Energy in Sweden 2022

With energy balance for year 1970–2020

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An overall picture of the energy situation in Sweden

With the publication of Energy in Sweden, the Swedish Energy Agency intends to provide an overall picture of the current situation and development of the energy sector in Sweden. As a supplement to the publication Energy in Sweden (Excel) is available on the Agency's website. [1]

Energy in Sweden contains information about the use and supply of energy, energy prices, energy markets and fuel markets, as well as current energy policy. The publication presents historical time series of developments in the energy sector. Energy in Sweden 2022 also includes some aspects of events in the energy sector up until autumn 2022. For forecasts of future developments please read the Swedish Energy Agency's latest short-term and long-term forecast.[2] As a follow-up on the energy policy goals, we refer to the Swedish Energy Agency's publication Energy Indicators.[3] For more updated information please read the Swedish Energy Agency's market and status reports.[4]

About the statistics

The annual statistics mainly come from the Swedish Energy Agency's energy balance, including data dating back to 2005, also published on the Agency's website.[5] The annual statistics upon which the energy balance is based, extend to the year 2020; a year marked by the COVID-19 pandemic. Therefore, the statistics for 2020 deviate from the norm in some regards.

This time the report has been published earlier compared to previous years due to Sweden's presidency in the EU initiated on 1 January 2023. In the normal case, the report would have been published in the spring of 2023 and all statistics regarding year 2021 could have been included. Some statistics, for example price statistics, are included until year 2021 to the extent that they are available. Further information about the statistics for which the Swedish Energy Agency is responsible, as well as other publications, is available on the agency's website.[6]

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[1] Energy in Sweden (Excel) contains statistics from the publication in raw data. Energy in Sweden (Excel) contains also additional statistics in addition to what is presented here.

[2] Energimyndigheten, *Prognoser och Scenarier [Forecasts and Scenarior]*, https://www.energimyndigheten.se/statistik/prognoser-och-scenarier/ (Retrieved 2022-10-24)

[3] Energimyndigheten, *Energiindikatorer [Energy indicators]*, https://www.energimyndigheten.se/statistik/energiindikatorer/ (Retrieved 2022-10-24)

[4] Energimyndigheten, *Prenumerera på marknads- och nulägesrapporter* [*Subscribe to reports on markets and current situations*,https://www.energimyndigheten.se/om-oss/press/prenumerera/laget-pa-energimarknaderna/ (Retrieved 2022-10-24)

[5] Energimyndigheten, Årlig energibalans [*Annual energy balance]*, http://pxexternal.energimyndigheten.se/pxweb/en/%C3%85rlig%20energibalans/%C3%85rlig%20energibalans__Balanser/EN0202_A.px/?rxid=ee03e1ee-e561-4ef6-8f06-aae44b13c8b3 (Retrieved 2022-10-24)

[6] Energimyndigheten, *Statistik [Statistics*], http://www.energimyndigheten.se/en/facts-and-figures/statistics/ (Retrieved 2022-10-24)

The impact on the energy situation and the publication Energy in Sweden due to the COVID-19 pandemic and the war in Ukraine

The energy statistics in this report are based on the energy balance for year 2020. Therefore, certain limitation in showing events in the statistics after year 2020 that have an impact in energy area, mirrors the report. The events referred to are the following:

- The impact of the COVID-19 pandemic during 2021 and 2022.
- Price increase on the energy market starting in the second half of 2021 and during 2022. Specifically, prices of fuel and electricity.
- Russia's war against Ukraine starting in the February 2022 and its impact on the energy sector.

The impact of the COVID-19 pandemic on the energy situation in 2020

The year 2020 was a special year both globally and in Sweden. During 2020, the COVID-19 pandemic continued with severe restrictions and recommendations which led to lower energy use in particular the transport and industrial sectors. The 2020 statistics will thus be an outlier in the development of energy use over the period.

Many countries in Europe introduced severe restrictions which meant isolation for a large part of the population which affected the energy market. As result of the restrictions, demand for raw energy materials decreased, mainly in the transport sector, leading to falling prices. Energy use in the transport sector was radically reduced due to travel restrictions. For example, the price of oil, natural gas and coal decreased due to lower demand, and so reduced the price of electricity.

Furthermore, industrial energy consumption reduced due to the COVID-19 pandemic. Trade restrictions, lockdowns, staff shortages, and low demand, led to an economically strained situation. This resulted in many factories and companies having to shut down. In addition, many components that are necessary for the Swedish energy system are imported from abroad such as spare parts, key components, and special services.

The impact of the war in Ukraine on the energy situation now and in the future

In the beginning of 2022, Russia started a war against Ukraine which caused a great uncertainty in the energy market due to extensive supply disruptions in deliveries of electricity, gas and fuel in Europe including in Sweden. Russia cut off supplies of gas and oil to Europe in response to the sanctions that were forced on Russia which led to a sharp increase in, among other things, electricity, and fuel prices. Therefore, the Ukraine war contributed to a strained energy situation in Europe and increased inflation in 2022.

Increased focus on security of supply

The perspective of secure energy supply and new policy instruments are brought up in separate subchapters. Since the 2020 report, the issue of secure energy supply has gained increased relevance. This resulted from limitations in fuel supply during pandemic, sharp increasing energy prices starting in second half of 2021 but also to Russia's war against Ukraine which effected, among other things, the supply of natural gas in Europe. These events have put energy and the security of supply in focus both in Sweden, in the rest of the EU and globally.

The European Commission adopted six sanction packages against Russia and is working actively to strengthen the EU's security of supply and expand its import options. The "green transition" has also been intensified. The European Commission announced a broad action plan containing various measures to quickly reduce dependence on Russian fossil fuels and accelerate the transition to renewable energy sources. All these measures affect energy use and legislation.

You can read more about how the energy situation in Sweden is affected by the invasion of Ukraine on the Energy Agency's website[7], and updated figures for 2021 can be read under Energy situation in figures 2023[8].

[7] Energimyndigheten, *Sveriges energiläge [Sweden's energy situation]*, https://www.energimyndigheten.se/om-oss/press/prenumerera/laget-pa-energimarknaderna/sa-paverkar-invasionen-av-ukraina-sveriges-energilage/ (Retrieved 2022-10-24)

[8] Energimyndigheten, *Energiläget [Energy in Sweden],* https://www.energimyndigheten.se/en/facts-and-figures/publications/ (Retrieved 2022-10-24)

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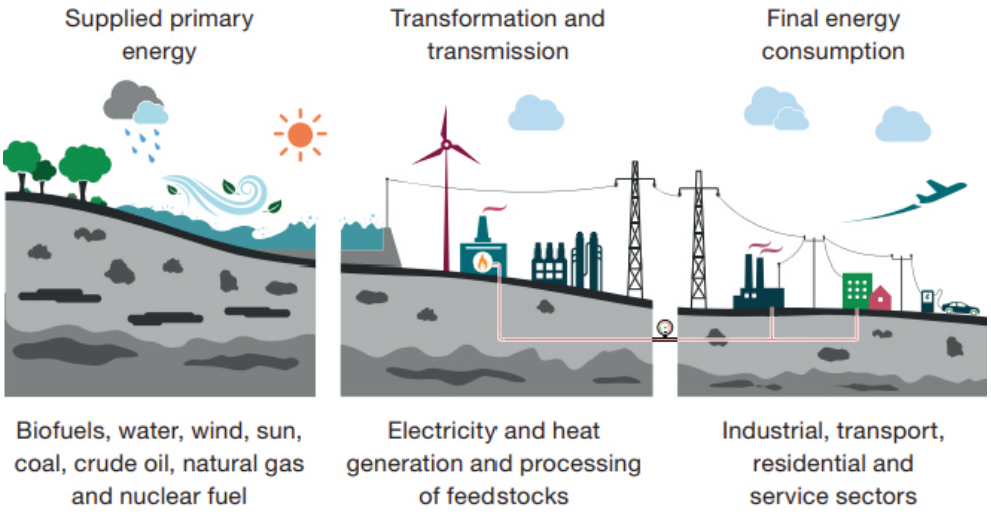
A balanced energy system

The energy system consists broadly of supply, transformation, distribution, and consumption of energy.



The Swedish energy system

The Swedish energy system is partly based on domestic sources of renewable energy such as water, wind, and biofuel. In addition, a large proportion of the energy supplied is dependent on imports, such as nuclear fuel for electricity production in nuclear reactors and fossil fuels, such as oil and natural gas for the transport system. Swedish electricity production is based largely on hydropower and nuclear power, but the expansion of wind power is steadily increasing. The use of biofuel for electricity and heat production is also increasing.

The final energy usage in Sweden can be divided into three user sectors: the industry sector, the transport sector, and the residential and service sector. The residential and service sector mainly use energy from district heating, electricity, oil, biofuels. In the industrial sector, energy is used to operate processes. This sector primarily uses biofuel and electricity.

Energy use within transportation is mainly based on oil products in the form of petrol, diesel, and aviation fuel. Electricity and biofuels are also a growing source of energy within transportation.

A more detailed description of energy supply and use in Sweden is presented in Figure 1. The figure illustrates current flows of supply and use for 2020.

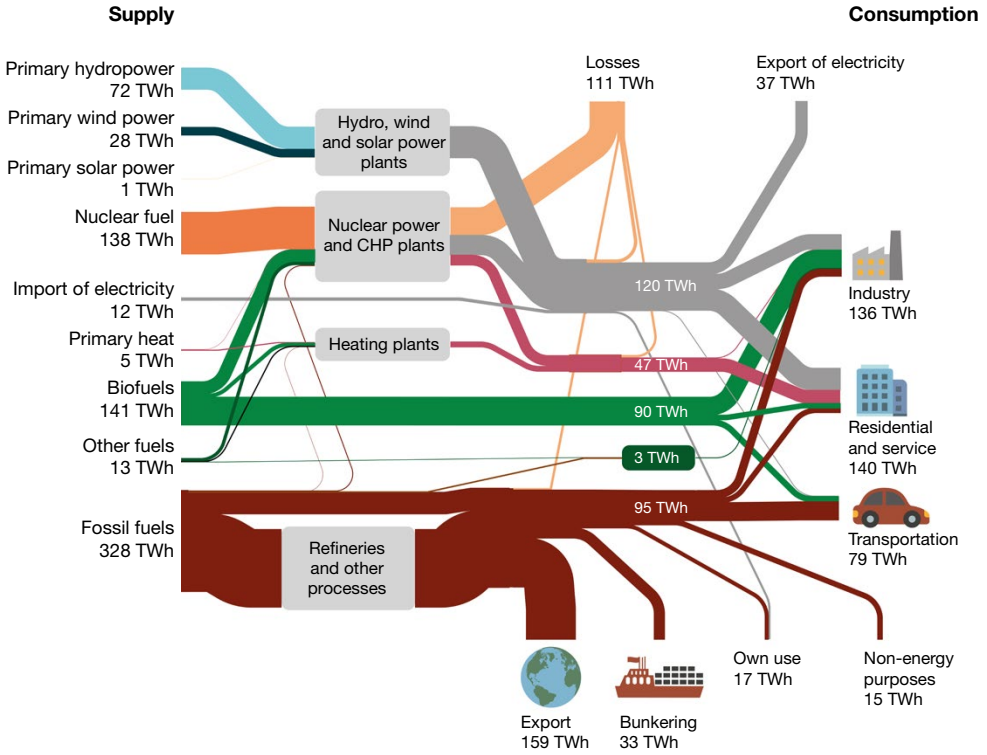


Figure 1. Energy supply and use in Sweden 2020, TWh.

Source: Swedish Energy Agency

The energy balance

The energy system is always in balance. Energy input is always equal to the energy use (when losses are included). Figure 2 shows an overview of how supply and use in Sweden's energy system was distributed in 2020.

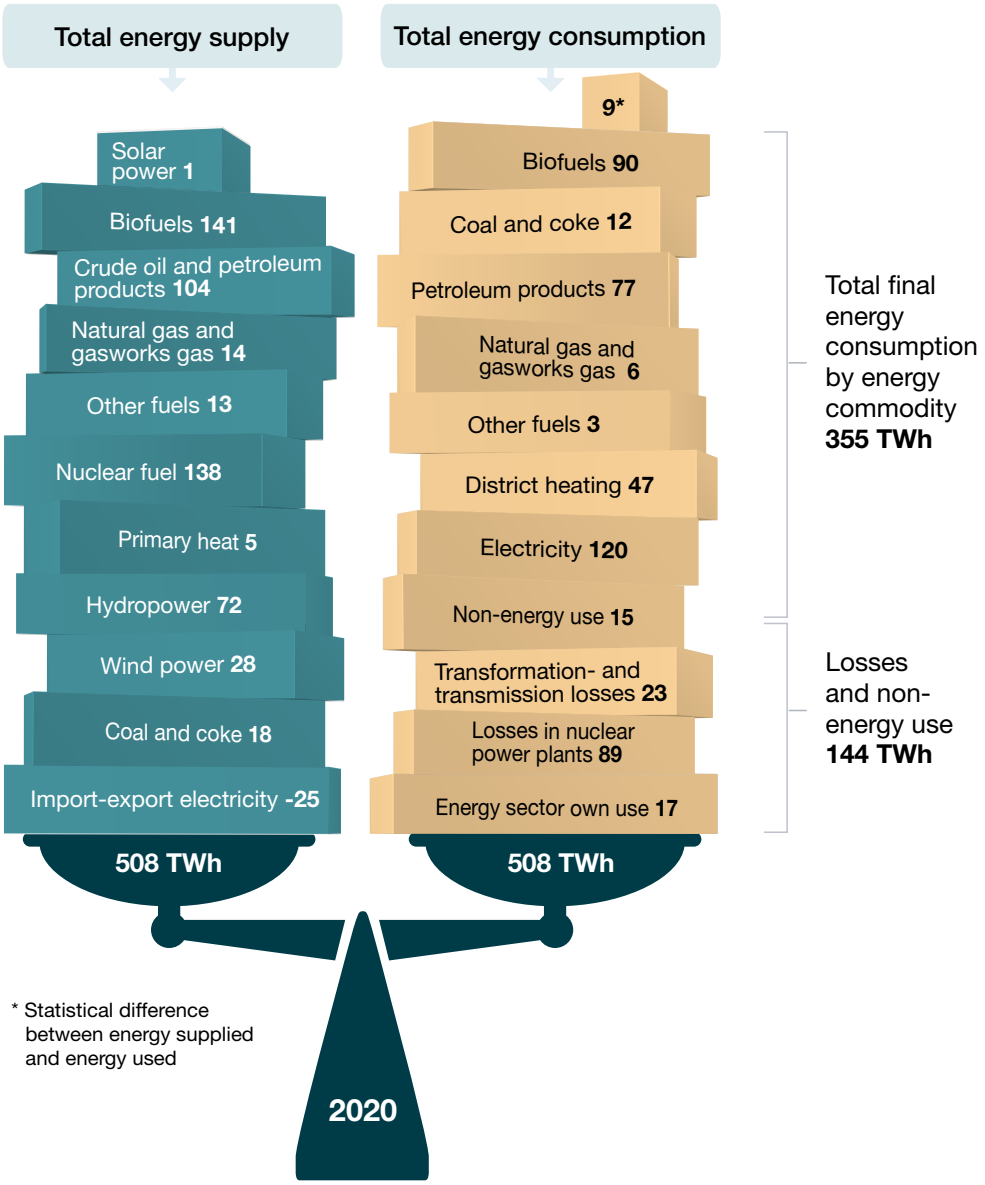


Figure 2. The energy balance in Sweden 2020.

