Energy Efficiency Trends and Policies in Sweden

Eskilstuna, January 2025

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Co-funded by the European Union

This project has received funding from the European Union's LIFE programme under grant agreement No. 101075902

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Project title

Odyssee-MURE – Monitoring the Energy Efficiency Pillar for Climate Neutrality

Notes

Funding

This project has received funding from the European Union's LIFE programme under grant agreement No. 101075902

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Introduction

This report explores the development of energy efficiency in Sweden, including a description of policy measures implemented to improve energy efficiency. The report has been made available within the Odysee-MURE project, and the analysis is based on statistics from the project's database which is available online (www.odyssee-mure.eu).

Total final energy consumption in Sweden decreased by approximately 3% from 2000 to 2022. The energy intensity, measured as primary energy usage in relation to GDP, has declined with 33% since 2005. This can be compared to Sweden's current national target for energy efficiency, which states that the energy intensity should decrease by 50% until 2030, compared to 2005.

In a comparison between the sectors, the largest energy efficiency improvements have been achieved in the residential and services sectors while progress in the transport and industry sectors was more modest.

Swedish energy efficiency policy is based on taxes on energy and carbon dioxide emissions, which create incentives for a decreased energy use. In addition to the taxation, several sector-specific measures have been implemented to target specific groups.

The details of the overall and sectoral development, as well as the specific policy instruments, are described in more detail in the following chapters.

Economic and policy context

Economic context

Figure 1 shows Sweden's long-term trends for real GDP, private consumption and industrial value added (GVA) in constant 2020 prices. The real GDP grew by roughly 56% between 2000 and 2022, corresponding to an average annual growth rate of around 2%. Growth was notably strong in the mid-2000s and again in the late 2010s.

In 2009, following the global financial crisis, the Swedish economy saw a decline of approximately 4% compared to 2008. As a small, open economy reliant on exports, Sweden was adversely affected by the global financial crisis. By 2010, growth had rebounded as demand gradually recovered, and the economic recovery was faster and stronger than in many other European countries. During the Covid-19 pandemic, the GDP declined by 2% relative to 2019 but recovered again in 2021.

Real gross value added in the industry increased by about 47% in total over the period 2000-2022. Annual growth rates varied more sharply compared to real GDP growth, which reflects the industrial sector's sensitivity to international demand and commodity price fluctuations.

Private consumption has also grown steadily. Between 2000 and 2022, real private consumption rose by about 60% - an average of just over 2% per year.

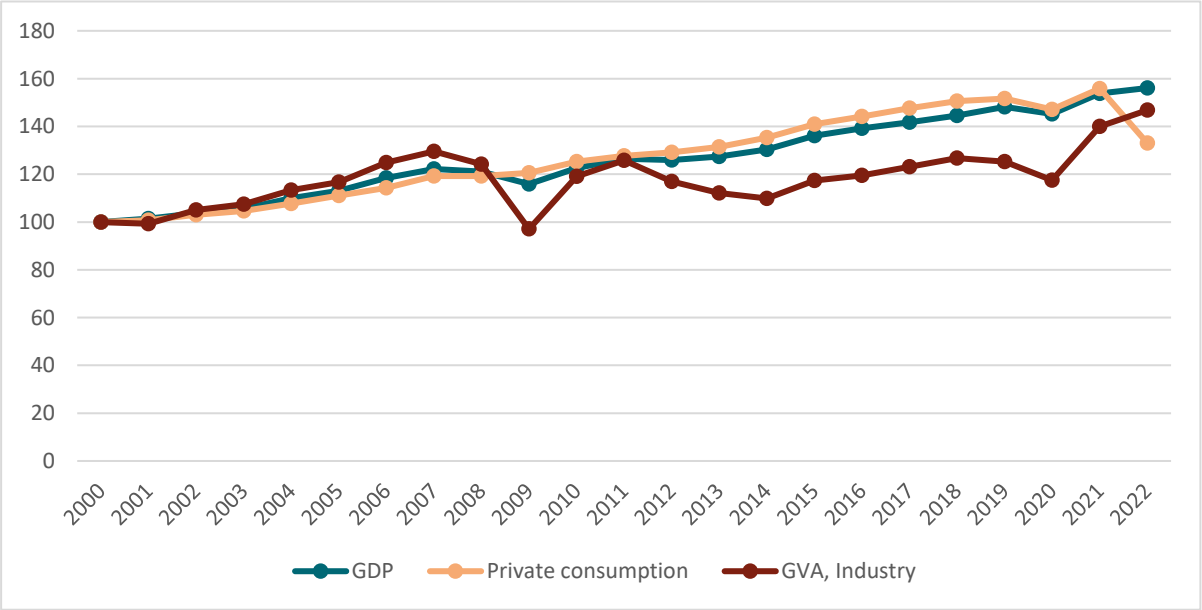

Figure 1. Macroeconomic development in Sweden. Index 2000=100. Source: Statistics Sweden

Policy background

The Swedish policy for energy and climate is based on the legally binding target to reach net zero emissions by 2045. The energy system as a whole has a relatively low climate impact which is largely due to the near-zero emissions power mix. Electrifying the wider energy system is key in achieving future goals for the energy transition, including an increased energy efficiency.

Since 2016, Sweden has had a goal of achieving a 50% more efficient energy use in 2030, compared to 2005. The target is expressed in terms of lower primary energy use in relation to GDP. In 2023,

the Swedish Government announced that the energy efficiency goal needs to be overhauled, as a result of the new Energy Efficiency Directive within the EU, in combination with altered national policies and ambitious plans for new green industrial establishments. The process for proposing a new national target has not yet been initiated.

Taxes on energy and carbon dioxide emissions continue to constitute the backbone of Swedish energy efficiency policy. They contribute to energy efficiency both directly, by reducing energy demand, and indirectly, since they are often the key drivers for other policy instruments. However, the taxes were not originally introduced primarily for energy efficiency purposes. In fact, in some cases, energy efficiency has followed only as a side effect.

Overall energy efficiency progress and policies

Development of energy consumption and energy efficiency trends

Total final energy consumption decreased by 2.8% from 2000 to 2022. The total consumption showed a decrease both with and without climatic corrections[1].

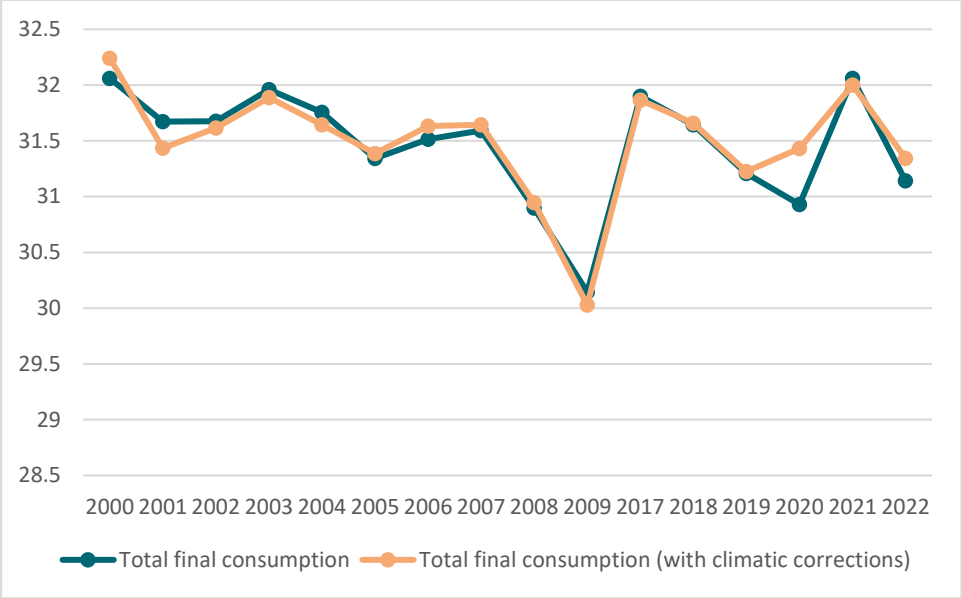

Figure 2. Total final consumption (with/without climatic corrections) in Mtoe. Source: Odyssee

[1] The climate correction refers to an adjustment of the space heating part of the consumption of the residential and service sectors, to the levels of a normal winter (long term average). The purpose of it is to leave out the influence of cold winters. This is particularly important when there are large climatic variations from one winter to the other.

