costs for energy efficiencies that improved the energy performance of a building by at least 20 percent, and was financed with funds from the EU recovery package available between 2021 and 2027. Small enterprises could obtain a maximum of 50 percent of the basis eligible for the support, medium-sized enterprises up to 40 percent and large enterprises up to 30 percent. The basis for assessing the support must be technology-neutral.
   - Step 2: In order to secure long-term conditions for property owners' work on energy-efficient renovation, the Government should commission the Swedish National Board of Housing, Building and Planning, in consultation with the Swedish Tax Agency, with investigating and submitting proposals regarding how a tax reduction corresponding to the above support levels could be designed to provide continued incentives for the energy-efficient renovation of apartment blocks after 2027.

Smart properties

The digitalisation of buildings presents heightened opportunities for property automation and, through artificial intelligence (AI), for controlling the energy use of buildings as efficiently as possible based on external factors such as weather, electricity price and/or power balance in the grid. Several properties can also be linked together, which enables the entire stock to be controlled more collectively in relation to the heat and power balance in the area. Examples in Örebro show that by using AI for heat control, energy use can be reduced by 10–20 percent annually and, in combination with more modern technology and behavioural changes, as much as 50 percent. Digitalisation and communication between buildings have tremendous potential to reduce both energy and power use in neighbourhoods, districts or entire cities. In order to facilitate and speed up developments, the legal scope for these digital energy platforms should therefore be investigated as well as possible support systems for increased implementation.

Proposal:

10. The Government should commission the Swedish Energy Agency with investigating the legal scope and need for support for heightened implementation of open digital energy platforms for communication between smart buildings (properties that automate control and regulation functions through AI).

Improved knowledge of energy efficiency measures and the possibilities they present

IEnergy efficiency investments and measures in houses are mainly carried out in connection with a change of ownership or in the event of a sharp increase in energy prices, like in 2022. In order to stimulate measures for house owners too, both in the short term to manage the high energy costs through energy savings, and in the long term to achieve permanent energy efficiency also in the stock of individual houses, policy instruments such as the dissemination of knowledge about effective measures, increased opportunities in connection with other renovation works and financial aid for implementing energy efficiencies are needed. Such policy instruments could, in the long term, reinforce households' resilience to changes in electricity prices and reduce the need for emergency market interventions like those proposed in 2022.

Energy and climate-related advice is an impartial and free-of-charge service in the municipalities that can provide support and advice on aspects such as energy efficiency improvements to private individuals, small and medium-sized enterprises, tenant-owner associations, private apartment block owners and associations. An evaluation by the energy and climate advisors has shown that 50 percent of companies that have obtained advice carry out some measure that has led to a measurable energy efficiency improvement. The quality of the advice varies, however, depending on the municipality, and there is a lack of resources to boost expertise and scope in the advice.

Energy declarations prepared for newly constructed houses, apartment blocks, numerous public premises and when houses are sold must meet a certain level of quality to work effectively and add to the property owner's knowledge level. The number of proposed measures and recommendations in the energy declarations is currently generally low. By providing cost-effective proposals for measures within energy efficiency, power and flexibility, the level of knowledge is raised, which lowers the threshold and clarifies incentives for implementing measures. For example, more measures turn out to be cost-effective if account is taken of the lifetime of the measure and future energy prices. Longer-term measures could be profitable if they are implemented in connection with the property owner performing other renovation work. However, this consideration is rarely taken into account in today's energy declarations, and there are no guidelines for how to perform such calculations.

Tax deductions for home repairs, conversion and extension, which are directed at private individuals, can grant a tax deduction for 30 percent for the labour cost for a number of energy efficiency measures in homes, although to a maximum of SEK 50,000 annually. More extensive energy efficiency measures such as installing waterborne heating systems are relatively expensive and there is thus a risk of the tax deduction for home repairs, conversion and extension encouraging smaller-scale measures at the expense of more substantial efficiency improvements. An extended period of time during which the deduction may be used, whereby the amount unused in the current year can be carried over to the following year, also improves possibilities of carrying out measures in connection with other renovation work which would otherwise risk being deprioritised as the SEK 50,000 cap does not suffice for them.

Around 173,000 houses are still heated with direct-acting electric heating, which is very inefficient and expensive. If holiday homes are included, the number is even higher. Installing new hot water central heating systems in an existing house is a costly and extensive measure. From an energy system perspective, it would be beneficial if this were done, but it is rarely profitable for the individual homeowner. Installing air-to-air heat pumps could be a less costly option. The Government has, in the 2023 Budget Bill, announced an investment grant for conversion of heating systems and renovation of houses with direct-acting electric or gas heating. In order to allow sufficient time to reach as many home owners as possible, thus reducing the sensitivity of vulnerable households to energy prices, increasing resilience to future crises and reducing power extraction in vulnerable areas, it should be possible to apply for the aid over a proposed period of five years, Also, 23,000 houses still have oil-fired boilers as their main source of heating. These households should also be covered by the proposed conversion aid.