Source: Swedish Energy Agency

Total energy supplied

The supply to the Swedish energy system has, since the mid-80s, remained at a level between 550 TWh and 600 TWh. In 2020, the total energy supplied amounted to 508 TWh and an additional 25 TWh electricity was net exported to other countries. Figure 3 shows an increasing supply from renewable energy. The main trends are that supply from biomass has increased steadily since the 1980s and the supply from wind power has increased since the beginning of 2000s. The supply from solar power has also increased rapidly during the 2010s, however it remains a small part of the overall energy supply and cannot be seen in the figure. In 2020, the supply from solar power was 1 TWh. The energy supply of fossil energy commodities such as crude oil and petroleum products has decreased by more than half since the 1970s.

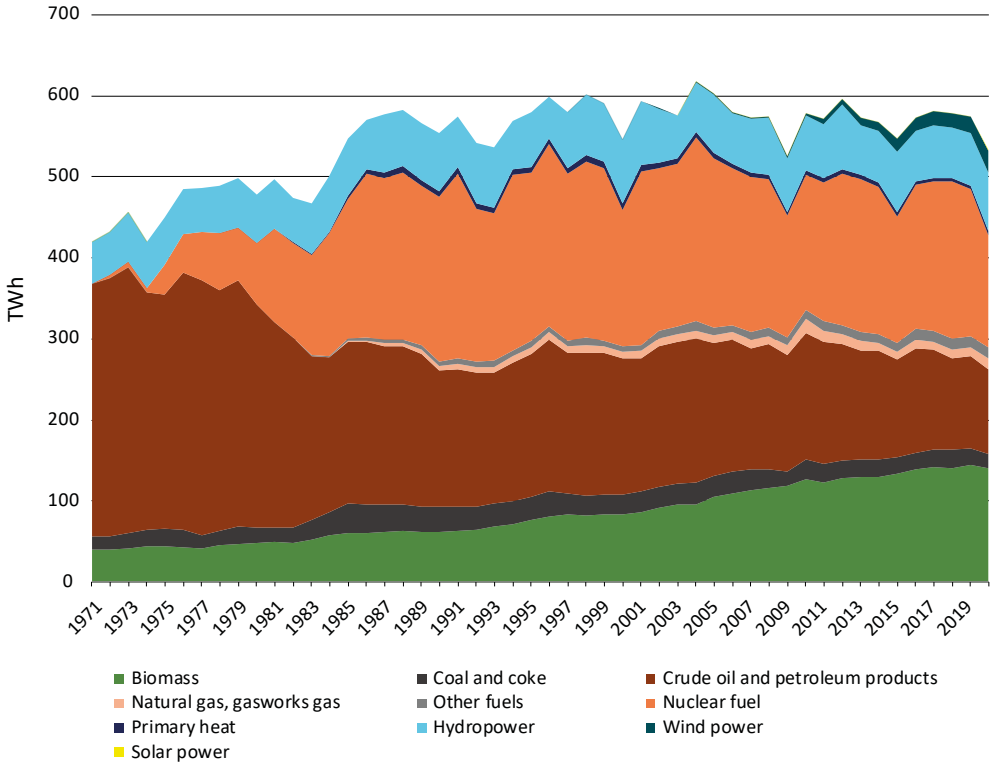


Figure 3. Total energy supply by energy commodity 1970–2020, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

Just over 27 per cent of the supplied energy in 2020 came from nuclear fuel and amounted to 138 TWh. Of that, 47 TWh was transformed into electricity while the rest were transformation losses. The supply of nuclear fuel was increasing during the 1970s and continued until the 1990s and was then at a relatively steady level until the year 2019. After that, the supply dropped significantly compared to previous years, partly due to a low availability of active reactors in 2020 and a lower installed power as Ringhals 2 and Ringhals 1 were taken out of operation at the end of 2019 and at the end of 2020, respectively.

In 2020, biomass accounted for 141 TWh of Sweden's supplied energy; a marginal decrease from the previous year, but the long-term trend is a steady increase. The supply from biomass has tripled over the past 40 years. In 2010, biomass accounted for 127 TWh of Sweden's energy supply and 10 years before that, in 2000, for 84 TWh. The district heating sector and the industrial sector are the major users of biomass and together accounted for 67 precent of use. The use of biomass in the transport sector has grown strongly in the last 20 years from under one TWh during 2000 to almost 17 TWh during 2020.

Fossil fuels in the form of oil products, natural gas, gasworks gas, coal and coke accounted for 136 TWh of the energy supplied in 2020. This resulted in 95 TWh of usable energy in

the form of coal, coke, petroleum products, natural gas, and gasworks gas. The remaining part accounted for losses and non-energy purposes[9].

Hydropower is a stable power source in the energy system and has produced electricity at approximately the same level since the 1980s. The level of production is highly dependent on the water supply, which can lead to variations in production from year to year. In 2020 the energy supply from hydropower was 72 TWh.

Electricity production from wind power has increased significantly during the 2010s in pace with the expansion of installed capacity. In 2020, the supply from wind power was 28 TWh which can be compared with 3 TWh in 2010.

Total final energy use is decreasing

In 2020, the total final energy use in the user sectors amounted to 355 TWh. The energy use is still at relative steady level but has decreased slightly during the 2010s. The residential and service sector and industry sector accounted for 140 TWh and 136 TWh respectively, while energy use in the transport sector amounted to 79 TWh, as shown in Figure 4.

For both the residential and service sector and the industrial sector, energy use was at approximately the same level for a long period of time. However, energy use decreased slightly in the industrial sector during 2010s. Energy use in the residential and service sector is impacted in the short-term primarily by the outdoor temperature, as a large proportion is used for heating. In the case of the transport sector, energy use generally declined throughout the 2010s, after having previously increased sharply since the 1970s. The reduction in recent years has been due to improved energy efficiency within the sector partly through a transition to more fuel-efficient vehicles. Read more about the energy use in the different user sectors in their respective sections.

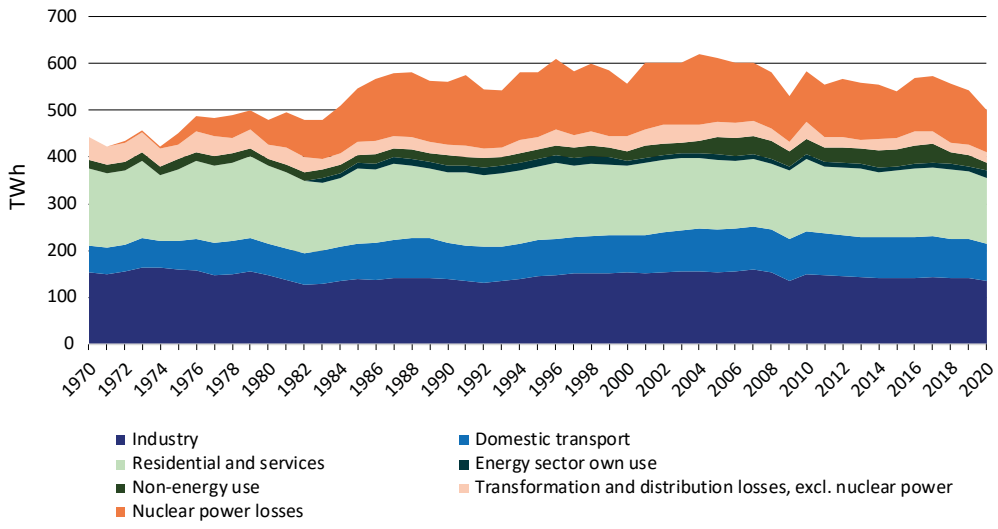


Figure 4. Total final energy use by user sector including losses and other use, 1970–2020, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

[9] For example, raw materials for the chemical industry, lubricating oils and oils for building- and construction operation.

The difference between supplied and used energy consists of losses, own use in the energy sector and uses for non-energy purposes which in 2020 amounted for 144 TWh. This is reduction compared to recent years, as shown in Figure 4. Over half of these losses, 89 TWh, result from cooling during electricity production in nuclear power plants. Other losses arise from heating and combined heat and power stations or as distribution losses in the delivery of electricity and district heating, amounted to 23 TWh in 2020. The use for non-energy purposes[10] amounted to 15 TWh in 2020 and have decreased slightly compared to previous years. Own use in the energy sector amounted to 17 TWh in 2020 and unchanged since the 1990s. This includes, among other things, use for heating, lightning, operating electricity in power plants and refineries.

The final use of petroleum products continues to decline

Electricity is the largest energy carrier for end use in Sweden. In 2020, total final electricity use was 120 TWh[11] with the residential and service sector using the most electricity followed by the industrial sector. Since 2017, biomass has become the second largest carrier of energy after electricity, and the final use in 2020 amounted to 90 TWh; a continued increase.

Petroleum products are the third largest energy carrier and the final use in 2020 amounted to 77 TWh. The petroleum products have decreased by more than half since the 1980s and continues to decline steadily. In 1980, the final use of petroleum products amounted to 208 TWh and oil products were by margin the largest energy carrier with the equivalent of 55 per cent of the total final use in Sweden. Today, Sweden's final use of petroleum products is almost exclusively in the transport sector. The total final energy use distributed by energy carrier in 2020 is shown in Figure 5.

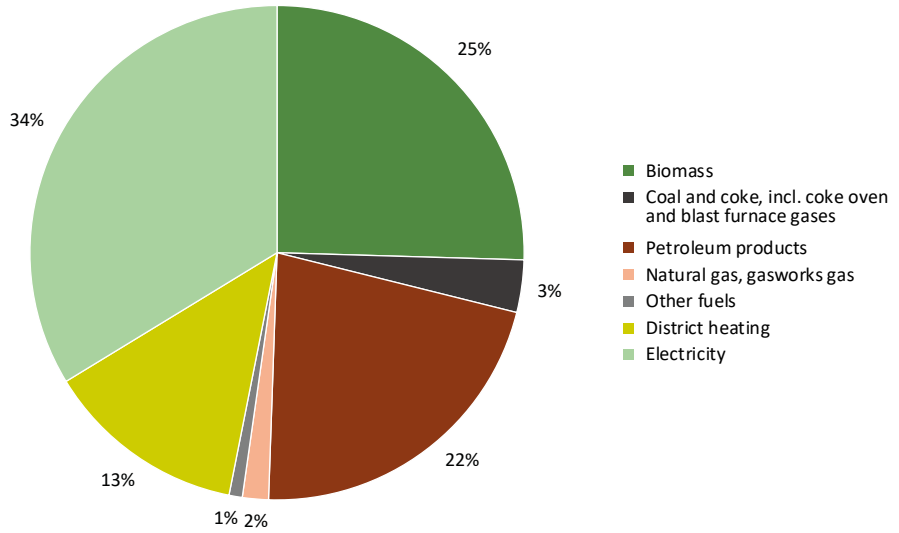


Figure 5. Total final energy use, by energy carrier 2020,355 TWh, in per cent.
Source: Swedish Energy Agency.

[10] For example, raw materials for the chemical industry, lubricating oils and oils for building- and construction operation.

[11] The total final electricity consumption does not include transmission losses or electricity used in district heating and refineries and more. Total electricity consumption was 135 TWh.

The electricity market

Swedish electricity production is based largely on hydropower and nuclear power, which together accounted for 74 per cent of electricity production in 2020, a share that has decreased from 96 per cent in 1990. The expansion of renewable electricity was extensive during the 2000s, with wind power accounting for the largest portion of the increase. Electricity use has declined since 1990 despite an increasing population. High inflow to the Nordic hydropower, increased wind production and low electricity consumption in 2020 resulted in the lowest electricity spot prices since 2000 in the stock exchange. Sweden net exports electricity for the tenth year in row.

Electricity consumption is decreasing despite increased population

The total amount of electricity used, including distribution losses, amounted to 135 TWh during 2020, see Figure 6. Energy was lower in 2019 and 2020 compared to 2018. Since 1990, the trend for electricity use has been slightly increasing until 2000. After the year 2000, electricity use has slightly decreased, although the use varies somewhat between years. This decrease is particularly notable as since 1990, the population has also increased by approximately 1.9 million.[12]

More than half of the electricity is used in the residential and service sector, with the next highest usage in the industrial sector. Read more about electricity use per sector in each chapter.