The energy intensity, measured in both primary energy and final energy consumption, declined significantly between 2000 and 2020, with only a slight decrease in primary energy intensity in the early 2000's. The primary energy intensity decreased by approximately 35.7% and the final energy intensity by approximately 40% between 2000 and 2022.

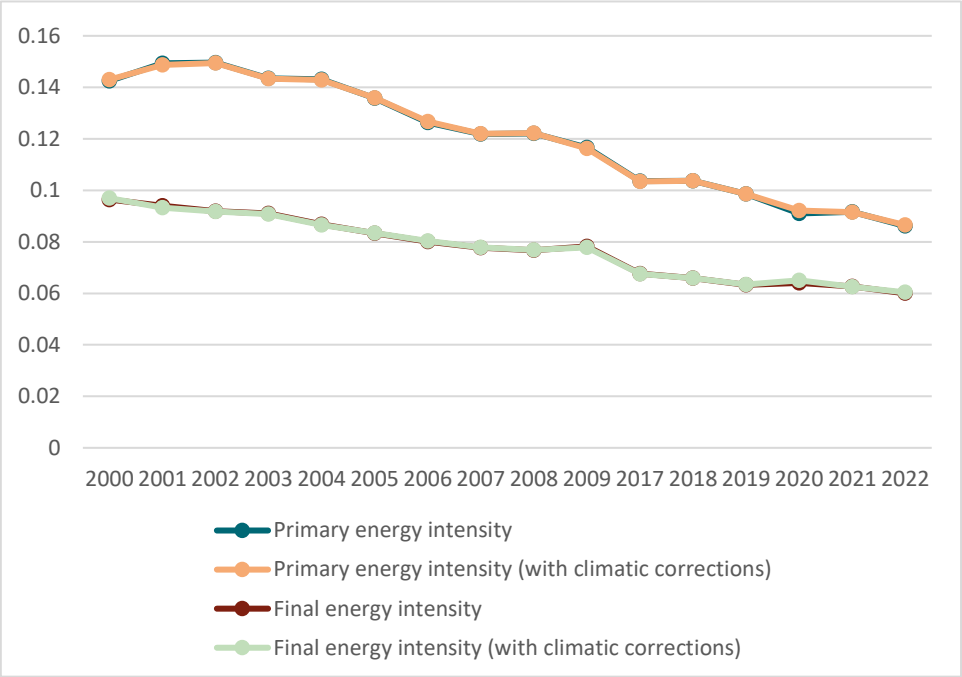

Figure 3. Primary and final energy intensity (with/without climatic corrections) in koe/EUR2015. Source: Odyssee

Although the overall energy intensities shown above already take into account the impact of short-term weather fluctuations and changes in activities, clearly capturing energy efficiency improvements is limited by many structural effects across the different energy consumption sectors (e.g. sector or product structure in the industrial and tertiary sectors) and several comfort effects (e.g. larger living area per household, higher room temperature, larger appliances). In addition, energy intensities which are based on monetary activities at a highly aggregated level (i.e. total GDP or added value of a sector) only give a limited understanding of the pure energy efficiency developments.

ODYSSEE tackles these limitations by providing a re-aggregated energy efficiency indicator called "ODEX". This index is obtained by aggregating the unit consumption changes at detailed levels (by sub-sector or end-use), observed over a given period. The unit consumption variation is measured in terms of a ratio that use physical instead of monetary activities, which is more suitable to evaluate pure energy efficiency trends.

In addition to that, ODYSSEE also goes further in isolating the pure energy efficiency evolution. Even with all effects considered, apparent (or observed) energy efficiency could increase from year to year, resulting in negative energy efficiency improvement. However, the pure technical energy efficiency should not be reverse, as it is not likely that private consumers and companies are acquiring less efficient equipment from a technical point of view. They can however underutilize it, what leads to a less efficient energy consumption (mainly in the industry). With the intention to provide a better proxy for the technical energy efficiency progress, the observed ODEX is cleared

from the effects of less efficient use of equipment, as well as from strong fluctuations linked to statistical errors, imperfect climatic corrections and influence of business cycles. The "technical" ODEX is the result of these adaptations[2].

Overall energy efficiency improved by 24.9% between 2000 and 2022, as measured by ODEX. The largest improvement, exceeding 30%, took place in the residential and services sectors. Progress in the transport and industry sectors was more modest, with an increase of 16.3% and 23% respectively.

The efficiency transport sector remained stable during the first half of the 2000's, but has since seen a steady decline. In the industry, significant improvements were mase before 2006 (i.e. before the onset of the financial crisis), but has since then slowed. Meanwhile, progress in the residential sector and in particular the services sector has been rather rapid and persistent.

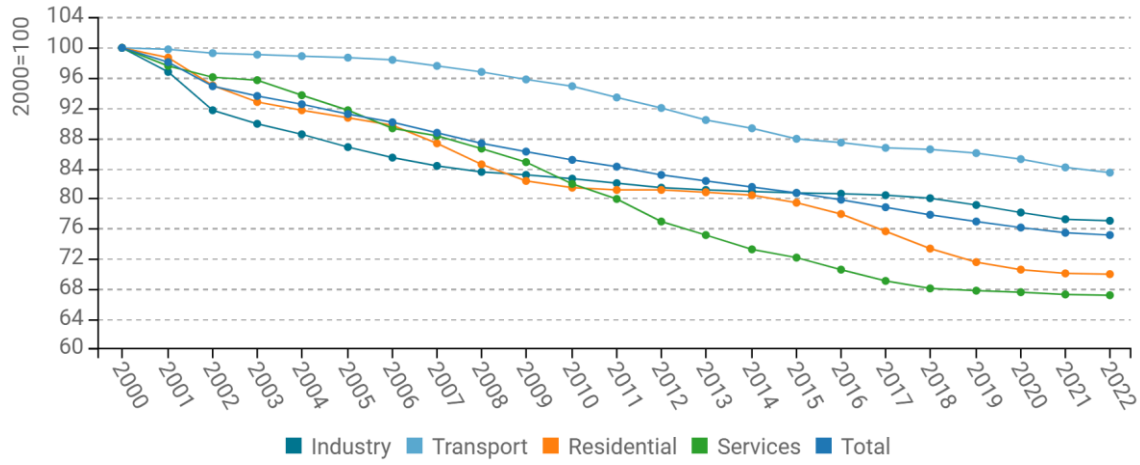

Figure 4. Technical energy efficiency index (ODEX) by sector and in total. Index 2000=100. Source: Odyssee

[2] Definition of ODEX indicators in ODYSSEE data base

Energy consumption based on ODYSSEE

Final energy consumption in Sweden was almost 31.3 Mtoe in 2022. The figure below demonstrates a decrease of 3%Mtoe since 2000, when the total consumption was close to 33 Mtoe. Energy consumption in the transport sector has shown a decrease by 0.47 Mtoe between 2000 and 2022. During the same period, industrial consumption decreased by 1.3 Mtoe and residential consumption by 0.33 Mtoe. The service sector saw an increase in energy consumption by 1.23 Mtoe.