Proposal:

11. The Government should increase the Swedish Energy Agency's long-term provision of resources for energy and climate advisors. It is proposed that the appropriation be increased by 50 percent on the basis of 2022 funding (SEK 120 million) to also cover the introduction of a certification to ensure competence and quality of advice and a higher degree of outreach.
12. The Government should amend the Energy Declarations Ordinance so that the policy instrument provides greater information on cost-effective measures with the goal of halving the building's energy use. The Energy Declarations Act should also be supplemented to include power and flexibility measures.
13. The Government extend the period during which the tax deduction for home repairs, conversion and extension may be used, for example three years, making the maximum amount of the deduction SEK 150,000. The deduction should also be extended to include deductions for advisory service and energy audits of properties and installation of smart control systems.
14. The Government should extend the investment grant, announced in the 2023 Budget Bill, for conversion of heating systems and renovation of houses with direct-acting electric or gas heating. It should be possible to apply for the aid over five years, as a proposal, and it should also include properties that are still heated by oil-fired boilers.

Industrial sector

The industrial sector is not as homogeneous as the housing sector, and uncertainties surrounding energy efficiency potentials are considerable due to a lack of statistics and knowledge compilations. However, it can still be said that the general potential for energy efficiency in industry is considerable; according to an EU report from 2021, Swedish industry can save just over 20 percent of energy by 2030. The assessment in this strategy is that a potential that is achievable by 2030 is at least around 15 TWh, of which about 5 TWh is electricity, while the rest mainly consists of various fuels.

In the industrial sector also, not enough efficiency improvements are being made, despite many of the measures being profitable. Lack of knowledge about how and where energy is used, competition for time and resources and measures that involve extensive changes to existing processes are some examples of why energy efficiencies are deprioritised.

The former policy instrument, the Energy Step Programme, included support for the planning and implementation of energy efficiency measures and was geared to companies in the mining and manufacturing industries that had performed an energy audit. The proposal presented previously in the strategy to introduce an energy efficiency programme, see Proposal 1, includes both the companies and the opportunities for financial aid previously covered by the Energy Step Programme.

Improved knowledge of and support for energy efficiency

Efficient use of energy in the industrial sector largely concerns knowledge, organisation and behaviour. An energy management system provides the organisation with a framework for its energy use and facilitates implementation of energy efficiency measures at both small and large companies.

Small and medium-sized enterprises often have considerable potential to improve their energy efficiency and, at the same time, strengthen their resilience to future crises. Here, however, there is also usually a great lack of knowledge and time, and it is difficult to prioritise the time and investment costs potentially involved in working with energy efficiency improvements. In order for energy efficiency measures, including profitable ones, to be prioritised by small and medium-sized enterprises, outreach activities and support systems are needed that include a systemic perspective on operations, working methods, knowledge and implementation. A systemic approach covering the whole of the business is important to raising interest and incentives for implementing measures. Between 2015 and 2021, the EU initiative National Regional Fund Programme was run by the Swedish Energy Agency, focusing on energy efficiency at small and medium-sized enterprises. The programme provided both information and financial aid. In 2018–2021, the Swedish Agency for Economic and Regional Growth ran the Robot Leap programme aimed at promoting automation and robotisation at small and medium-sized industrial companies. The programme provided training and financial aid for bringing external expertise into the company. Both programmes had an outreach approach. The European Regional Development Fund (ERDF) continues to provide funding for energy efficiencies.

The Energy Audit Act covers large companies and includes requirements for reviewing the company's energy use and proposals for cost-effective measures. The Act does not currently cover power and flexibility.

Proposal:

15. The Government should commission the Swedish Agency for Economic and Regional Growth and the Swedish Energy Agency, within the bounds of the European Regional Development Fund (ERDF), with jointly continuing to support small and medium-sized enterprises financially and in terms of know-how with automation and energy efficiency improvements. The Government should also supplement the commission with support for the regions in order to facilitate the co-financing required by ERDF. Lessons learned from the previous programmes, the Robot Leap and the National Regional Fund Programme, should be used in designing the joint commission.
16. The Energy Audit Act should be supplemented to include power and flexibility.

Untapped potential in residual heat from industry

Recovery of residual heat for district heating has an untapped potential of 3 TWh/year[56] and this will probably increase as new industrial operations are established. High-temperature residual heat is already used today to a great extent where geographical and economic conditions exist. Residual heat can also be used in ways other than for district heating, for example for food production in greenhouses or fish and shrimp farms. There are also opportunities for industrial companies to reuse residual heat from industrial processes in their own premises and processes.