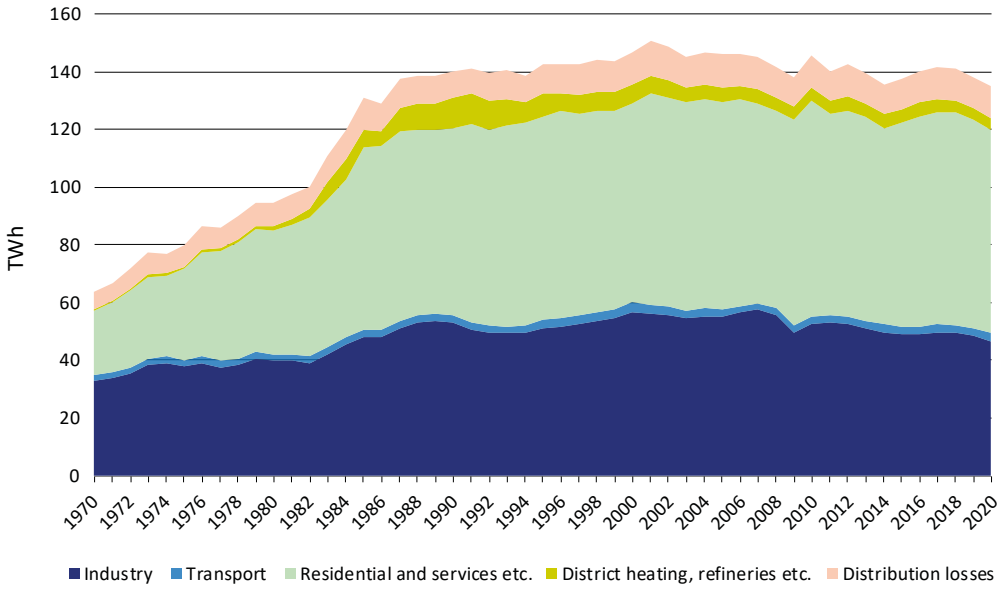


Figure 6. Electricity use, by sector, from 1970–2020, TWh.
Source: Swedish Energy Agency

[12] SCB, *Befolkningsstatistik [Demographics],* https://www.scb.se/hitta-statistik/statistik-efter-amne/befolkning/befolkningens-sammansattning/befolkningsstatistik/ (Retrieved 2022-09-19)

Factors such as population changes and structural changes of industry have an impact on the use of electricity. Outdoor temperatures also have a notable affect due to electricity being a dominant source of heating in Sweden. Economic and technological developments and energy prices are other factors that impact the use of electricity. Particularly in 2020 the COVID-19 pandemic affected electricity consumption.

Hydropower and nuclear power dominate electricity production and renewable energy is increasing

The total electricity production amounted to 161 TWh in 2020, see Figure 7. The trend since 1990 shows an increased annual electricity production. In recent years, the increase has mainly been due to the expansion of wind power. Hydropower accounted for 45 per cent of total electricity production, nuclear power for 29 per cent, wind power 17 per cent and solar power 1 per cent. The remaining 8 per cent was combustion-based production, which mainly takes place in cogeneration plants and in industry.

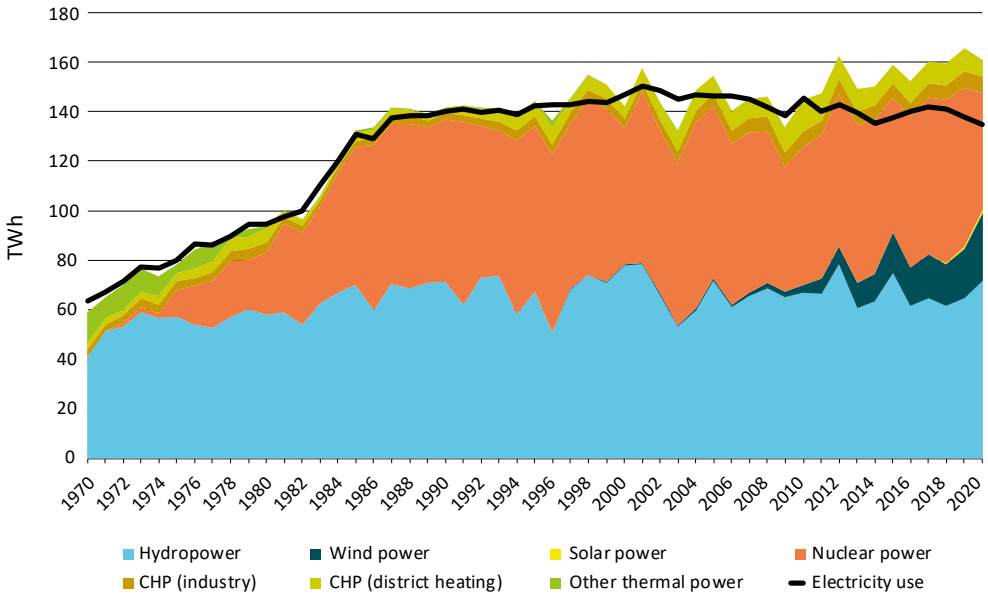


Figure 7. Net electricity production and electricity use 1970-2020, TWh.

Source: Swedish Energy Agency and Statistics Sweden.

Notes: Wind power was included in hydropower up to and including 1996.

Nuclear power plants produced 47.3 TWh in 2020 which was the lowest production levels since 1984. Electricity production from nuclear power decreased mainly due to Ringhals 1 been taken out of service at the end of 2020[13] but also due to very low electricity prices during spring and summer which led to the extension of the outage. 2020 was special year for nuclear power as many reactors were having technical problems that led to less production and shutdowns. There were also difficulties in obtaining inspection staff due to the restrictions of the COVID-19 pandemic. In the beginning of 2021, there were six nuclear power reactors in operation.

[13] Ringhals 2 was taken out of service in the end of 2019.

Combustion-based electricity production accounted for 13 TWh in 2020. This is mainly produced in combined heat and power plants, which produced 6.7 TWh, and within industry, so-called industrial cogeneration, which produced 6.4 TWh. Oil-fired condensing power plants and gas turbines primarily provide reserve capacity, amounting to 0.02 TWh. Biomass accounting for 81 per cent of used fuel in 2020.

Coal and residual gases, in the form of coke oven and blast furnace gases, accounted for 6 per cent of the fuel used. The remaining fuels are natural gas, other fuels[14], and a small amount of oil.

Electricity production from renewable energy sources was 111 TWh in 2020 and has been increasing since 1990, which can be seen in Figure 8. This corresponds to 69 the per cent of total electricity produced in 2020.

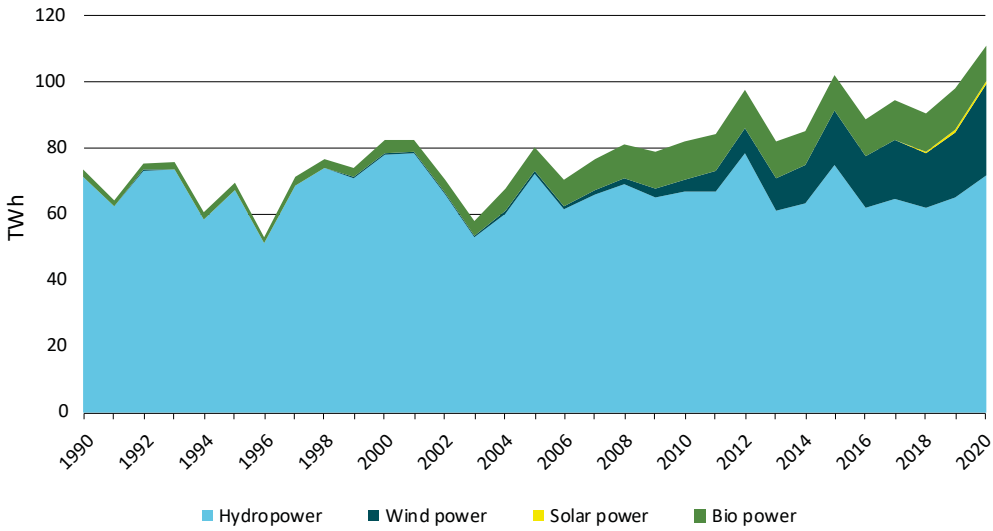


Figure 8. Electricity production of renewable energy sources 1990-2020, TWh.
Source: Swedish Energy Agency

Hydropower produced 72 TWh in 2020. Production from hydropower varies over the years due to water availability. In the past 25 years, the production has varied between 78 TWh at its highest and 51 TWh at its lowest.

Wind power produced 72 TWh in 2020, which is 7,7 TWh more than the year before. Although production varies between years due to wind conditions, production from wind power has increased sharply since 2018 due to fast expansion of installed capacity. In 2020, 322 wind turbines were built, which corresponded to 1.4 GW of new wind power. At the end of 2020, the total number of wind turbines amounted to 4 298 with a total installed power of 10 082 MW.[15] The fast expansion of wind power continued during 2021 with new total installed power of 12 116 MW, an increase of 2 GW compared to 2020. The total number of wind turbines amounted to 4 754 and production was 27.1 TWh, which

[14] Other fuels are fossil fuels and mainly consist of the fossil part of the waste, followed by peat.

[15] Energimyndigheten, *Vindkraftsstatistik [Wind Power Statistics],* http://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/vindkraftsstatistik/?currentTab=0#mainheading (Retrieved 2022-10-11)

is a decrease compared to 2020. The production reduction was due to bad weather conditions as well as manufacturing errors that led production to stop.[16]

Of the combustion-based electricity production, 10.6 TWh of electricity was produced with biomass. Production is at a stable level, although it varies slightly between years. During the last 10 years, an average of 11.2 TWh of electricity has been produced annually with biomass.

Electricity produced using photovoltaic cells still accounts for a very small share of the electricity supply but is growing rapidly. The installed photovoltaic capacity was 1 089 MW by the end of 2020, an increase from 698 MW in 2019. The installed photovoltaic capacity further increased during 2021 by 498 MW (to 1 587 MW)[17]. The photovoltaic market consists of both grid-connected and independent systems, where grid-connected systems account for most of the capacity. Electricity production from photovoltaic cells amounted to 1 TWh in 2020, which is 56 per cent more than in 2019. The rapid increase has been due to financial incentives for investments, increased environmental awareness, the price of electricity, and the fact that the price of photovoltaic cells has decreased in recent years.

Still large net exports in 2020

In 2020, Swedish net export of electricity amounted to 25 TWh, which is the largest electricity export to date. This is the tenth year in a row that Sweden has net exported electricity and the volumes have increased in recent years. The flows of trade between Sweden and neighboring countries vary both between years and throughout the year, see Figure 9.

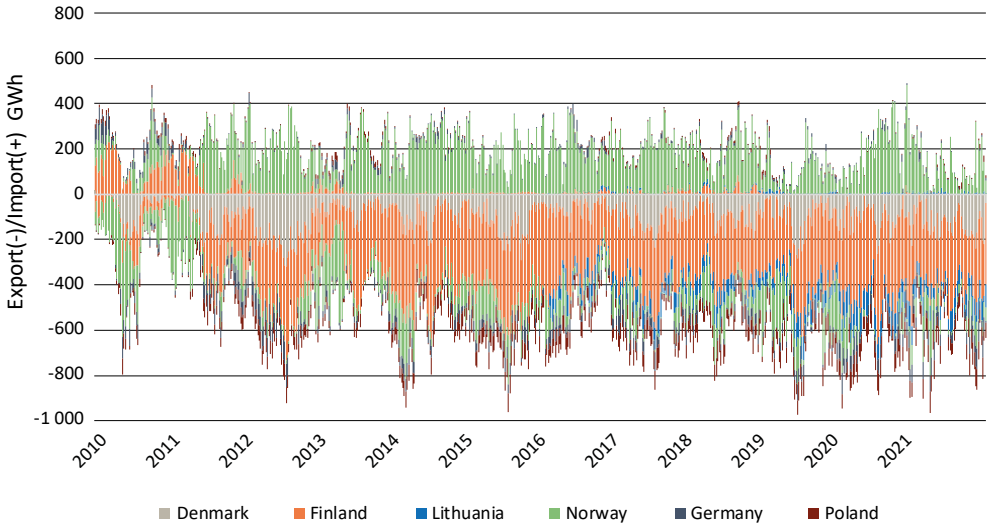


Figure 9. Electricity trade with other countries 2010–2021, GWh/week.
Source: Weekly Statistics Power Situation, Swedenergy.

[16] Liljeström E., *Orsaken till haveriet: "Infästningen misslyckades" [The cause of the breakdown: "The attachment* failed"], SVT Nyheter 2021-01-15. https://www.svt.se/nyheter/lokalt/vasterbotten/orsaken-till-haveriet-infastningen-misslyckades (Retrieved 2022-10-11)

[17] Energimyndigheten, *Nätanslutna solcellsanläggningar [Grid-connected photovoltaic systems],* http://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/natanslutna-solcellsanlaggningar/ (Retrieved 2022-10-11)

Trade in electricity between countries depends on price differences between different electricity areas.[18] Price differences may be the result of the availability of water, the availability of nuclear power, the capacities for transmission, the use of the electricity and the availability of natural gas in parts of Europe such as Germany. The electricity grid is interconnected, and the electricity can flow across national borders but within the limitations of the electricity cables. This has an impact on the electricity price between the different electricity areas. Most net imports came from Norway while most net exports were sent to Finland both in 2019 and 2020, see Figure 10.