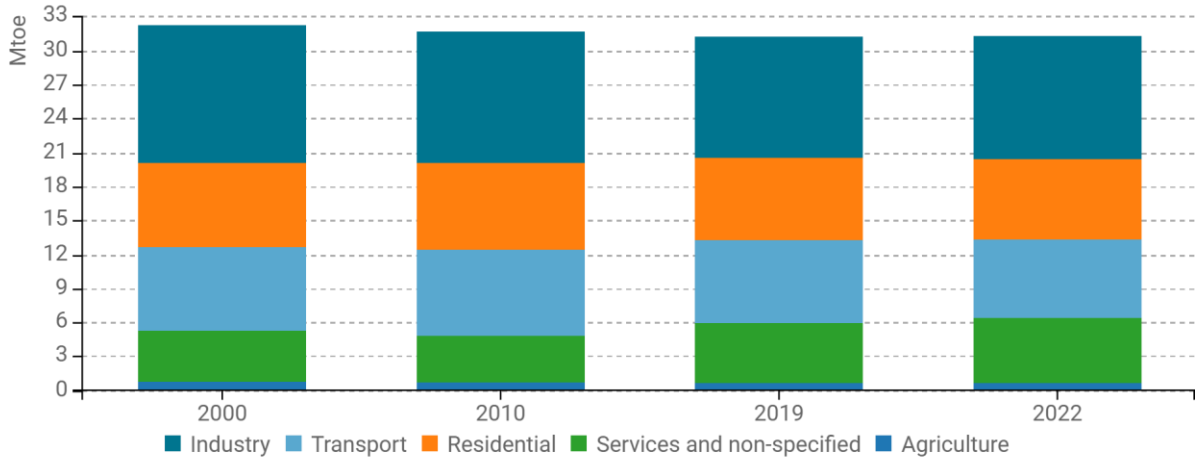

Figure 5. Final energy consumption by sector in Mtoe. Source: Odyssee

During 2000 oil and electricity were dominant in final energy consumption in Sweden. During the time 2000 to 2022 the share of oil products has decreased by approximately 46%. At the same time, the final energy consumption of renewable energy increased by 75%.

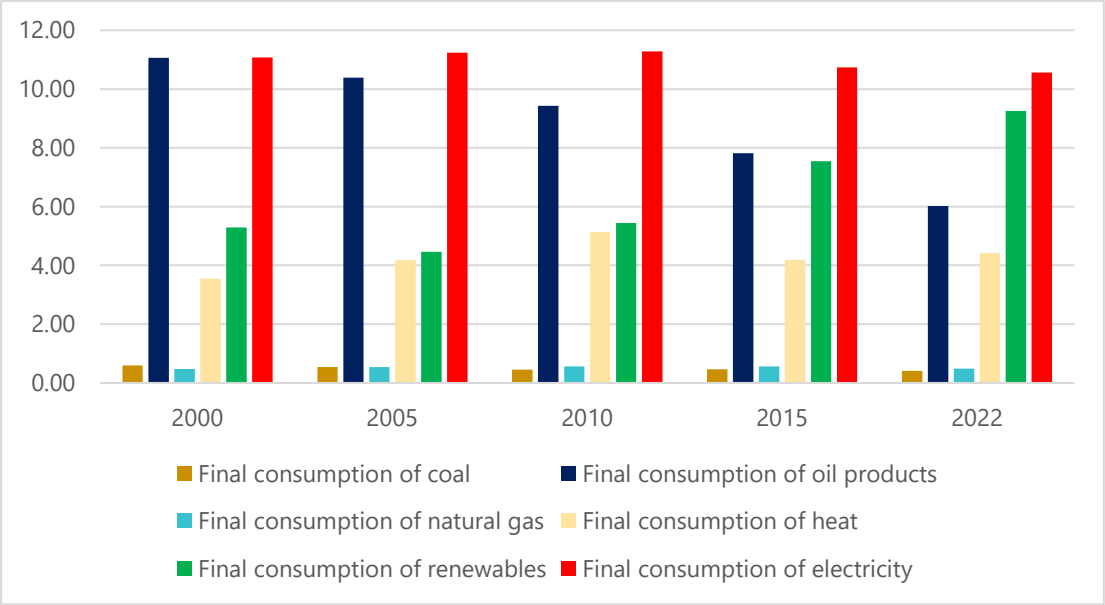

Figure 6. Final energy consumption by fuel in Sweden in Mtoe. Source: Odyssee

Decomposition of final energy demand

Sweden's final energy consumption decreased from 32.1 Mtoe in 2000 to 31.2 Mtoe in 2022. The largest reduction comes from energy savings, which lowered energy consumption by 8.8 Mtoe, followed by a decrease of 3.2 Mtoe due to structural changes. The largest upward driver is increased

activity, adding 8.2 Mtoe, while ''Other'' factors add 2.9 Mtoe, offsetting some of the decline. This demonstrates that despite economic and societal growth, efficiency gains and structural shifts have contained final energy consumption.

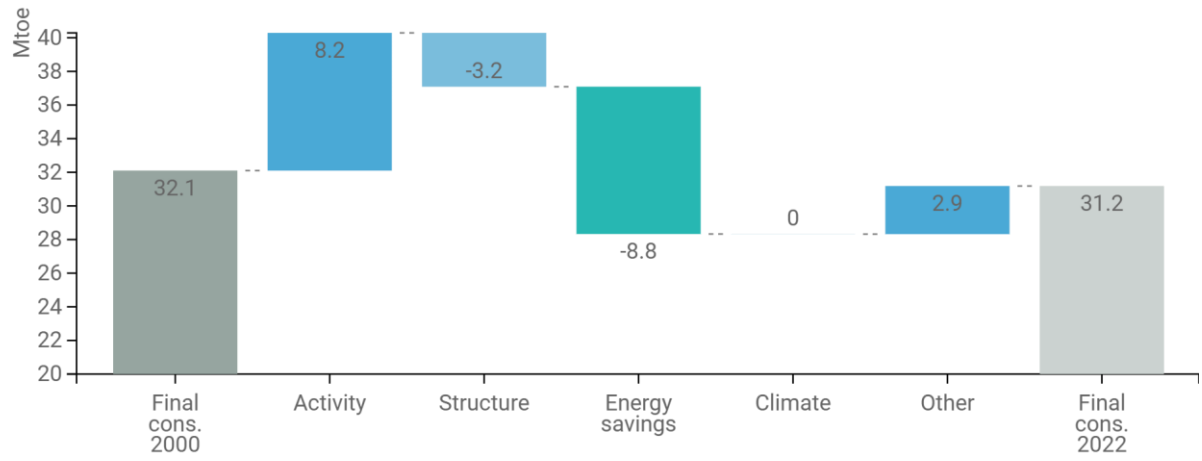

Figure 7. Final energy consumption decomposition in Mtoe. Source: Odyssee

Energy Savings

Swedish energy savings has shown notable improvements between 2000 and 2022 across key sectors. Industry achieved the largest savings at 3.04 Mtoe, followed by residential at 2.65 Mtoe, services at 1.61, and transport at 1.46 Mtoe. The base year of 2000 sets the reference at zero, with consistent increases observed annually. The data highlights the effects of various efficiency initiatives, particularly in industries and households.

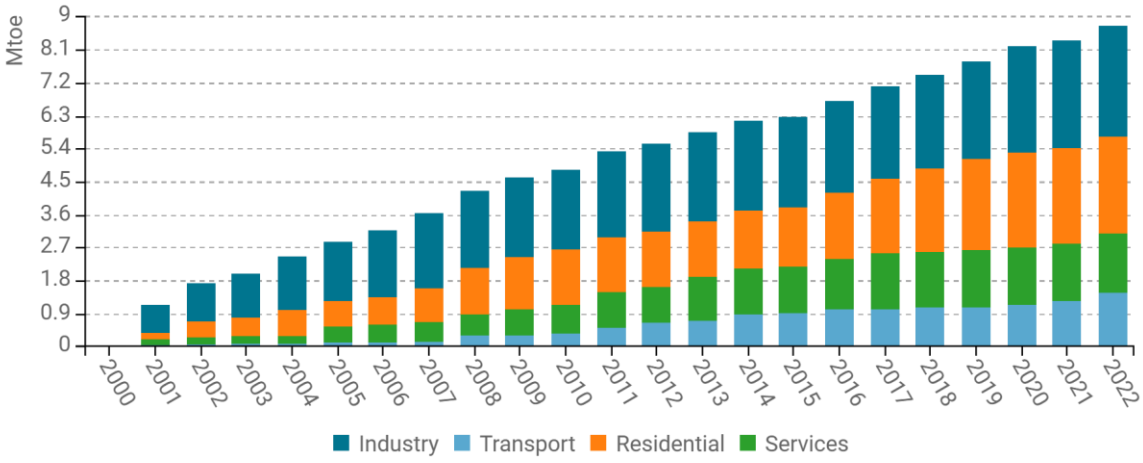

Figure 8. Energy savings by sector in Mtoe. Source: Odyssee

Cross cutting energy efficiency policies

As previously mentioned, the foundation for Swedish energy efficiency policy is taxes on energy and carbon dioxide emissions. However, the positive effects stem not only from the tax itself, but also from the concurrent effects of other policy instruments.