A substantial part of industry's climate transition requires heightened production and use of hydrogen. The Swedish Energy Agency's proposal for a national strategy for hydrogen, electrofuels and ammonia, presented in November 2021, proposes a planning target of 5 GW of installed electrolytic power by 2030, which could generate up to 4 TWh/year of heat.[83]

Use of residual heat is resource-efficient and needs to increase compared with today. For this, it is essential that management and recovery of residual heat is included in the planning and projecting of new plants that ensure the heat is used where possible.

Proposal:

17. The Government should commission the Swedish Energy Agency with investigating possibilities to better harness surplus heat. The commission may include, for example, an amendment to the Electricity Act such that terms for system solutions can ensure maximum use of residual energy generated at new plants, removal of barriers to harnessing surplus heat as well as policy instruments that encourage and incentivise adaptations of customers' plants to enable lower temperatures in district heating networks.

6.2. Actors' commitments

Actors in energy, real estate and industry have long been working on energy efficiency issues. The climate transition brings a sharp increase in the need for electricity from both the industrial and transport sectors. Efficient energy use will thus be even more important than before, both from a climate angle and in order to increase Sweden's self-sufficiency and resilience to future crises. As noted in the strategy, there are numerous challenges. For example, a lack of knowledge among both households and companies concerning energy use and possible efficiency improvement measures, prioritisation among investments to be made and short-term return requirements. The following actors, which also endorse this strategy, are therefore committed to continuing their work and intensifying efforts to ensure efficient use of energy and power:

ABB undertakes to continue to implement energy management systems in its own operations, in line with its commitment to the EP100 initiative, and to establish energy efficiency targets in line with its sustainability strategy. The company also undertakes to continue to bring stakeholders together to work on raising awareness of the potential in energy efficiency improvements and to encourage action for a more energy-efficient world within the bounds of the Energy Efficiency Movement.

Akademiska Hus has the goal of achieving climate neutrality throughout the entire value chain by 2035, as well as reducing new construction projects and rewarding conversion and renovation in order to reduce climate impact and optimise energy use. Akademiska Hus has also undertaken, by 2025, to halve the total amount of energy delivered to its properties, including the energy of tenants, compared with 2000. Akademiska Hus also undertakes to inform its customers of energy efficiency opportunities, share experience in the industry about energy sharing and flexibility solutions, and request more possibilities from suppliers for flexibility to steer energy consumption away from power peaks.

Alfa Laval is constantly working on developing technologies and service solutions for heightened energy efficiency. As a manufacturer of heat transfer technology, the company helps its customers to reduce annual energy demand by 100 GW, which is equivalent to 50 million tonnes of carbon emissions. Alfa Laval aims to become carbon-neutral in 2030 and is taking measures to improve energy efficiency in its manufacturing processes and buildings, investing in surplus heat recovery and cooperating with suppliers and customers to improve climate impact from material flows. Alfa Laval is also an active Member of the Energy Efficiency Movement, and has launched the Energy Hunter training programme.

AMF Fastigheter works systematically with enhancing energy use efficiency. Since 2009, energy use has been reduced by 53 percent. The target for 2022 is to achieve an energy performance of 84 kWh/square metre per year, a goal reached already in 2021. New power and energy targets have been developed for the period 2023–2025. AMF Fastigheter is also participating in Svenska Kraftnät's frequency containment reserve (FCR), in which the properties can reduce their electricity consumption at critical times and offload the grid. The measure will be implemented in five buildings with a capacity of 1.5 MW.

Eways, with the overall goal of accelerating the transition towards a fossil-free vehicle fleet, is committed to being at the cutting edge, actively informing and sharing knowledge and experience on efficient electric car charging with suppliers, customers and other business contacts and making constant advancements within its own organisation.

Fabege has an energy performance goal of a maximum of 77 kWh/square metre Atemp property energy by 2023, which was already achieved in 2021. The new goal in the long run is to reach 70 kWh/square metre. Fabege also aims to reduce its power need and is actively working to find solutions in this respect.

Heimstaden Sweden is, with the aim of reducing energy use, implementing measures to increase the use of modern and cost-effective technologies, such as smart control systems, construction technology measures to reduce heat losses, recovery technology and requirement-setting in new construction projects. Heimstaden has a goal to reduce the amount of purchased energy by 2 percent annually by 2025 and for fossil-free operations by the same year. Conditions for joining a frequency balancing project are being investigated. Newly constructed buildings are certified with a Miljöbyggnad Silver rating and solar panels are installed for local energy generation if appropriate.