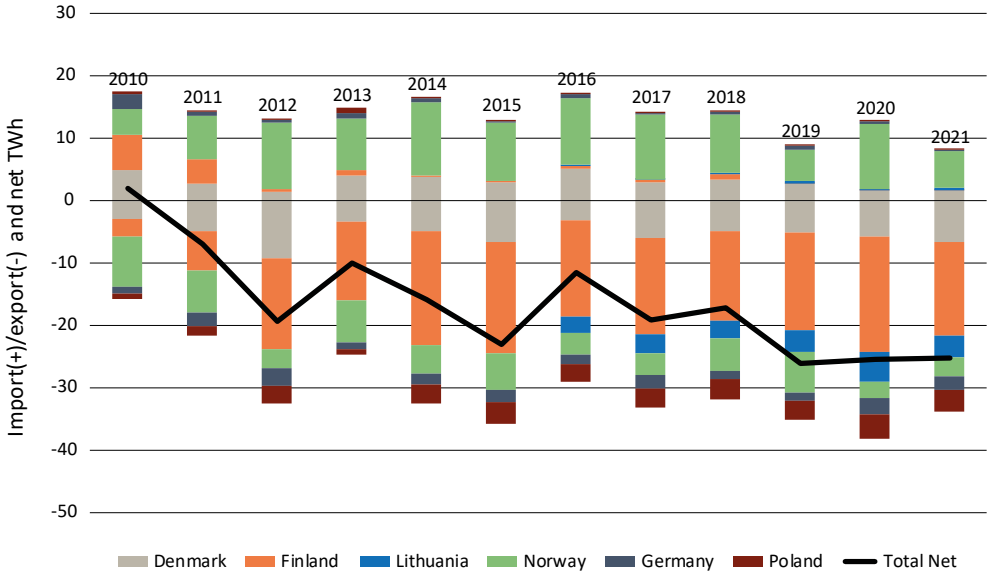


Figure 10. Electricity trade with other countries 2010–2021 including net, TWh/year.
Source: Weekly Statistics Power Situation, Swedenergy.

Sweden currently has transmission connections with Norway, Finland, Denmark, Germany, Poland and, since the beginning of 2016, Lithuania. At the end of 2016, a decision was made to continue the planning for another transmission connection to Finland that can be in operation in 2025. In spring 2017, a policy decision was also taken on a new connection to Germany, which is scheduled to be operational in 2028/2029.[19] The Swedish Transmission System Operator, Svenska kraftnät, is developing the grid continuously, and there are many development projects in progress.[20]

[18] Sweden is divided into 4 so-called electricity areas.

[19] Svenska kraftnät, *Med anledning av avbruten upphandling blir Hansa PowerBridge försenad [Due to the cancellation of procurement, Hansa PowerBridge is delayed]*, https://www.svk.se/utveckling-av-kraftsystemet/transmissionsnatet/transmissionsnatsprojekt/hansa-powerbridge/nyheter/med-anledning-av-avbruten-upphandling-blir-hansa-powerbridge-forsenad/ (Retrieved 2022-11-03)

[20] Read more about ongoing and planned developing projects on Svenska Kraftnäts website https://www.svk.se/utveckling-av-kraftsystemet/transmissionsnatet/transmissionsnatsprojekt/

The installed power is increasing in the electricity system

Following the deregulation of the Swedish electricity market in 1996, there was a marked decrease in installed electricity production capacity. This was primarily due to thermal power being phased out, as it was no longer profitable. After 2000, the capacity increased again and is now greater than prior to the deregulation.

Wind power accounts for the largest proportion of the increase in installed capacity. Increased capacity in nuclear power plants and in combined heat and power plants has also contributed to the total capacity increase. The increase has primarily occurred through expansion within the framework of the electricity certificate system, for example expansion of wind power. Installed electricity generation capacity by type of power are show in Figure 11.

In December 2020, the total installed electricity production capacity was 43 426 MW an increase on prior year due to a sharp increase in wind power capacity. Hydropower accounted for 38 per cent; wind power accounted for 28 per cent; nuclear power accounted for 16 per cent, and other thermal power accounted for 14 per cent. Photovoltaic cells installed capacity have increased by 46 per cent in one year and now accounts now for 4 per cent of total installed electricity production.

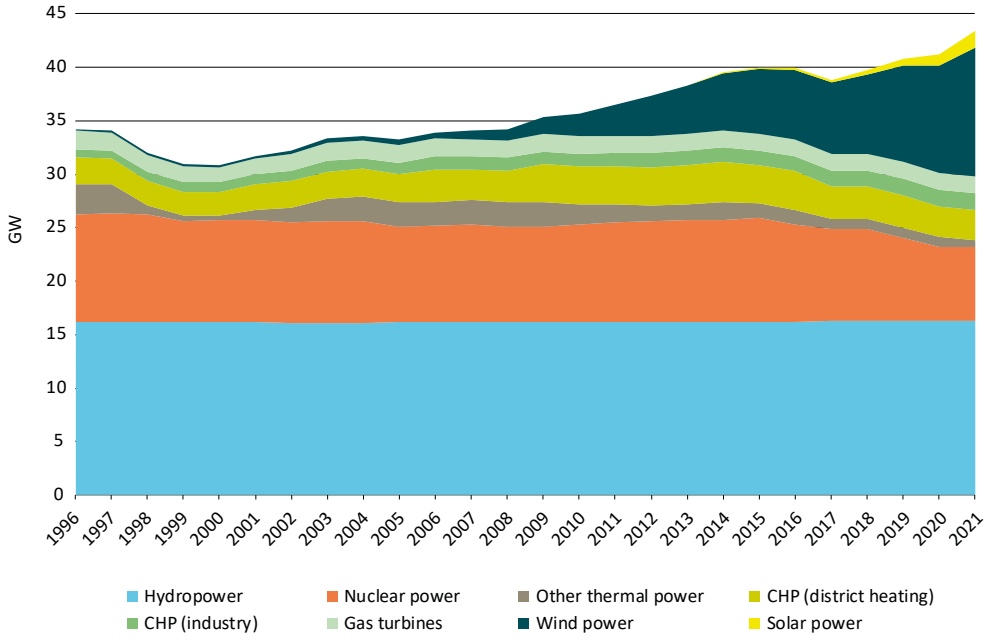


Figure 11. Electricity production capacity, 1996–2021, GW.
Source: Swedenergy.

The decrease in installed electricity production between 2016 and 2017 was mainly due to reactor 1 in Oskarshamn, several CHP (industry) and one CHP (district heating) was taken out of service. It is not possible to use the entire installed capacity at the same time as there are limitations on availability. The available capacity differs from one type of power to the next. Hydropower stations located on the same water course are, for example, dependent on one another and the availability of water. Availability in nuclear power plants depends on the operational situation and yearly inspections.

In terms of wind power, availability depends on the strength, duration, and location of air currents. The power situation can become strained in periods with a higher demand than normal and/or with low available capacity. Prior to each winter, Svenska kraftnät, which maintains and operates the national grid, assesses the power situation for the coming winter.[21]

The highest power output during winter 2021/2022 happened on 7 December 2021, between 5 and 6 pm, and amounted to 25 600 MW. In previous winter highest power output happened 12 February and amounted to 25 500 MW. Even though the difference between the installed capacity and the maximum power output appears to be large, the power generation system may become strained.[22]

Karlshamnsverket, which is procured in the power reserve, has been put into service for about 10 hours in 2021 due to strained power situations during the winter, and in addition to this, there was an activation due to insufficient reserves in Poland (5 h). The forecast for the coming winter also shows that the reserve power may be needed. In the forecasts, Svenska kraftnät shows a negative power balance during winter 2022/2023 with a deficit of approximatly 1,400 MW throughout Sweden. Situations like these increase Sweden's dependence on imports from other countries. However, with weak power balance during peak load hours in neighboring countries due to the energy situation in Europe, import possibilities are currently limited. The forecasts show an increased risk that so-called rolling power outages" may be implemented during winter 2022/2023.[23]

Measures and control measures for a secure electricity supply

Electricity customers may experience three different forms of disruptions in electricity supply: power outages, electrical energy shortages and electrical power shortages.

Power outages that took place in conjunction with Storm Gudrun in 2005 led to the Electricity Act being amended to place more stringent requirements on the suppliers and distributors of electricity. Electricity customers now have the right to compensation for power outages lasting longer than 12 hours. A functional requirement was introduced into the Electricity Act on 1 January 2011, stipulating that unplanned interruptions in electricity transmission may not exceed 24 hours unless it is due to reasons that are beyond the electricity network companies' control. Among other things, this functional requirement has contributed to an increasing number of electricity network companies implementing comprehensive weatherproofing measures.

An *electrical energy shortage* refers to a prolonged situation where the total availability of electrical energy[24] is not expected to equal the total demand for electricity. For an individual electricity user, this is primarily noticeable by high electricity prices.

Electricity power shortage occurs when the demand for electricity is greater than the availability. An extensive electricity power shortage has never occurred in Sweden in modern times. The basis for avoiding power shortage is that the market's players trade

[21] The power balance in the Swedish electricity market, report 2022, 2022/879, Svenska kraftnät 2022.

[22] Ibid

[23] Ibid

[24] Electrical energy refers to the "raw material" used to produce electricity, e.g., water in reservoirs, oil, nuclear fuel, or gas.

in balance. When this is not sufficient, the Swedish system operator, Svenska kraftnät, has several technical and commercial mechanisms at its disposal to maintain balance in the electricity system, for example the power reserve and disturbance reserves.

If these mechanisms are not sufficient, Svenska kraftnät can order specially designated electricity network companies to disconnect load (manual consumption disconnection, MFK). This means that part of the consumption is disconnected for one or a few hours to avoid system collapse. To mitigate the consequences för society, a method for planning and prioritizing socially important electricity users so called the Bord has been established.[25] The purpose of the Board is to, to the extent that it is safe to operate, allocate available power to power lines to which societally important electricity users are connected.

Sweden's electricity supply is basically stable, but several factors have increased the risk of power shortages during peak load hours. A reduced share of electricity production in southern Sweden and the war in Ukraine have worsened the power situation in electricity area 3 and 4. In electricity area 1 and 2, the electricity supply is considered more robust.

From record low electricity prices in 2020 to high prices in 2021

In 2020, electricity prices were at a record low, but in 2021 electricity prices increased significantly. In 2021, the annual average value of the system price of electricity on Nord Pool was 63 öre/kWh.[26] This is an increase of 52 öre (450 per cent) compared to 2020. Annual and monthly averages for the system price on Nord pool and the spot price for electricity area SE3/Sweden are shown in Figure 12.

The main reason for the price increases was natural gas prices increased to very high levels due to the reopening after COVID-19 restrictions which lead to increase demand for natural gas. Production of natural gas could not meet demand and, moreover, natural gas inventory levels were low. High natural gas prices drove up prices and demand for coal and EU-ETS. In addition, at the beginning and end of 2021, there was a deficit in the hydrological balance while it was less windy and colder than normal. The price of emission trading units rose from having been around 30 euros/tonne during January 2021 to 80 euros/tonne. At their highest emission trading units were traded for 90 euros/tonne which effected prices upwards.[27]. While these effects mainly occurred on the continent, the interconnected markets led to an impact on the Nordic prices

[25] Förordning (2011:931) *om planering för prioritering av samhällsviktiga elanvändare* [*on planning for the prioritisation of essential electricity users.]*

[26] The system price on the Nord Pool Spot is a reference price for financial trading. It does not take into account transfer limitations in the market.

[27] Energimyndigheten, *Årskrönika energimarknaderna 2021 [Annual chronicle of energy markets 2021]*

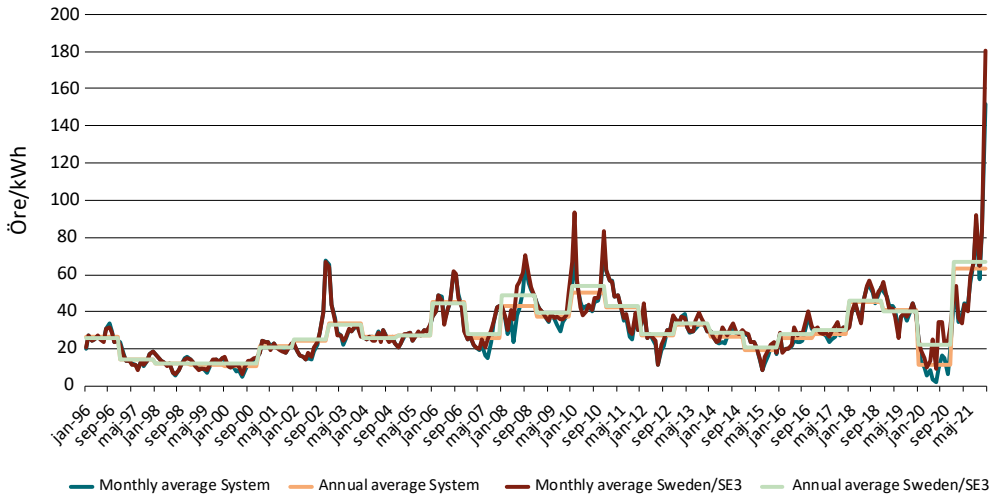


Figure 12. Average electricity price, yearly and monthly for the system Nordpool and for Sweden's electricity area 3 (SE3), 1996-2021, öre/kWh.

Source: Nord Pool Spot.

Note: Since Sweden was divided into 4 electricity areas in November 2011 there are no prices for the whole of Sweden. In the figure, SE3 has been set as an estimate for Sweden after November 2011 as most people lives in that area.

Since 1 November 2011, Sweden has been divided into four electricity areas. The prices in the individual areas are determined by production and consumption within each area and by the transmission of power to and from adjacent areas. When two adjacent electricity areas have the same price, they form a price area, especially during low demand hours. Big price differences between two adjacent electricity areas are a signal that something needs to be adjusted in the system. It could be that greater transmission capacity between the electricity areas needs to be built, more production is needed within a certain electricity area, or electricity consumption needs to be reduced. In this way more homogeneous prices within the country could be achieved.

In 2021, there were big differences in the annual average price between electricity areas in Sweden. The differences in the annual average price were mainly between southern (SE3, SE4) and northern (SE1, SE2) Sweden. In 2021, the annual average price differential between SE4 and SE1 was 38.5 öre/kWh, which was an increase from previous year were the annual average price differential was 11.19 öre/kWh[28]. Before 2020 the differences in the annual average price between electricity areas in Sweden had been smaller.

The electricity prices described here are not the electricity prices that the consumer pays[29], rather they are the electricity prices resulting from trade on the electricity exchange Nord Pool Spot. Sweden and Norway started the Nordic electricity exchange Nord Pool in 1996. In addition to Statnett and Svenska kraftnät, the transmission system operators in Finland, Denmark, Estonia and Lithuania are also owners of the Nordic electricity exchange. Nord Pool's actors consist of power producers, electricity suppliers, major end-users, portfolio managers, capital managers and brokers.