The taxes create a general incentive to reduce energy use, but because of the broad approach, further instruments are necessary to target specific user groups. These instruments will be described in the following sectoral policy chapters.

After the current national energy efficiency target measuring energy intensity was implemented in 2016, a reduction of 20% was registered already by 2017. However, the development over the following years has not followed the same steep decline and data for 2021 show a total of 33% reduced energy intensity since 2005.

Sectoral energy efficiency progress and policies

Residential and Service sector

Factoring in climate variations, Sweden's final energy consumption in the residential buildings sector has decreased by 0.33 Mtoe between 2000 and 2022. Over the same period, the consumption in the services sector decreased by 0.27 Mtoe.

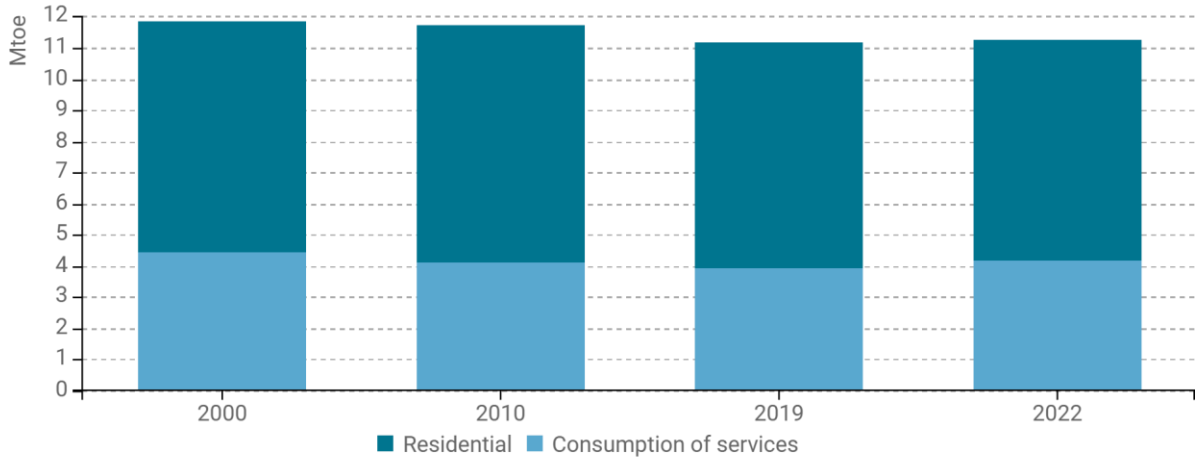

Figure 9. Final energy consumption in buildings (with climatic corrections). Source: Odyssee

Swedish households' final energy consumption, adjusted for climate variations, has shifted by end-use between 2000 and 2022. Space heating decreased from 5.18 Mtoe to 4.12 Mtoe, and water heating decreased from 1.19 Mtoe to 1.02 Mtoe, indicating some efficiency gains or changes in heating practices. Meanwhile, energy consumption for cooking remained low and stable while consumption for electrical appliances and lighting increased from 1.24 Mtoe to 1.51 Mtoe over the same period.

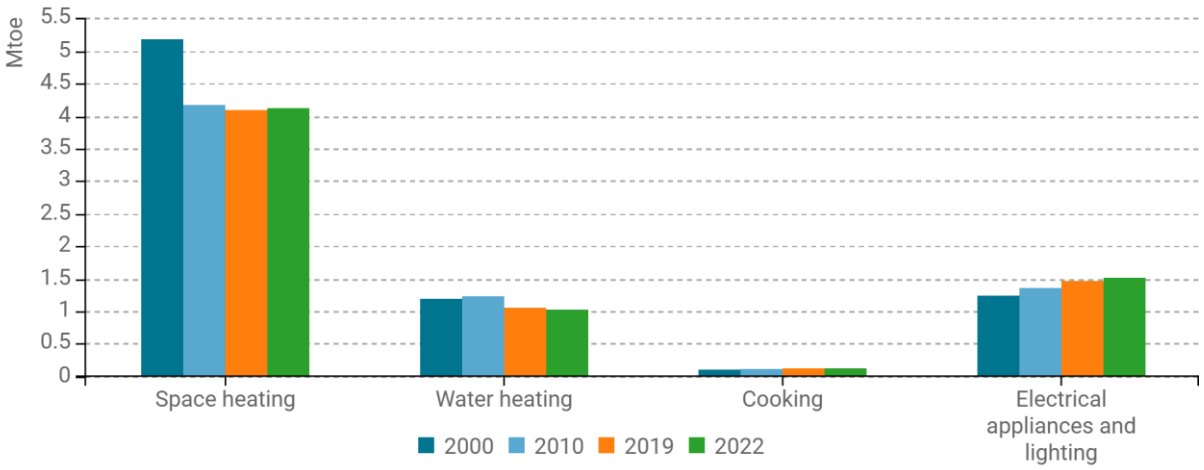

Figure 10. Energy consumption by end-use of households (with climatic corrections). Source: Odyssee

Energy consumption of space heating per m2 has shown a significant downward trend between 2000 and 2022, from 11.5 to 7.88 koe/m2, although with annual variations. This is largely due to more energy efficient buildings (building materials, windows) and fuel substitution (e.g. installing heat pumps).

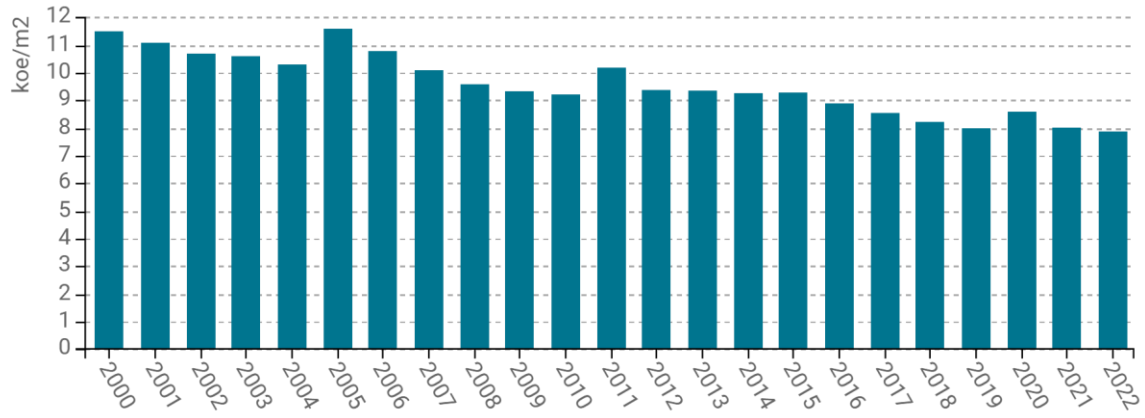

Figure 11. Energy consumption of household space heating per m2 (with climatic corrections). Source: Odysse

Energy consumption for electrical appliances and lighting has increased by 3 % between 2000 and 2022 to reach 0.328 toe per dwelling. On the contrary, energy consumption for water heating has decreased from 0.28 toe to 0.22 toe per dwelling. There is also a slight increase in energy used for cooking.