Holmen undertakes to shift its focus away from energy saving to energy cost performance at the Hallstavik paper mill, where only electricity is used as primary energy. This gives more flexible use of electricity at times of the day when usage is otherwise low. That way, Holmen can reduce its electricity costs. Also, revenues from support services procured by Svenska Kraftnät generate extra profitability and efficiency improvements in the entire electricity system. Energy cost performance shall be less than 3 MWh per tonne.

HSB has a goal to reduce its climate impact by 50 percent by 2030 compared with 2020. The goal covers all the tenant-owner associations that are HSB members. This will be done through energy efficiency, energy renovation and transition to renewable energy. HSB also intends to set concrete goals for energy efficiency and for increased electricity production from solar panels.

The Swedish Union of Tenants is working with a popular educational initiative aimed at providing Sweden's 1.5 million tenant households with knowledge, information and tools to use energy more efficiently.

Kraftringen has the objective, by 2025, to reduce energy use in its buildings by cutting heat use by 30 percent and electricity use (excluding electric car charging) by 20 percent compared to 2021. Kraftringen also has a goal for the proportion of recovered residual heat in the district heating network to equal 200 GWh by 2030 (outcome for 2021: 37 GWh), and to reduce energy use among the tenant-owner associations and property owners (not individual houses) included in the company's heating market by at least 10 percent from 2022 to 2030.

Löfbergs has long been working on energy efficiency, resulting in the company, over the past 30 years, having managed to double coffee production without increasing total use of electricity and energy. Löfbergs has an energy use goal under monitoring – that energy use per kilo of produced coffee will not rise.

Perstorp Group is in the final stages of developing a new electricity strategy, an important part of which is to make electricity use more efficient, primarily linked to the company's production sites. Efficiency improvements are constantly ongoing as part of overall work on continuous improvements, but will shift up a gear once the electricity strategy is approved, and will also be driven by ambitious but realistic objectives, which are linked to the company's greenhouse gas reduction goal.

Rikshem undertakes to continue its energy and climate development in line with its climate roadmap. The company's energy targets, renovations and energy efforts are the foundation for energy and climate performance improvements. Rikshem shares its experience through participation in BeBo and Fastighetsägarna's sustainability council's development group for energy.

SKF Sverige AB undertakes to improve the energy performance of its building stock through energy efficiencies and other measures, such that degree-day-compensated purchased energy for heating in 2030 is less than 50 percent of the 2020 level. SKF also aims to improve energy performance in manufacturing by 5 percent annually. At the Gothenburg plant, the ambition is to substantially increase production, with the commitment that total energy use for manufacturing shall not increase in connection with these changes. Also, through innovation and continuous improvements, SKF will continue to help to reduce energy losses in the applications in which its products and services are used, and continue to urge suppliers and employees to contribute to more efficient energy use.

Stena Fastigheter aims to reduce its energy use by 2 percent annually on the basis of the 2020 level, and to be self-sufficient in electricity by 2030 with an interim target of 50 percent for 2026. Stena Fastighether is also working with power peaks and energy storage, as well as renewable energy.

Swegon is committed to continuously working with energy performance in building stocks both in terms of building envelopes and systems. Swegon's goal is to reduce energy consumption and greenhouse gas emissions (Scope 1 and 2) by 5 percent in relation to its turnover annually. Furthermore, Swegon will annually arrange external webinars on energy efficiency and indoor climate through the Swegon Air Academy and adapt products and steer towards open communication standards for property automation that simplify flexibility.

Södra Skogsägarna works strategically with investments in energy efficiency measures, which has led to Södra being a net producer of electricity. Södra has the objective to reduce energy consumption per unit produced (for example energy consumption per tonne of pulp and per cubic metre of sawn timber). Its long-term vision is to become independent of purchased energy.

Vasakronan is to become self-sufficient in energy and not need to purchase any energy. The goal includes aggressive efficiency efforts, additional in-house energy generation and building up more storage capacity to be able to "refuel" energy when it is inexpensive and sell/use it when it is expensive. Thus, the goal also indirectly contains a peak shaving target. Besides, Vasakronan is also working on power-saving projects and various demand-response measures in its properties.

Victoriahem undertakes to improve the energy efficiency of its property stock so that purchased electricity and district heating can be reduced by 30 percent compared to 2015 by the end of 2030. Victoriahem is also committed to reducing energy use in its own offices by 30 percent and reviewing electricity use by replacing all lighting with LED, switching off office equipment and investing in good energy classes when purchasing new equipment. Also, Victoriahem will annually train its staff in the fields of energy, environment and sustainability and cooperate with its energy suppliers to offer the company's buildings as flexibility potential to avoid bottlenecks in energy systems or a need to turn on fossil-based back-up.

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