[28] Calculated based on an annual average value of the electricity price for electricity areas SE1 and SE4.

[29] End-customer prices also include costs for power grids, profit, taxes, and VAT depending on customer category. Read more about end-customer prices in the chapters on the Housing and service sector and the industry sector

The electricity certificate system supports renewable electricity production

The electricity certificate system

The electricity certificate system is a market-based support system that aims to increase the share of renewable electricity production. For every MWh of electricity produced by an approved facility with a renewable energy source, the producer receives an electricity certificate which has a resale value. The buyer of electricity certificates has a so-called quota obligation. Electricity suppliers and certain electricity users are required to purchase a certain proportion of electricity certificates in relation to their electricity supply or electricity use. The size of the share is determined by a percentage (quota) for each year. The quotas are based on the expected expansion and consumption of renewable electricity within electricity certificate market.

Since 1 January 2012, Sweden and Norway have had a common[30] electricity certificate market. Producers can build renewable electricity production in both Norway and Sweden and trade the electricity certificates across national boundaries. The target of the common electricity certificate market was to increase renewable electricity production by 46.4 TWh between the years 2012 and 2030. Sweden will finance 15.2 TWh and Norway 13.2 TWh, but it is up to the market to decide where and when new production will take place. Sweden an additional target to increase renewable electricity production by 18 TWh. This target is only financed by Sweden. The joint target of 28.4 TWh to 2020 was reached in May 2019. The joint target for electricity certificate market of 46.4 TWh was recached in March 2021.

During 2020, a stop date for the electricity certificate system was decided. The stop date meant that electricity certificates no longer are issued for production of renewable electricity in facilities that are commissioned after 31 December 2021. The stop date also means that electricity certificate system will end in the end of 2035. On 18 September 2020, a new agreement was signed between Sweden and Norway where, among other things, a stop date was written. The Norwegian government had also already decided on a stop date in Norway of December 31, 2021.

In 2021, electricity production from renewable energy sources and peat within the common electricity certificate system amounted to 53 TWh of which 35 TWh was produced in Sweden. Figure 13 shows how the production of renewable electricity in Sweden has increased between 2003–2021 and how production is distributed between different sources of energy. Up and until 2012 the most electricity in the system was produced by biofuels and after that by wind power. By the turn of the year 2012/2013, many older plants were phased out of the system since they were no longer eligible for electricity certificates, which is the reason for the decrease seen in the figure below. Then electricity-certified power generation fell, primarily from bio power, but also from hydropower.

[30] Read more about the common electricity certificate system in the latest annual report from the Swedish Energy Agency and Norwegian Water Resources and Energy Directorate (NVE), http://www.energimyndigheten.se/fornybart/elcertifikatsystemet/marknadsstatistik/?currentTab=1#mainheading, or in the latest quarterly report http://www.energimyndigheten.se/fornybart/elcertifikatsystemet/marknadsstatistik/?currentTab=2#mainheading.

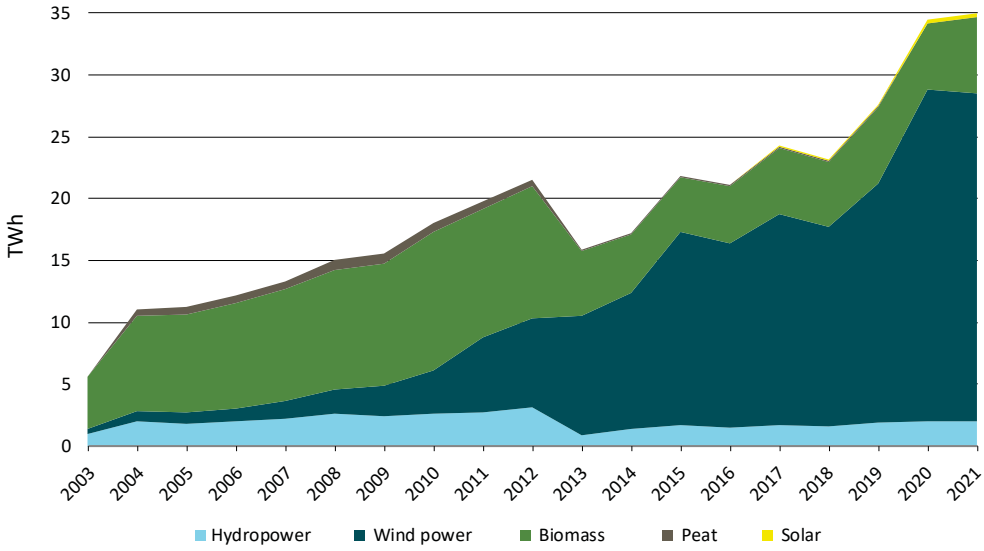


Figure 13. Electricity production in Sweden per type of power in the electricity certificate system 2003–2021, GWh.

Source: Swedish Energy Agency.

The price of electricity certificates has varied since the system was introduced in Sweden in 2003, reaching its highest point, a little over 350 SEK, in 2008. Since 2012 the average monthly price has not been over 180 SEK per certificate. In January 2021, the average price was 1.7 SEK per certificate. During 2021, the highest and lowest average monthly price was 2.7 SEK per certificate (Mars) respective 1.25 SEK per certificate (October).[31] The price of electricity certificates has fallen to very low levels and is expected to fall further.

One reason for the relatively low price in recent years is that the expansion of renewable electricity has been fast while the production has been high, which has led to the supply of certificates being greater than the demand. The demand for electricity certificates has also been lower than expected as Sweden's electricity use has been lower than was assessed when the quotas[32] were determined.

Policy measures, directives and regulations that affect the electricity market

The energy agreement

In 2018, the proposals made in the Energy Agreement were decided.[33] Proposals that are related to electricity market include a target of 100 per cent renewable electricity generation by 2040 (which does not imply a stop date for nuclear power), a phase out of the thermal output tax for nuclear power, a reduced property tax for hydropower, an extended and increased ambition in the electricity certificate system and increased opportunities for demand flexibility.

[31] Price statistics for electricity certificates are taken from annual reports. http://www.energimyndigheten.se/fornybart/elcertifikatsystemet/marknadsstatistik/?currentTab=1#mainheading (Retrieved 2022-11-23)

[32] The quota levels provide the demand for electricity certificates and are based on the forecast quota-obligatory electricity use and assumed cancellation of electricity certificates.

[33] Read more about the Energy Agreement and what that work resulted in under chapter Energy and climate policy.

New legal acts from the EU

In November 2016, the European Commission published a first proposal for a comprehensive revision of several key legal acts in the energy field, Clean Energy for all in Europe.[34] All acts have now been decided by the European Parliament and the Council of the European Union. Acts thar are related to electricity market are, among other things, an electricity market regulation and an electricity market directive that makes the EU's electricity market more interconnected, flexible, and focused on consumers, and additionally the regulation on risk preparedness in the electricity sector (secure electricity supply in crisis situations).

New model for the electricity market is in process

The work to introduce a new market model in the electricity market, a so-called electricity trader-centric market model[35] is ongoing and was expected to be implemented in the latter part of 2022. The model requires that information is exchanged between electricity market participants in a so-called electricity market hub. Data will, among other things, become more readily available, contributing to increased services for demand flexibility. The project is currently on hold with work ongoing to make a legislative council referral and bill.

New tariffs and increased requirements clarify network fees to customers

In 2018, the government decided to introduce an opportunity for network companies, within the framework of a pilot project, to test new tariffs designed to exploit demand flexibility. Through at new provision in the Electricity Act[36], from 1 January 2019 grid companies could test tariffs that can stimulate demand flexibility on a smaller number of customers within a customer segment. In this way, the network companies can test and develop the tariffs to stimulate the kind of flexibility that is necessary within their own network area.

Furthermore, from 1 January 2019, network companies have been obliged to inform customers about how such tariffs are designed and what opportunities customers have to impact their costs by changing conditions or consumption patterns.[37] This information must be given to customers regardless of whether it is a tariff within a pilot project or not.

Strategy for a sustainable wind power expansion

The Swedish Energy Agency and the Swedish Environmental Protection Agency have together developed a strategy for sustainable wind power development. The starting point was the Energy Agreement's goal of 100 per cent renewable electricity production

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[34] Europeiska rådet, *Ren energi för alla [Clean Energy for All],* https://www.consilium.europa.eu/sv/press/press-releases/2019/05/22/clean-energy-for-all-council-adopts-remaining-files-on-electricity-market-and-agency-for-the-cooperation-of-energy-regulators/ (Retrieved 2020-03-19)

[35] Energimarknadsinspektionen, Elhandlarcentrisk marknadsmodell och hubb – fortsatt regelutveckling *[*Electricity retailer-centric market model and hub – continued regulatory development*]*, https://ei.se/sv/Projekt/Projekt/elhandlarcentrisk-marknadsmodell-och-hubb-fortsatt-regelutveckling/ (retrieved 2020-03-19)

[36] SFS (1997:857) *Ellag [Electricity act]*, 4 kap. 4 a§.

[37] SFS (1997:857) *Ellag [Electricity act]*, 4 kap. 11 b§.

by 2040. To achieve this transition, an extensive expansion of wind power is required and that this needs to be achieved in a sustainable manner. The Swedish Environmental Protection Agency and the Swedish Energy Agency have therefore developed a joint strategy for a sustainable wind power expansion that considers resource efficiency, human health, impact on the environment and more. The initiative is a measure within the framework of the Environmental Target Council[38].

The focus of the work was to coordinate government actors' views on wind power, produce guidelines for trade-offs between different interests and deliver a planning basis for wind power that breaks down the national need for wind power at a regional and municipal level.

The strategy contains, among other things, an improved planning process for wind power with regional expansion needs and a national planning basis to facilitate and guide regional work. It also contains a proposal for adaptions to municipal authority to improve the permit process, where a greater proportion of the wind power projects that have been started should be able to lead to a permit being granted.[39]

Refund of energy tax for electricity after battery storage

From 1 January 2019, it is possible to apply for a refund of energy tax on electricity that has been fed out of a concession-required electricity network, stored, and then fed back into the same concession-required electricity network again. This is to avoid unintentional double taxation. The change has been applied from 1 January 2018, which means that it is possible to reclaim tax from 2018.[40]

The electrification strategy

In February 2022, the government decided on a national strategy for electrification. The strategy has been developed in collaboration with businesses, authorities, and other social actors. The purpose of the electrification strategy is to develop the electricity system for a rapid climate transition. The strategy includes 67 measures to be implemented during 2022–2024. The government has budgeted 80 million SEK for 2022–2024. The government has given tasks to, among others, Swedish power grid, Energy Agency, and Swedish Transport Administration to implement action points.[41]

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[38] The government has established the Environmental Target Council as a platform for more measures and intensified work at all levels in society to achieve Sweden's environmental target. Environmental Target Council presents on 1 Mars each year measures that authorities undertake to implement to increase the pace working towards achieving the environmental targets. Environmental Target Council mandate runs until May 6, 2022.

[39] Energimyndigheten, *Nationell strategi för en hållbar vindkraftsutbyggnad [National strategy for sustainable wind power expansion*]. ER 2021:2.

[40] Skatteverket, *Återbetalning av energiskatt för el efter batterilagring [Refund of energy tax on electricity after battery storage]*, https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/nyheterinompunktskatter/2018/nyheterinompunktskatter/aterbetalningavenergiskattforelefterbatterilagring.5.309a41aa1672ad0c8377c21.html (hämtad 2020-03-19).

[41] Regeringskansliet, Nationell strategi för elektrifiering, 2022 [National strategy for electrification, 2022]

EU Commission's crisis package to reduce the demand for electricity

The European Commission decided that member states are obligated to reduce electricity consumption by 5 per cent during peak price hours and aim to reduce overall demand for electricity by 10 per cent. In reducing demand, this crisis package, seeks to ease network strains and in doing so flower the heightened electricity costs for households. The Commission have also decided a temporary revenue cap on 'inframarginal' electricity producers at €180 EUR/MWh and redistribution of these revenues to consumers as compensation for high electricity prices. A temporary solidarity contribution on excess profits generated from fossil energy carrier. It would be collected by Member States on 2022 profits.[42]

Reducing gas for safe winter

EU commission adopted a regulation on a voluntary reduction of natural gas demand by 15 precent this winter between 1 August 2022 and 31 March 2023. Both households and industries are affected by the legislation. [43]

A European Green Deal

The Green Deal is one of the EU's six priorities for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. Read more about European Green Deal in chapter Energy and climate policy.

RepowerEU

REPowerEU is set by the European Commission's plan to rapidly reduce dependence from Russian fossil fuels and fast forward the green transition. This is done by lowering consumption, diversifying energy supply and accelerate clean energy. Read more about REPowerEU in chapter Energy and climate policy.

[42] European commission, *Energy prices: Commission proposes emergency market intervention to reduce bills for Europeans*, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_5489 (2022-11-07)

[43] European council, *Council adopts regulation on reducing gas demand by 15% this winter*, https://www.consilium.europa.eu/en/press/press-releases/2022/08/05/council-adopts-regulation-on-reducing-gas-demand-by-15-this-winter/ (2022-11-07)

The district heating market

District heating has been available in Sweden since the 1950s and was previously produced mainly in thermal power plants. The share of district heating produced by cogeneration has gradually increased and is today around 45 per cent[44] compared to 38 per cent ten years ago[45]. In 2020, district heating was responsible for 58 per cent of the total energy use for heating and hot water in dwelling and non-residential premises. Just over 52 per cent of the district heating was used in multi-dwelling buildings, while non-residential premises accounted for 35 per cent and one- and two-dwelling building accounted for 12 per cent.[46]

Reduced district heating use and increased transmission losses

The use of district heating has increased steadily since the 1970s, but in recent years it has reached a certain saturation and gradually flattened, see Figure 14. In the last ten years, district heating use has varied between 54 and 60 TWh. The large increase in 2010 is thus an effect of a cold winter. In 2020, district heating use was 54 TWh which was a decrease compared to previous years.