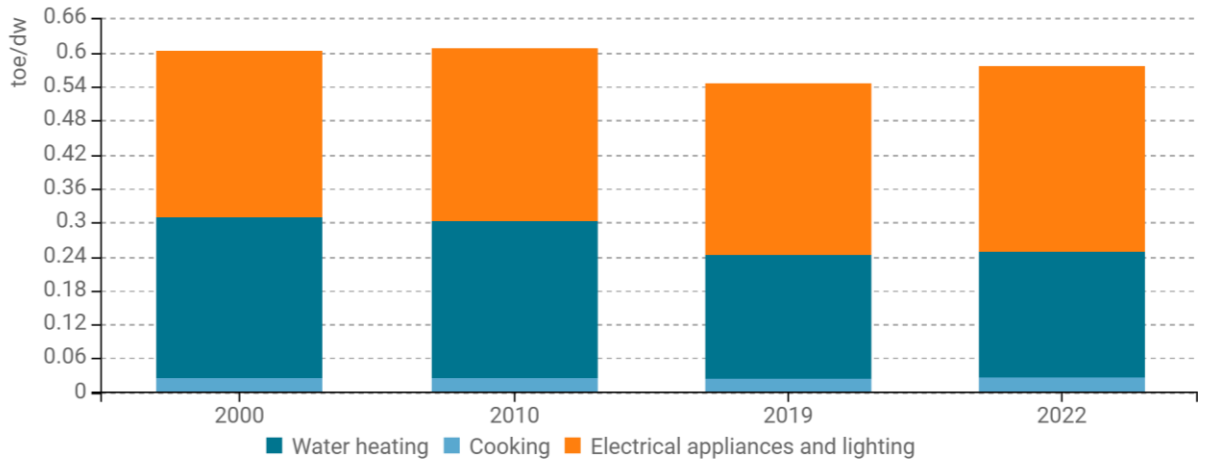

Figure 12. Energy consumption per dwelling by end-use (except space heating). Source: Odyssee

Total energy consumption decreased by 0.33 Mtoe between 2000 and 2022, from 7.29 to 6.96 Mtoe. The single most important factor pulling down energy use is energy savings, amounting to a 2.65 Mtoe decrease over the period. This is partly counterbalanced by upward trends, such as the increasing number of dwellings, more appliances per dwelling and larger homes.

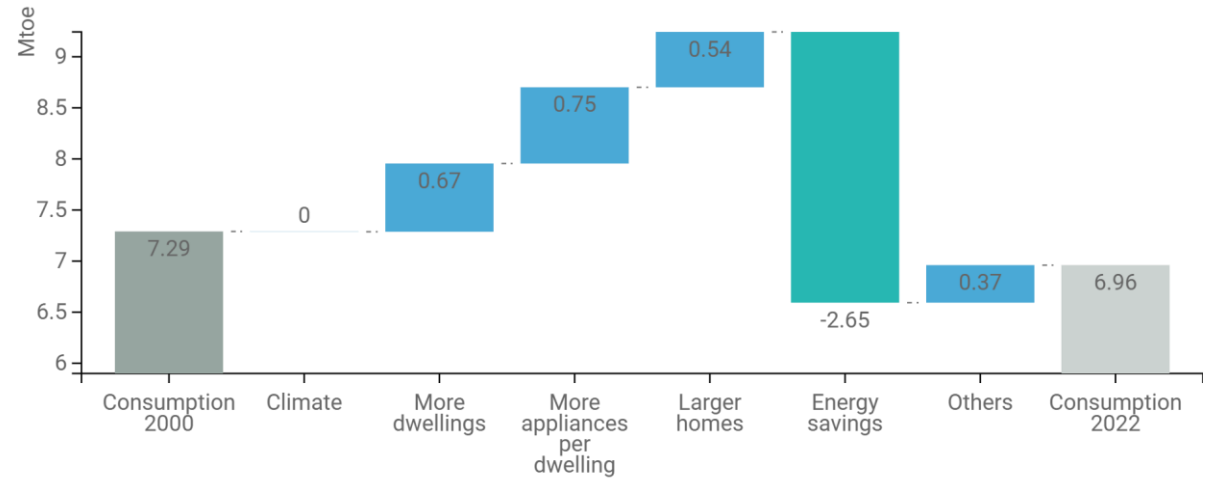

Figure 13. Main drivers of the energy consumption variation in households. Source: Odyssee

Between 2000 and 2022, the energy consumption for space heating in households decreased from 4.98 Mtoe to 3.96 Mtoe, a decrease of 1.02 Mtoe. The single most important factor pulling down energy used for space heating is savings, amounting to a decrease of 1.69 Mtoe over the period. Increased activity and larger homes are factors have contributed to an increase in the energy use for space heating.

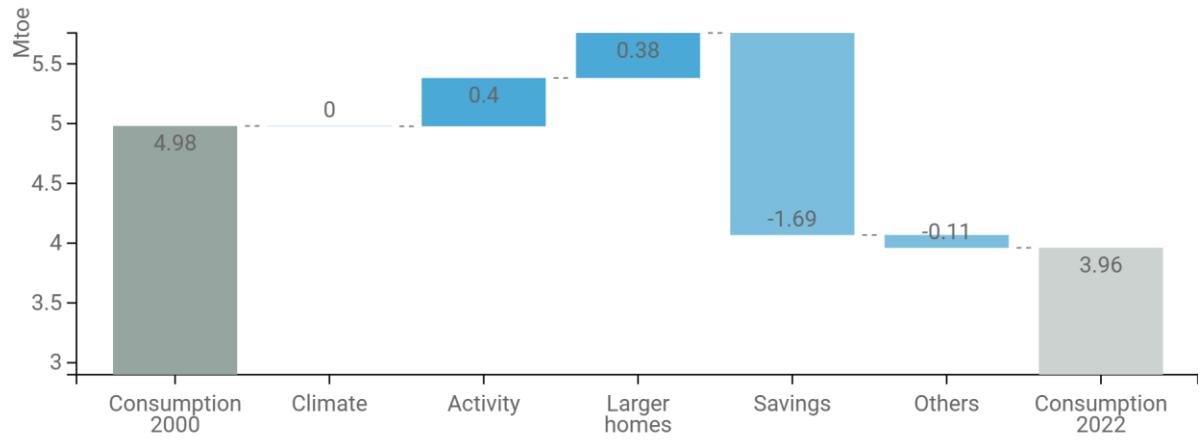

Figure 14. Main drivers of the space heating consumption variation of households. Source: Odyssee

The most notable change in the services sector, by branch, is ''Other services'', where the energy consumption dropped from 1.35 Mtoe to 1.1 Mtoe between 2000 and 2022. The energy consumption in health services also declined, from 0.52 Mtoe to 0.45 Mtoe, while consumption in hotels and restaurants increased from 0.18 Mtoe to 0.24 Mtoe. Other branches remained relatively stable, exhibiting only minor fluctuations in energy use.

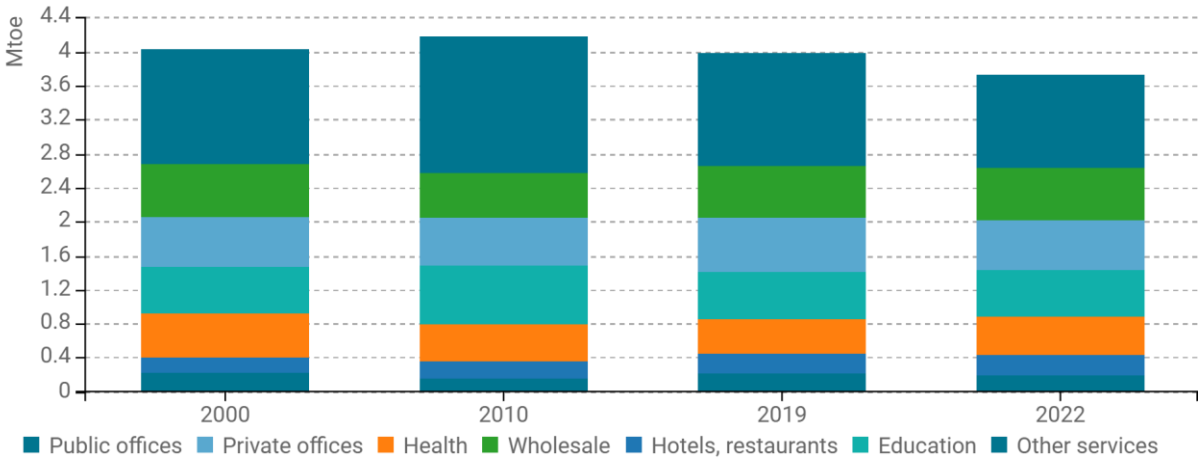

Figure 15. Final energy consumption of services by branch. Source: Odyssee

Electricity consumption per m^2 in services has increased by 16.8% during the years 2000-2022, while the total energy consumption per m^2 in services has decreased by 10% over the same period.

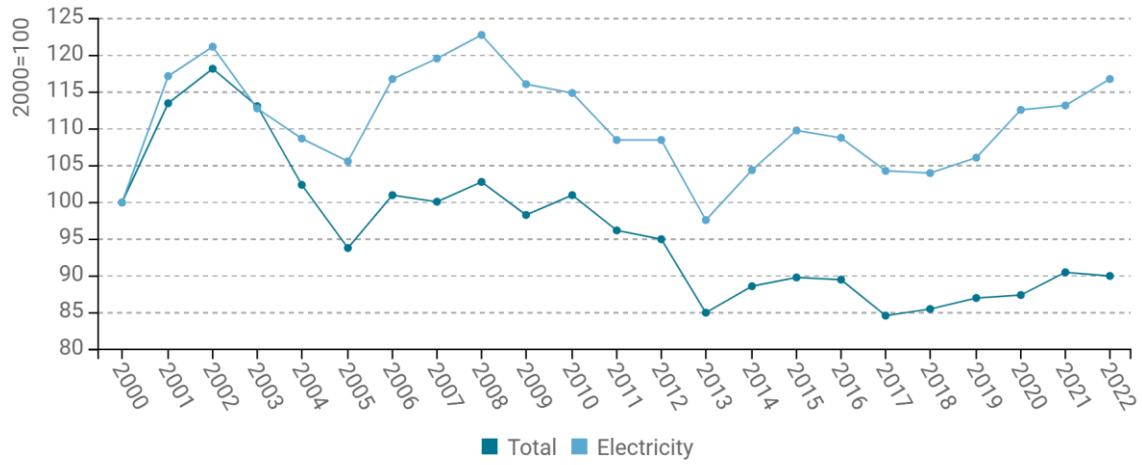

Figure 16. Energy and electricity consumption per m2 in services (with climatic corrections). Index 2000=100. Source: Odyssee

Policy

In Sweden, taxes on energy and carbon dioxide are a powerful instrument for energy efficiency. It has been proven that the energy savings resulting from taxation has had a major impact in the reduction of energy use. However, taxation is supported by other policy instruments, for instance technology procurement groups, where certain actors jointly make purchases of new technology in order to put a downward pressure on prices. There are currently three such procurement groups affecting the buildings sector. One is directed towards landlords of commercial buildings, one towards landlords of residential buildings and one towards builders of individual homes. Moreover, since the 1950's, Sweden has included energy efficiency requirements in the building code, which is updated at least once a decade. The building code applies to all new buildings, and stricter energy efficiency requirements have been introduced with each update of the building code.

Measures

Programme for buildings with very low energy use (LÅGAN): A programme aimed at changing the building process for buildings with a very low energy use. The goal is to contribute to a national market for low energy-buildings and to a wide range of suppliers nationally. The programme gives support to demonstration facilities and regional or local collaboration initiatives. 40 percent of the funding comes from the Swedish Energy Agency, and the project is administrated by the Swedish Construction Federation, the industry organization for construction companies in Sweden.

Energy Performance of Buildings (2002/91/EC) amendment (2018/844/EU): The prime responsibility for implementing the EPBD lies with the Swedish National Board of Housing, Building, and Planning (Boverket), which is the issuing authority of the Swedish Building Codes (Byggregler). Currently, a process for simplifying these is underway.

Industry sector

Between 2000 and 2022 total energy consumption within the industry sector decreased by 1.2 Mtoe, from 12.2 to 11 Mtoe. Paper and pulp industry, accounting for half of the industrial energy consumption, reduced its consumption from 6.0 Mtoe to 5.8 Mtoe. Steel industry consumption decreased by 25%, from 1.1 Mtoe to 0.85 Mtoe.

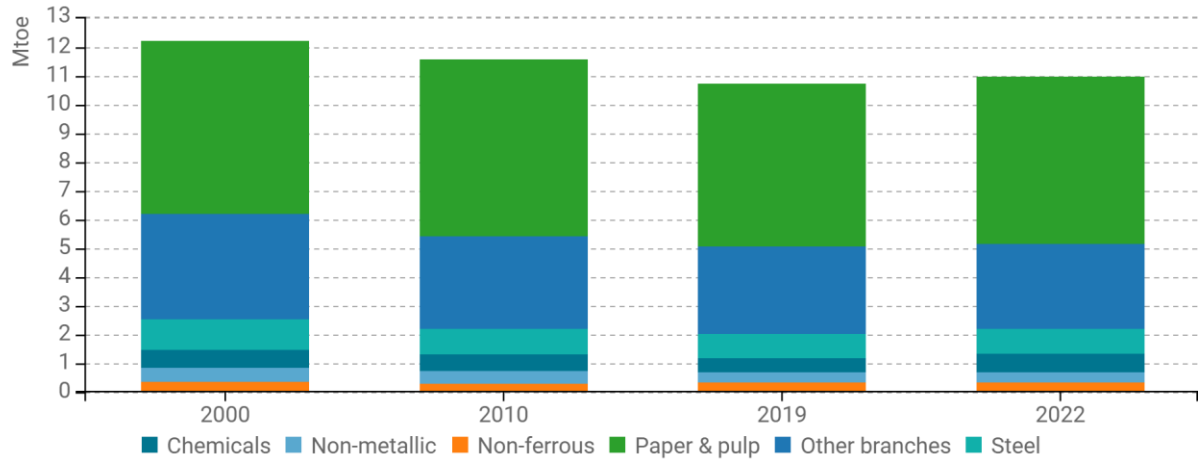

Figure 17. Final energy consumption of industry by branch. Source: Odyssee

Unit consumption of cement fell by 22.7 % between 2000 and 2022. For steel, the unit consumption increased by 6.6% over the same period. Paper and pulp unit consumption was 10.8% higher in 2022 compared to 2000.

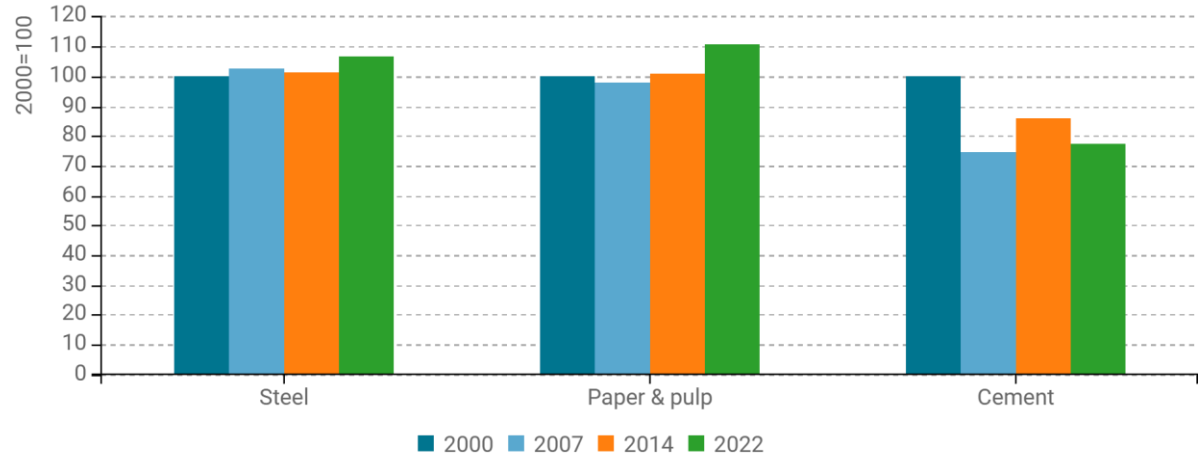

Figure 18. Unit consumption of energy-intensive products (toe/t). Source: Odyssee

Total industrial energy consumption in 2000 was 12.2 Mtoe, and 11 Mtoe in 2022. Energy savings had the greatest impact in this reduction, but structural changes also contributed to some extent. Upward pressure mainly came from increased activity and other, unspecified factors.