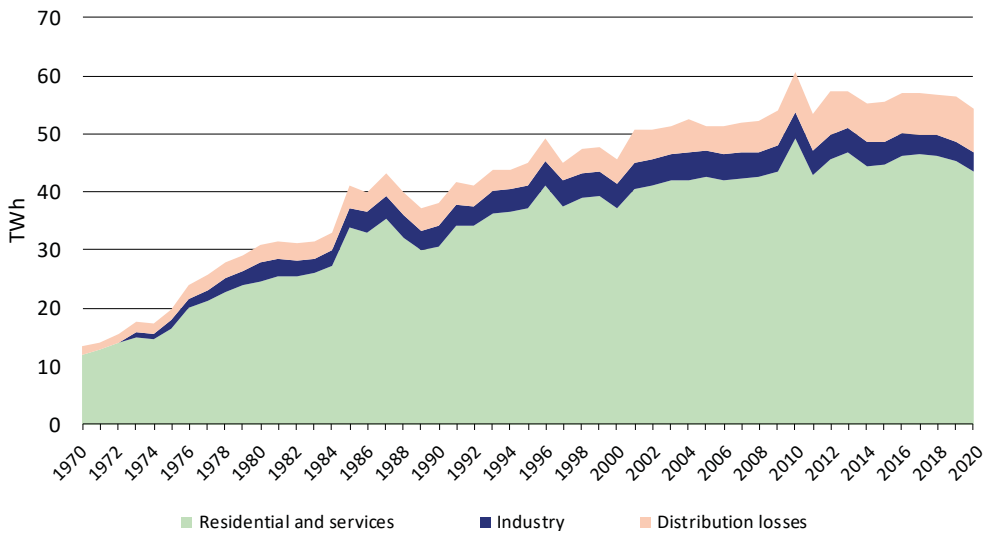

Figure 14. District heating consumption 1971–2020, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

The percentage losses have increased slightly over the years, which may be due to the growth and expand of district heating to less heat-dense areas resulting in more heat being lost per heated area. In 2020, 14 per cent of the total district heating use consisted of losses.

[44] SCB, *Årlig energistatistik (el, gas och fjärrvärme), Fjärrvärme [Annual energy statistics (electricity, gas and district heating), District heating],* https://www.scb.se/hitta-statistik/statistik-efter-amne/energi/tillforsel-och-anvandning-av-energi/arlig-energistatistik-el-gas-och-fjarrvarme/pong/tabell-och-diagram/fjarrvarme-gwh/ (Retrieved 2022-09-14)

[45] A CHP plant produces both electricity and heat, while a thermal power plant produces only heat.

[46] Energimyndigheten, *Energiläget i siffror 2020* [*Energy in Sweden (Excel) 2020]*, http://www.energimyndigheten.se/statistik/energilaget/?currentTab=1#mainheading (Retrieved 2020-02-28)

Biomass has increased greatly in district heating production

Several different fuels can be used for district heating production, and a major transition towards renewable fuels has taken place since the 1970s. Figure 15 shows the input energy used in district heating production in the period from 1970 to 2020.

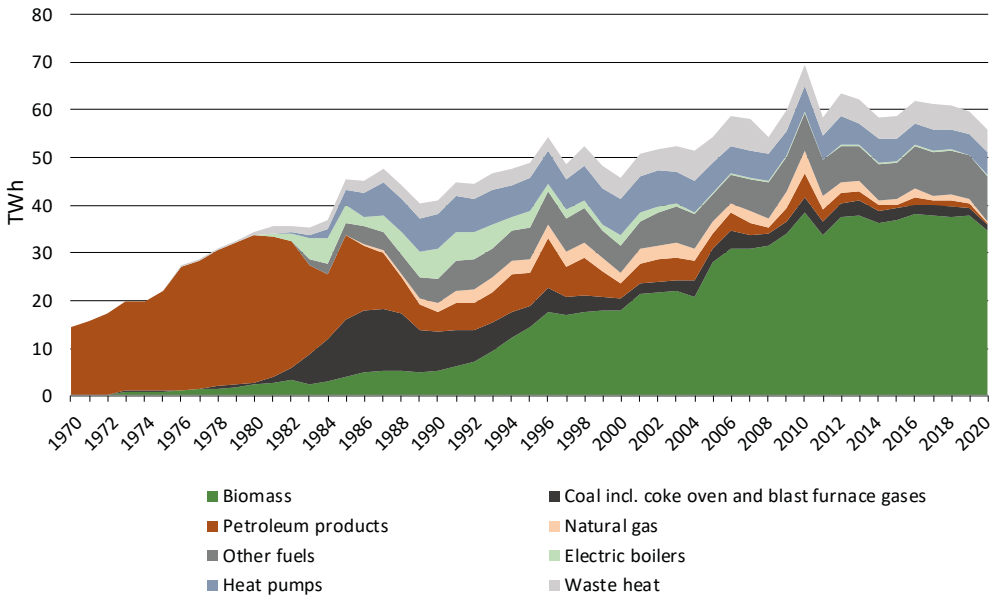

Figure 15. Input energy used in the production of district heating 1971–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

In 2020, biomass accounted for 62 per cent and waste heat for 8 per cent of the input energy in district heating production. The use of heat pumps has decreased in the district heating system in recent years. Between 2000 and 2009, on average heat pumps accounted 12 per cent, while the corresponding figure for 2010–2020 amounted to 8 per cent. The use of electric boilers has almost completely disappeared since the early 2000s. The previous greater use of electric boilers and heat pumps in district heating systems was due to lower electricity prices at that time. The use of waste has increased in the past decade. The increase has been due to the 2002 ban on dumping combustible waste, and the 2005 ban against dumping organic waste. Waste is included in the statistical item biomass (organic waste) and other fuels (fossil waste). Peat is also included in the 'other fuels' item.

Prices and forms of ownership differ greatly

There are significant differences in the prices of district heating from one municipality to the next. In 2015, Luleå Municipality had Sweden's lowest district heating price at SEK 110.1/m2 for an apartment building, while Ydre Municipality had Sweden's highest price at SEK 209.9/m2. The average price was SEK 171.4/m2.[47]

[47] Nils Holgersson-gruppen (2021), *Fastigheten Nils Holgerssons underbara resa genom Sverige - en avgiftsstudie för 2021* [*The property Nils Holgersson's wonderful journey through Sweden - a fee study for 2021], https://nilsholgersson.nu/rapporter/rapport-2021/fjarrvarme-2021/* (Retrieved 2022-09-12).

After the deregulation of the district heating market, which was done in conjunction with the deregulation of the electricity market in 1996, district heating companies were to be run on a commercial basis and make a profit. Many municipalities also sold their companies to private actors. This led to an average price increase of 3.5 per cent per year between 2000 and 2012. The price increase has slowed due to the introduction of the Price Dialogue (see below) and municipalities that bought back previously sold district heating companies. For the past four years, price trends have been in line with the consumer price index (CPI).

The price differences between municipalities depend on factors such as the district heating companies' ownership structures, yield requirements and input fuels. Geographical conditions for district heating installation also affect the price, as well as the age of the installations. Consumer options in the heating market thus depend, to a large extent, on where they live.

The price dialogue increases confidence in the industry

In 2013, the Swedish District Heating Association, the Swedish Association of Public Housing Companies (SABO) and Riksbyggen AB created a consultation process regarding price changes called the Price Dialogue (Prisdialogen). The initiative involves an agreement between the parties in the district heating market to improve the dialogue between district heating companies and customers. With the new members for 2021, Price Dialogue's members amount to 75 per cent of the entire district heating market. Approximately one fifth of the customers who participated in the Price Dialogue's consultation process believe that they were able to influence their supplier's pricing model and price structure, and overall satisfaction with the district heating supplier is also higher among customers who participated in the process.[48]

Secure supply of district heating

District heating is the dominant energy carrier for heating in apartment buildings and premises, while the most important energy carriers for one- and two-dwelling building are electric heating and biofuel. However, district heating experiences few disruptions with limited consequences and is considered relatively secure for residences and other premises.

There are currently no state-regulated functional requirements for the heat supply. In 2015, the Energy Agency investigated the ability of district heating companies to prevent and remedy interruptions in the district heating supply as part of a government task.[49] The investigation resulted in a recommendation to the government to consider regulation of district heating's security of supply. The energy companies have written a report, based on the Energy Agency's investigation, which aims to define terms for security of supply. [50] Furthermore, the report also aims to produce indicators and key figures that describe the security of supply in the district heating system.

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[48] Bjerkejö P., Fransson N. (2022), *Uppföljning av Prisdialogen 2022 [Follow-up of the Price Dialogue 2022],* https://www.prisdialogen.se/wp-content/uploads/2022/03/Uppfoljning-Prisdialogen-2022-IVLs-slutrapport.pdf (Retrieved 2022-09-12).

[49] The risk of interruptions in district heating – Report on the financial situation of district heating companies and their ability to prevent and remedy outages*,* ER 2016:03, Swedish Energy Agency

[50] Security of supply in district heating networks, Energy companies, April 2019.

District cooling continue to increase

District cooling is used mainly in offices and other business premises and for industrial cooling processes. The principal of district cooling is the same as for district heating. This involves the production of cold water in a large facility for distribution in pipes to consumers. The most common method of production is to utilize waste heat or sea water to produce district cooling with the help of refrigeration machines. Sometimes this takes place at the same time as the production of district heating. Another common method of production is to use cold water directly from the bottom of the sea or a lake, known as free cooling.

The market for district cooling has expanded a great deal since the first facility was built in 1992. Supplies of district cooling decreased in 2019 compared to 2018 was as 2018 was a warmer year. In 2021, district cooling supply increased with 3 per cent compared to 2020, see Figure 16. In 2021, a total of 37 companies supplied district cooling and the district cooling network was amounted to 528 km.[51]

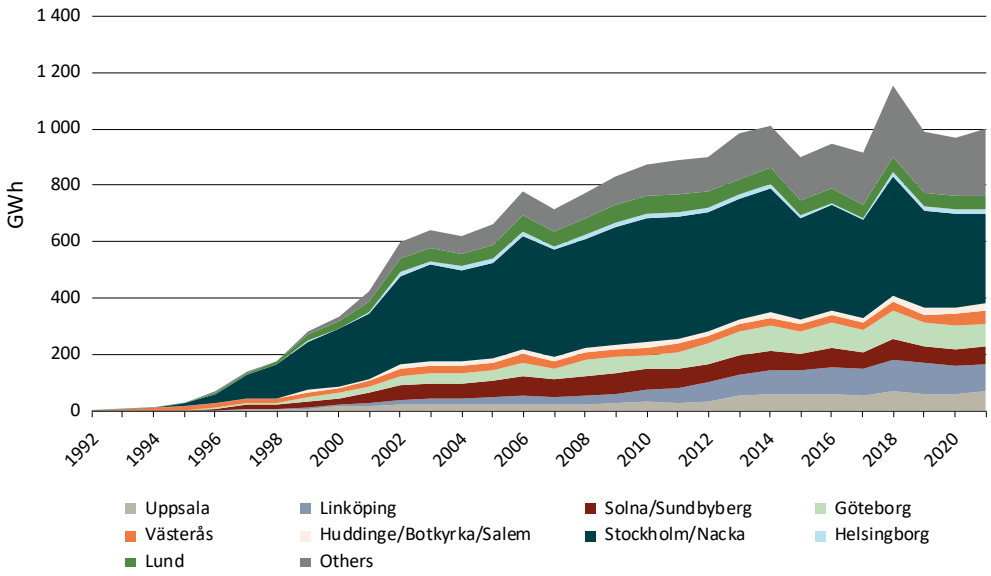

Figure 16. District cooling supply 1992–2021, GWh.
Source: Energiföretagen

Policy measures, directives and regulations that affect the district heating market

Increase in carbon dioxide tax and energy tax for cogeneration and heat production

Biofuel and peat for heat production are exempt from energy and carbon dioxide tax. Other fuel used for heat production in cogeneration plants and other heating plants within the EU's emissions trading system EU ETS pays full energy tax and 91 per cent carbon dioxide tax since August 1, 2019. This is a sharp increase for the cogeneration plants as these fuels were previously only had 11 per cent carbon dioxide tax and 30 per

[51] The reported net length has been corrected due to an error in reported was discovered in 2022.

cent energy tax. Cogeneration plants that are not part of the EU ETS pay full energy tax and full carbon dioxide tax on fuel used to produce heat. This is also an increase, as before 1 August 2019 these fuels had a tax reduction and paid only 30 per cent energy tax.

In 2022, the government proposed that fuel consumed in cogeneration production or in other heat production plants that produces heat within the emission trading system should be exempt from carbon dioxide tax. The changes are proposed to enter into force on 1 January 2023.[52]

Tax on waste combustion

From 1 April 2020 a tax on waste combustion was introduced to achieve the national climate goals and to achieve more resource-efficient and non-toxic waste management.[53] The tax is expected to lead to a reduction in waste combustion capacity in Sweden after 2030 and may thus also contribute to reducing Sweden's territorial fossil greenhouse gas emissions. However, the tax shall not be paid for dangerous waste, biofuels, animal by products or waste that is brought into a co-generation plant that mainly produces material, where waste combustion is included in production process of material. The tax has increased in 2020 and 2021.[54]

The Ministry of Finance wrote a memorandum September 2022 on ending the waste combustion tax.[55] The Swedish Tax Agency has evaluated the waste combustion tax and concluded that the tax dose not lead towards a more resource-efficient and non-toxic waste management in an effective and cost-effective way. According to Swedish Tax Agency the taxation has a negative impact in co-generation plants.

Implementation of changes in the Energy Efficiency Directive

The government proposed a change of the District Hearing Act and a new District Cooling Act in a bill.[56] The change is a result of the revision of the Renewable Energy Directive (RED II)[57]. The new District Cooling Act contain rules regarding measurement and invoicing. In the District Heating Act some changes, and clarifications are proposed regarding measurement, invoicing, and the provision of information.