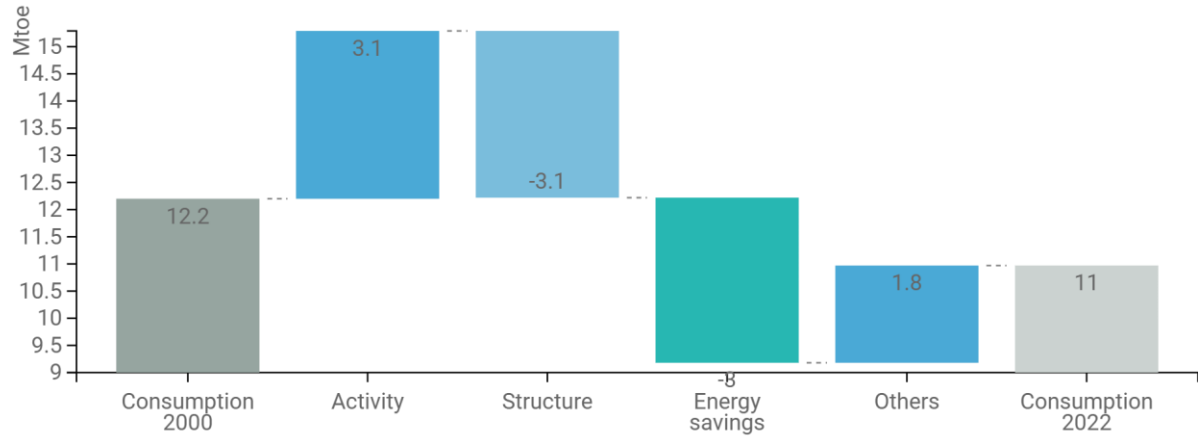

Figure 19. Main drivers of the energy consumption variation in industry. Source: Odyssee

Policy

There are, and have been, several policy instruments aimed at increasing energy efficiency within the industry, including both large industries and SMEs.

Between 2008 and 2014 there was a programme in place whereby large energy-consuming industries were allowed some relaxation on certain taxes if they committed themselves to verifiable measures for energy efficiency. Moreover, there are several active energy efficiency networks for industries, divided according to branch. Even if the companies participating in the networks are competitors, they have many issues in common which can be handled through collaboration and sharing of knowledge.

Measures

Energy mapping: In Sweden, large companies are obliged by law to carry out an energy mapping. The mapping shows how energy is used in different parts of the company with the purpose of improving energy efficiency. The mapping has to be carried out by a certified actor, or within a certified energy or environmental management system, and includes proposals for cost efficient measures to lower the company's energy usage and improve energy efficiency. The Swedish Energy Agency also provides guidelines and support for small and medium-sized companies that wish to carry out an energy mapping for their operations, but they are not subject to any legal requirements.

Local energy and climate counsellors for SME: Local energy and climate counsellors provide cost-free advice to small and medium-sized enterprises, private individuals and associations on questions regarding heating, energy efficiency, transports, energy costs and other issues. The service is provided on a municipal level and supported financially by the Swedish Energy Agency.

The Environmental Code: The legislation in the Swedish Environmental Code aims to increase energy conservation and efficiency. Energy efficiency and resource conservation are factors that are taken into account when examining permits under the Environmental Code regarding, for example, large industries. These are also issues that are included in the supervision of industries and other companies. According to the Environmental Code, requirements can be placed on companies to use the best possible technology for conserving energy.

Transport sector

Energy consumption in the transport sector has decreased by 8.5% between 2000 and 2022. The split between different modes of transportation has remained very stable and is dominated by road transport, which accounts for 92% of the energy use.

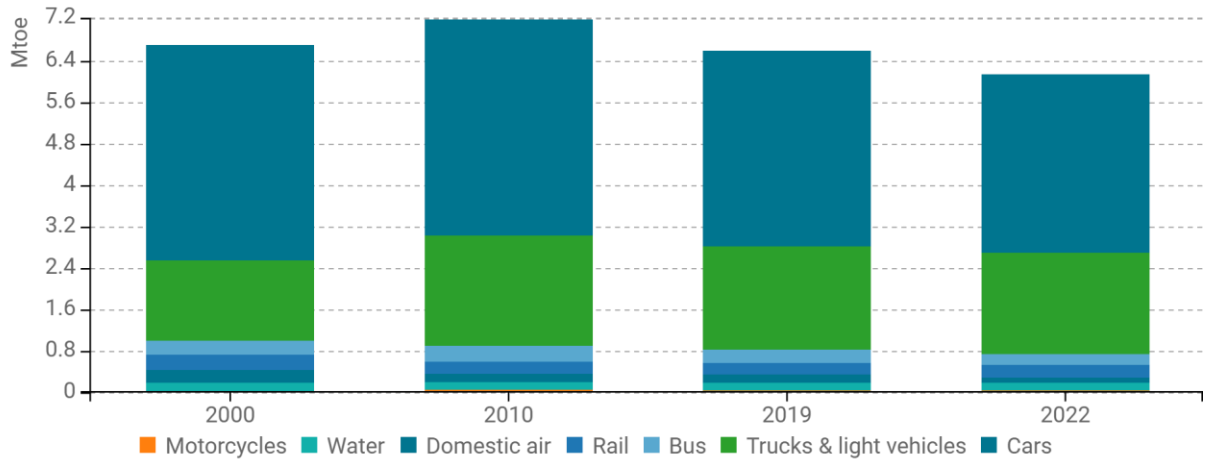

Figure 20. Transport energy consumption by mode. Source: Odyssee

The share of rail in inland passenger traffic increased by 4.6% between 2000 and 2022, which is partly a result of extensive campaigns. The share of car transport decreased by 5% and share of bus transport has increased by 4% over the period 2000-2022.

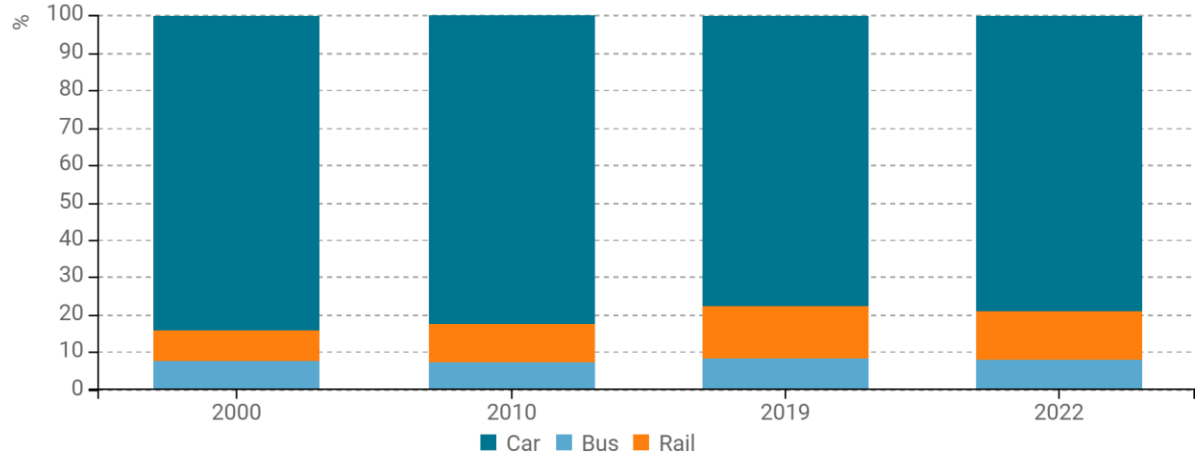

Figure 21. Modal split of inland passenger traffic. Source: Odyssee

For inland freight traffic, there has been a significant shift to road transport, which increased from 58.9% to 65.5% over the period 2000-2022 to the detriment of rail and water transport.

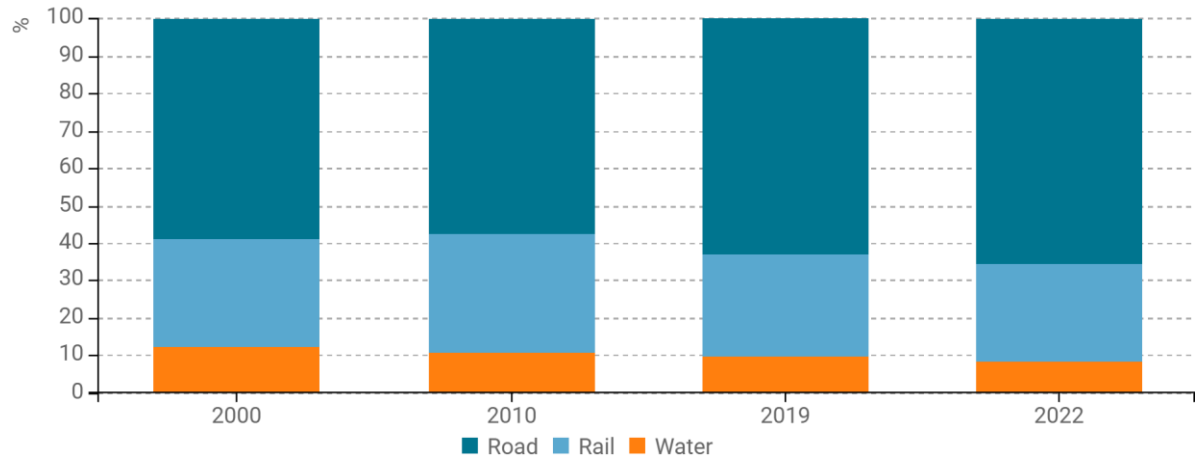

Figure 22. Modal split of inland freight traffic. Source: Odyssee

The energy consumption of cars per passenger-km decreased with 9.3% between 2000 and 2022.

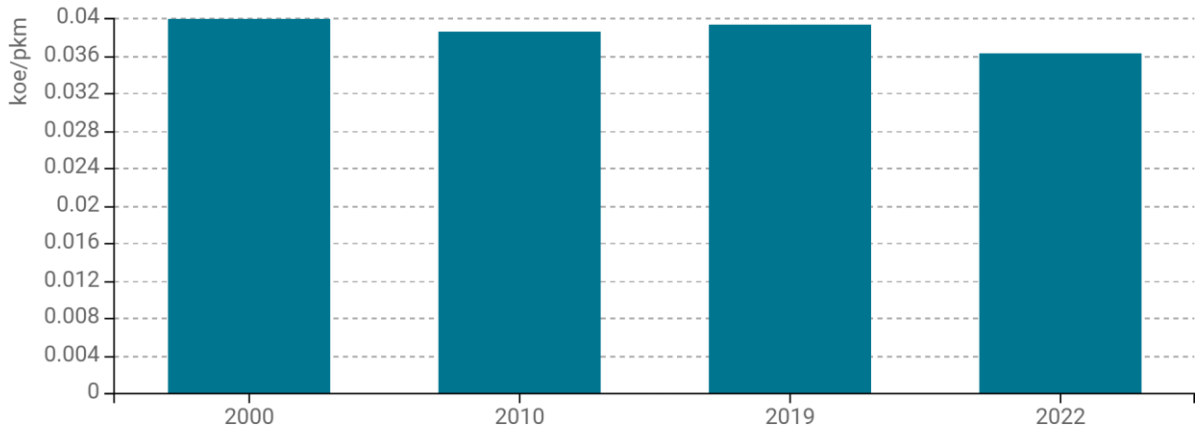

Figure 23. Energy consumption of cars per passenger-km. Source: Odyssee

Total energy consumption for transport decreased from 7.4 Mtoe to 6.92 Mtoe between 2000 and 2022. The main reason behind the downward trend is increased energy savings, while modal shift has played a minor role. The major upward pressure comes from increased activity.

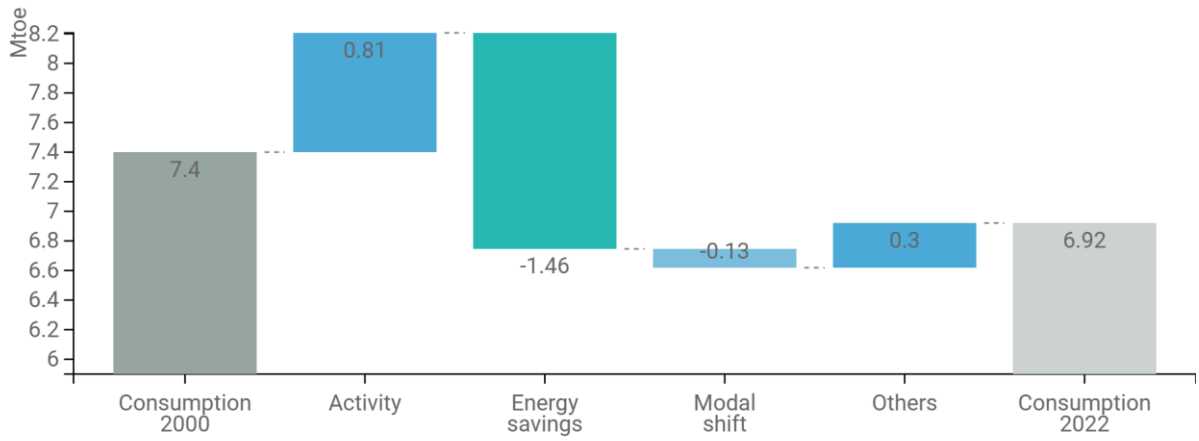

Figure 24. Main drivers of the energy consumption variation in transport. Source: Odyssee

Policy

The most important policy instrument in the transport sector are the previously mentioned taxes on energy and carbon dioxide. In addition to this, there are several specific policy instruments aimed at energy efficiency in the transport sector, such as the malus system for private vehicles and the fuel blending mandate described below.

Measures

Greenhouse gas reduction mandate / Fuel blending mandate: Fuel suppliers are obliged to reduce GHG emissions by increasing the blending of petrol and diesel with biofuels. This measure also increases fuel costs and thereby increases the incentive to switch to more energy efficient vehicles with a more efficient fuel consumption.

Government Procurement of Low-emission Vehicles and Transportation: In order to reduce GHG emissions, vehicles and transport services must become more energy efficient. By working strategically with procurement and setting requirements for, for example, using electricity or renewable fuels for transportation, public procurement is contributing to pushing the development in the right direction.

Low-emission zones: Municipalities can decide to exclude certain vehicles from particularly environmentally sensitive areas. From January 1, 2020, municipalities have the mandate to introduce low-emission zones of class 1, 2 or 3 in their municipality. Low-emission zones have thus far been implemented in several municipalities, including Sweden's three largest cities.[3]

[3] Miljözoner - Transportstyrelsen

Discussion and conclusion

This report analyses the development of the energy efficiency in Sweden at the level of the overall economy and all final energy consumption sectors between 2000 and 2022. It also gives a picture of Sweden's policy landscape targeted towards energy efficiency.

It can be concluded that Sweden has achieved economic growth while improving energy efficiency. The Swedish economy grew by roughly 56% between 2000 and 2022, corresponding to an average annual growth rate of around 2%. Meanwhile, energy intensity measured by both primary and final energy consumption declined significantly between 2000 and 2022. Primary energy intensity decreased by approximately 35.7% and final energy intensity by approximately 40% between 2000 and 2022.

In a comparison between the sectors, the largest energy efficiency improvements have been achieved in the residential and services sectors while progress in the transport and industry sectors was more modest.

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