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[52] Regeringen, *Tillfälligt sänkt skatt på drivmedel och sänkt skatt på bränslen i viss värmeproduktion* [*Temporarily reduced tax on fuel and reduced tax on fuels in certain heat production],* https://www.regeringen.se/rattsliga-dokument/departementsserien-och-promemorior/2022/10/tillfalligt-sankt-skatt-pa-drivmedel-och-sankt-skatt-pa-branslen-i-viss-varmeproduktion/ (Retrieved 2022-11-07)

[53] Proposal 2019/2020:1, *Budgetpropositionen för 2020* [*The budget proposal for 2020*.]

[54] Lag (2019:1274) om skatt på avfall som förbränns [Act (2019:1274) on the tax on waste incinerated]

[55] Regeringen, *Avskaffad avfallsförbränningsskatt och slopad energiskattenedsättning för datorhallar,[Abolished waste incineration tax and abolished energy tax reduction for data centers]* https://www.regeringen.se/rattsliga-dokument/departementsserien-och-promemorior/2022/09/avskaffad-avfallsforbranningsskatt-och-slopad-energiskattenedsattning-for-datorhallar/ (Retrieved2022-09-14)

[56] Regeringens proposition 2021/22:124, *Genomförande av ändringar i energieffektiviseringsdirektivet om värme, kyla och tappvarmvatten för hushållsbruk,* Infrastrukturdepartementet 2022 *[Abolished waste incineration tax and abolished energy tax reduction for data centers]*, https://www.regeringen.se/rattsliga-dokument/departementsserien-och-promemorior/2022/09/avskaffad-avfallsforbranningsskatt-och-slopad-energiskattenedsattning-for-datorhallar/ (Retrieved2022-09-14)

[57] RED II is the revised Renewable Energy Directive.

The biomass market

Biomass is a collective term for several different types of fuels. In addition to unprocessed and processed wood fuels, the term also encompasses biofuels from agriculture, combustible waste, bioethanol, biodiesel, biogas, and bio gasoline.

Increased use of biomass

The use of biomass in the Swedish energy system has increased over the years. Biomass accounted for 52 TWh or 11 per cent of the total energy supply in 1983. In 2020, the use of biomass has increased to 141 TWh, which is equivalent to 40 per cent of the total energy supply. However, biomass use decreased slightly compared to the previous year due to lower use of biomass for electricity production and district heating in 2020. In recent years, the use of biomass in the transport sector has increased rapidly and accounted for 16.8 TWh in 2020. The increased use in the district heating sector has also been significant over a longer perspective while industrial use has been dominant throughout the period from 1983.

Figure 17 shows the use of biomass in the industrial sector, the residential and service sector, the transport sector and electricity and district heating production.

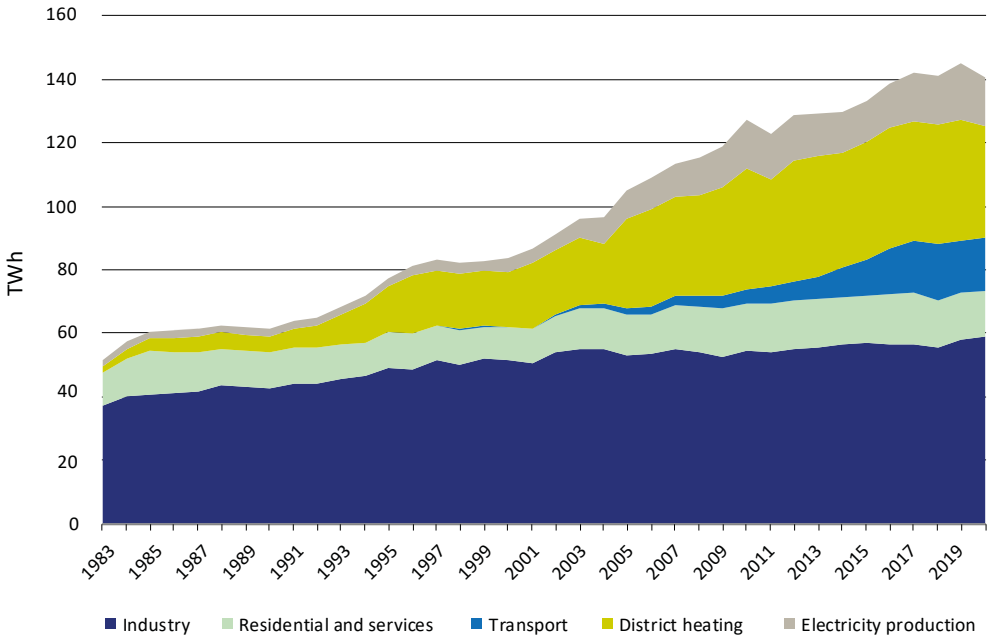

Figure 17. Use of biomass per sector 1983–2020, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

At the beginning of the 1990s, Sweden introduced both a tax on emissions of carbon dioxide and higher energy taxes. However, biomass became exempt from both energy and carbon dioxide taxes, which has contributed to a sharp increase in the use of biomass.

The rising prices of fossil fuels have also benefited the use of biomass, as have the introduction of the electricity certificate system in 2003 and the emissions trading system in 2005. Read more about electricity certificate system and emission trading system in chapters Electricity Market and Energy and Climate Policy.

All pure and highly blended biofuels that meet the sustainability criteria[58] are completely exempt from carbon dioxide tax and energy tax, according to the Energy Tax Act[59]. This is done through deductions in the excise tax return. The tax reduction has been adjusted several times in recent years. Read more about the reduction of taxes in the chapter on Energy and climate policy. For up-to-date information on tax rates and reductions read more on the Swedish Tax Agency's website[60].

Figure 18 shows the use of biomass by fuel type for 2005-2020. The two largest segments consist of unprocessed wood fuel and black liquor[61], followed by biodiesel and biological municipal waste[62]. Biodiesel is a type of fuel that has increased the most in recent years.

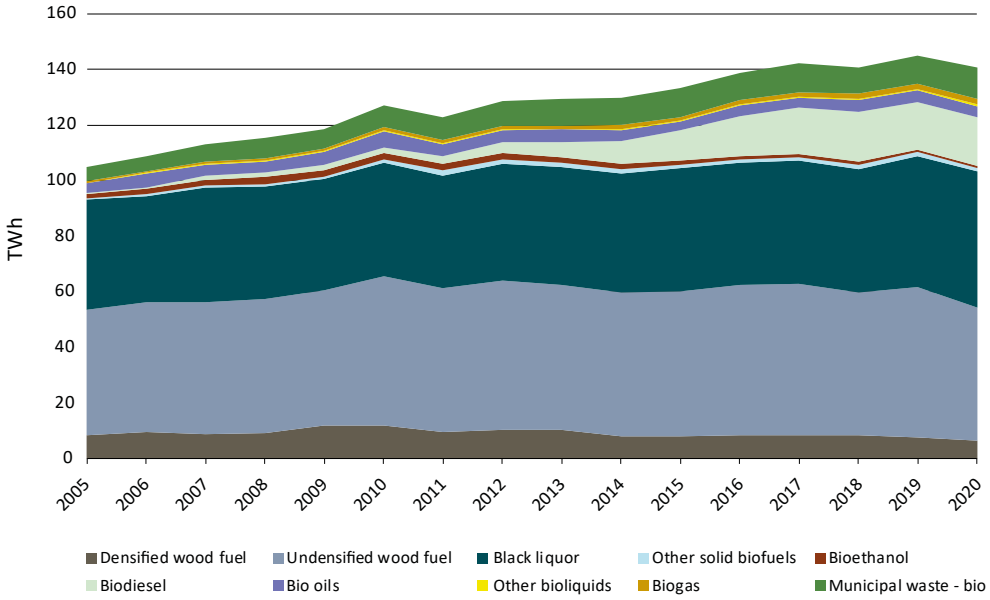

Figure 18. Use of biomass per fuel category 2005-2020, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

Previously, peat was also recognized together with biomass in the statistics, which is not done any longer. Nowadays peat is reported under the item other fuels along with fossil waste. The use of peat in electricity and heat production is, as with biomass, exempt from energy and carbon dioxide taxes. However, the use of peat is subject to

[58] SFS 2010:598, *Lag om hållbarhetskriterier för biodrivmedel och flytande biobränslen [Act on sustainability criteria for biofuels and bioliquids]*

[59] SFS 1994:1776, *Lag om skatt på energi [Act on energy tax]*

[60] Skatteverket, *Skattebefrielse för biodrivmedel* [*Tax exemption for biofuels]*. https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/ (Retrieved2020-03-13).

[61] Black liquor is a by-product of the pulp and paper industry which is formed when boiling wood chips into pulp.

[62] Household waste of biological origin.

sulphur tax. Peat is defined in the emissions trading system as a fossil fuel and thus electricity and heating producers pay a cost for emission allowances. Since 2004, electricity produced from peat has been entitled to electricity certificates when the production takes place in approved combined heat and power facilities.[63] This is one reason why peat remains part of the energy system. The use of peat for electricity and heat production has, however, declined over the past ten years, and amounted to 0.6 TWh in 2021[64].

Strong domestic wood fuel market and increasing imports

The large-scale wood fuel market in Sweden is essentially a bilateral deal between the forest industry and the energy companies. The market got off to a fast start in the early 1980s, before climate issues came into focus and the EU began to get involved in energy supply and the environment. [65]

The Swedish market for wood fuels is becoming increasingly dependent on EU policy. A significant trade in wood fuel occurs regionally in Europe but also in the east and with pellets across the Atlantic. In recent years, the demand for solid biofuels has increased in the entire Baltic Sea area thanks to several new and large biofuel-fired cogeneration plants, both in Sweden and in the neighboring countries. However, in the small-scale market biofuel use for heating and hot water in single-family houses decreased from just over 9 TWh in 2018 to historically low levels of around 8 TWh in the unusually mild 2020[66]. However, in 2021 the trend appears to have turned upwards again.

Most of the wood fuels used domestically are produced in Sweden and only a small share is imported. The gathering of statistical data on the importation of wood fuels is not fully complete but, according to this data, Sweden imported 0.2 TWh of decomposed and unprocessed forest and energy forest fuels were imported during 2020. And approximately 2.7 TWh of recycled wood fuels were imported during 2020.[67] During the same year, the net export of pellets amounted to 0.2 TWh because of less pellet use in Sweden.[68] The reason was, among other things, lower energy use in 2020. Also so-called indirect import occurs when forest companies import round timber for industrial processes. By products and residuals from industrial processes such as bark and shavings can be used as fuel or raw material for pellets, briquettes, and sawdust. This means that indirect import is also included in Domestically produced fuel in Sweden's energy balance.

The total volume of peat produced in Sweden has decreased since 2018. The use of peat depends on the weather and shortage of wood fuel. In recent years, there has been

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63 Proposition 2003/04:42, *Torv och elcertifikat [Peat in the electricity certificate system]*

64 Quarterly fuel statistics, 4th quarter 2021 and year 2021,EN 31 SM 2201, Energimyndigheten och SCB, 2022. Converted from the unit toe to TWh.

65 Hogfors, Sven, *Trädbränslemarknad i förändring, [Bioenergi, Changing wood fuel market, Bioenergy,]* No. 1 (2018), s. 53.

66 The 2020 statistics for one- and two dwelling buildingsand apartment buildings/premises have been model-estimated based on the 2018 and 2019 energy use as well as the stock of buildings on 31-12-2020.

67 Energimyndigheten och SCB, EN0122, *Produktion, import och export av oförädlade trädbränslen*, 2019 [*Production, import and export of unprocessed wood fuels*, 2019] http://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/produktion-import-och-export-av-oforadlade-tradbranslen/ (Retrieved 2020-03-13).

68 Pelletsförbundet, *Leveransvolymer [Volumes of delivery]*, https://pelletsforbundet.se/om-pellets/statistik/leveransvolymer/ (2022-11-03)

a shift in the peat harvest from energy peat[69] to cultivation peat[70]. The production of cultivation peat has increased, while the production of energy peat has decreased. The reduced demand for energy peat is mainly due to the price development of emission trading, as peat is part of the EU's system of emission trade.[71]

Increasing prices on wood fuel

The increased use of biomass for electricity and heat production has particularly led to an increased demand for wood fuels. Throughout the 1980s and 90s, the prices of wood fuels for thermal power plants remained relatively unchanged, due to good availability of cheap and easily accessible biomass in the form of waste from the forestry industry. The increased demand for wood fuels led to increased competition, which caused prices to rise during the 2000s, see Figure 19. When the demand and prices increased extraction of fuel from forests increased which is the main reason why increased use has been possible.

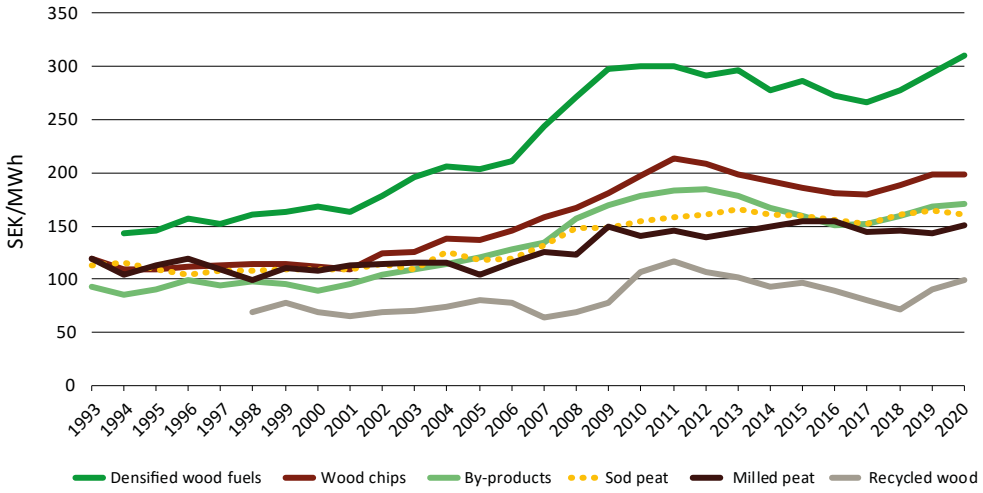

Figure 19. Wood fuel and peat prices for heating plants 1994–2020, current prices, SEK/MWh.

Source: Swedish Energy Agency and Statistics Sweden.

Note: Milled peat is peat that is harvested with the help of a milling machine and therefore given a finely divided form. Milled peat made up approximately 79 per cent and sod peat the remaining part of the harvested volume of energy peat in 2021. The ratio has varied greatly during the current period.

Figure 19 shows the annual average values of current rates for wood fuels, i.e., their nominal prices. The figure indicates that the decrease in prices that began following the coldest winter, in 2009/2010, has continued for densified wood fuels, wood chips and by-products until 2018. Prices for densified wood fuels has continued to increase in 2021 while the price on industrial by products and wood chip was dampened.

High availability of wood chips and filled stocks despite higher demand, dampened prices for wood chips in the beginning of 2021. There were large stocks of wood chips

[69] Energy peat is mainly used in the production of hot water in heating plants.

[70] Cultivation peat is mainly used as a soil improver in the horticulture industry.

[71] SCB, *Skörden av odlingstorv har ökat kraftigt [The harvest of cultivated peat has increased sharply]*, https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/markanvandning/torv-produktion-anvandning-och-miljoeffekter-torv/pong/statistiknyhet/torv-2020-produktion-anvandning-och-miljoeffekter/ (Retrieved 2022-11-03)

at the beginning of the year which may be an effect of the COVID-19 pandemic, as the community restarted after shutdown stocks were depleted. High prices for electricity and emission trading have led to increased demand for biofuels in general, which in turn has led to higher prices for solid biofuels as well. Border closures associated with the COVID-19 pandemic reduced the trade of biofuels across borders further increasing prices. High natural gas prices in Europe caused some industrial users to switch to solid fuels such as pellets or wood chips. Deliveries of wood chips from Belarus to the Baltic States were negatively affected during the year due to a migrant conflict and sanctions against the country. A shortage of truck drivers on the continent affected shipping costs.[72]

After the dry summer of 2018, large parts of the country, like other countries in Europe, were affected significantly by the insect pest, the spruce bark beetle. The spruce bark beetle continued to cause major forest damage in Svealand and Götaland during 2021. A significant amount of insect-damaged wood was to be chipped for fuel. A gradually increasing proportion of the insect-damaged wood was in demand as sawn timber or pulpwood in Scandinavia, China and North America.

The use of recycled wood increased sharply in the country during the 2010s. The price of recycled wood has increased steadily since 2018 but leveled off in 2021. Knowledge of the Swedish heating market has grown among foreign recycling companies in countries where in many places the supply of recycled wood exceeds demand.[73] However, international competition for recycled wood has increased in recent years and therefore imports to Sweden appear to have decreased in 2021.

The use of biofuels in transport sector is increasing

The use of biofuels in Sweden started in the early 2000s and since then the production and use have increased. Biofuels are used for transport purposes but also to a certain extent for the operation of industrial and agricultural machinery. In 2020 20.3 TWh[74] of biofuels were used of which 16.8 TWh[75] was used for domestic transport. In total biofuels accounted for 21 per cent of the final energy used in domestic transport sector in 2020. Read more in the chapter transport sector.

The use of transport biofuel in Sweden consists of low-level and high-level biodiesel blends, biogas in pure form or mixed with natural gas, and low- and high-level ethanol blends. The biofuel that was delivered in the largest quantity in 2021 was HVO (15.9 TWh), of which 80 per cent was low-level and just over 20 per cent HVO100.[76] A total of 1.3 TWh of ethanol was delivered, of which 89 per cent was delivered as low-level. Low-blended ethanol can also be designated E10, while high-blended ethanol includes E85 and ED95. There are two different types of biodiesel products in the Swedish market: HVO (hydrotreated vegetable oils) and FAME (fatty acid methyl esters).

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[72] Energimyndigheten, *Årskrönika energimarknader 2021* [*Annual Chronicle of Energy Markets 2021]*, http://www.energimyndigheten.se/48e78e/globalassets/om-oss/lagesrapporter/arskronika-energimarknader-2021.pdf (Retrieved2022-11-03)

[73] Hogfors, Sven, *Trädbränslemarknad i förändring, Bioenergi* [*Changing Wood Fuel Market, Bioenergy],* No. 1 (2018), s.53.

[74] Drivmedel 2022, ER 2022:08, Energimyndigheten 2022. 2021 användes 22,0 TWh biodrivmedel

[75] This figure also includes biogas.

[76] Drivmedel 2020, ER 2021:29, Bilaga Figur 6, Energimyndigheten 2021.

Biodiesel

Both HVO and FAME can be produced from various types of oil plants such as rape, soy, and palm. Animal fats are also used for production, for example different types of slaughterhouse waste.

FAME

In Sweden, rapeseed oil is commonly used in the production of FAME. The use of FAME has decreased in 2021 compared to 2020. The raw materials for FAME used in Sweden are imported, the largest share came from Germany in 2020. Figure 20 shows the distribution of the raw material's country of origin for FAME used in 2020.

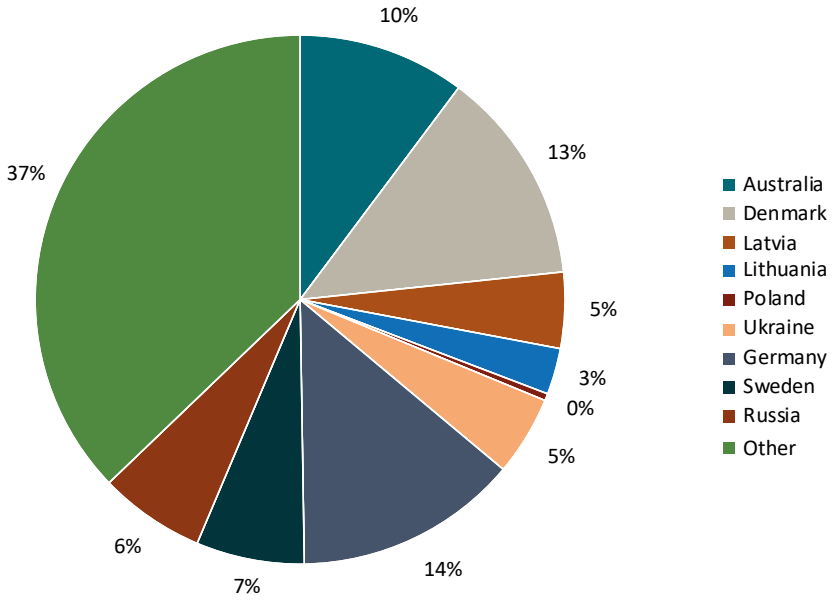

Figure 20. FAME used in Sweden, by country of origin, in 2020.

Source: Swedish Energy Agency

Note: Other* includes Bahrain, Belgium, Bulgaria, Chile, Colombia, Egypt, United Arab Emirates, Canada, Kuwait, Luxembourg, Peru, Malaysia, Saudi Arabia, South Africa, Taiwan, Thailand, Tunisia, USA, Greece, Indonesia, Kazakhstan, China, Netherlands, Poland, Switzerland, Spain, Great Britain, Lithuania, Ukraine, Russia.[77]

The use of low-level FAME has increased slightly in 2021 compared to previous years. The increase may be due to the reduction obligation that entered into force on 1 July 2018. Read more about the reduction obligation further down in the section. In Sweden, it is permitted to blend up to 7 per cent by volume of FAME in fossil diesel by the Swedish Environmental Class 1 standard for diesel. The EU's Fuel Quality Directive also governs the blending level and sets a ceiling of 7 per cent by volume.

High-blended FAME, known as B100, has been available on the market for a long time but requires some material adjustments to a normal diesel engine. It also requires approval from the engine manufacturer.[78]

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[77] Ibid

[78] SPBI, *Dieselbränsle med tillsats av förnybar RME (FAME) – fakta för dig med dieselmotor* [*Diesel fuel with the addition of renewable RME (FAME) – facts for you with a diesel engine]*, https://spbi.se/wp-content/uploads/2018/05/FAME-fakta-för-dig-med-dieselmotor.pdf (2019-10-24)

HVO

The raw materials for the HVO delivered to the Swedish market in 2021 were mainly animal fats from slaughterhouse waste and PFAD-based HVO[79]. The raw materials delivered for HVO decreased in 2020 and 2021 compared to previous years. In 2021, most HVO originated in Europe compared to previous years when the largest share came from Southeast Asia. Figure 21 shows raw material country of origin for 2020. The share of raw materials of Swedish origin has also increased.

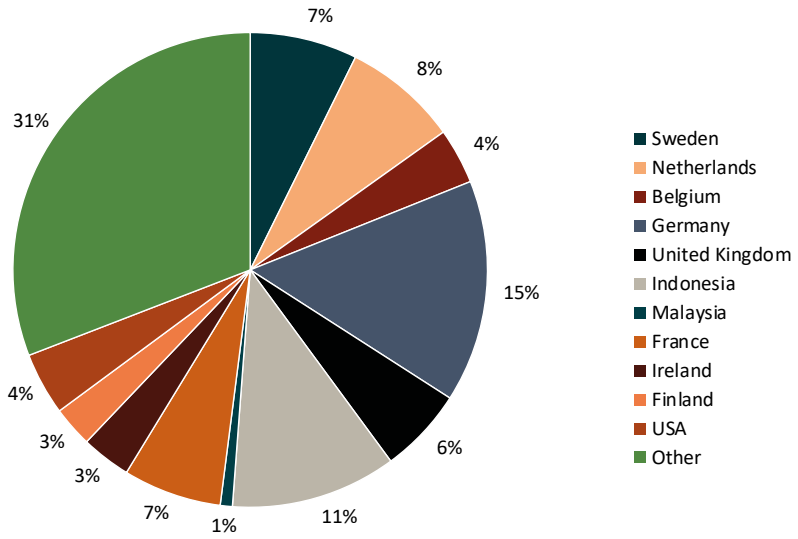

Figure 21. HVO used in Sweden, by country of origin, in 2020.

Source: Swedish Energy Agency

Note: Other includes Argentina, Australia, Belgium, Denmark, El Salvador, Estonia, Finland, France, Gabon, Greece, Ireland, Italy, Japan, Canada, Croatia, Lithuania, Netherlands, New Zealand, Poland, Portugal, Romania, Russia, Switzerland, Serbia, Slovakia, Slovenia, Spain, United Kingdom, Thailand, Czech Republic, Ukraine, Uruguay, Vietnam, Austria. [80]

HVO appeared on the Swedish market in 2011. Its use has since increased rapidly and accounted for more than 70 per cent of the total biofuels used in Sweden. About one fifth of HVO use is HVO100 (pure HVO) and the rest is blended into diesel. After the reduction obligation came into force, there has been a slight reduction in HVO100 deliveries in favor of low-blended HVO and to meet the requirements of the reduction obligation. Unlike FAME, HVO is chemically identical to fossil diesel, allowing a considerably higher percentage to be mixed with fossil diesel. In 2021, the average mixture of HVO in diesel was 30 per cent by volume.

HVO100 was introduced in the market in 2015 and is now offered by several fuel companies. As with B100, approval from engine and vehicle manufacturers is required for warranties and emission values to apply if HVO100 is used. Several car manufacturers approve certain models to use HVO100.

[79] Palm Fatty Acid Distillate is a product that is formed during the processing of palm oil for food

[80] Drivmedel 2020, ER 2021:29, Bilaga Figur 6, Energimyndigheten 2021.

Ethanol

Ethanol is produced through the fermentation of sugar and other carbohydrate-rich feedstocks such as sugar cane, maize, cereals and sugar beet. A low blended ethanol is essentially in all 95-octane petrol and in some volumes of 98-octane petrol delivered to the Swedish market and is sold as a high blend through the transport fuels E85 and ED95. The raw materials for the ethanol delivered to the Swedish market in 2021 consisted of 54 per cent of corn and roughly 22 per cent of wheat. [81] Both corn and wheat have increased as raw materials, while sugar cane and sugar beet have decreased in use.

E10 petrol was introduced to the market in Sweden and the UK on August 1, 2021, which has led to increased demand for ethanol for blending. E10 replaced E5 petrol. Overall petrol usage has gradually decreased since 2005. This has also led to the amount of ethanol used for low-blending to have decreased. The decrease is due to increased engine efficiency in new cars and the fact that diesel cars have increased their market share. In 2020 the use of ethanol has decreased compared to previous years, both high-blended and low-blended ethanol decrease in volume terms in the transport sector.[82]

New sales of ethanol cars have dropped sharply since the peak of 59,024 private cars in 2008. In 2021, 1 143 ethanol cars were newly registered which can be compared to 2020 when 43 cars powered by ethanol were registered.[83] The reason for that increase is the bonus malus[84] system that was introduced in 2018, where cars with lower emissions are rewarded at the time of purchase with a bonus, while vehicles with relatively high emissions of carbon dioxide are charged with a higher tax. After the introduction of the system, ethanol cars became a more economical alternative compared to petrol cars as petrol cars are taxed more highly after the introduction of the bonus-malus system. Fuel used in ethanol cars is usually E85.

Price development for transport biofuels

The price development of biofuels is based on supply and demand. In turn, access and demand are affected by control instruments at local and global level, such as customs duties, quotas, taxes and subsidies. Price developments are also affected by the raw material cost as it represents a significant part of the total production cost for biofuels.

Figure 22 shows the price trend for biodiesel and ethanol. The price of ethanol increased at the end of 2021due to lower production within the EU than expected, low availability of imported ethanol outside of the EU and the introduction of E10 which increased the demand for ethanol.

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[81] Drivmedel 2022, ER 2022:08, Energimyndigheten 2022.

[82] Energimyndigheten, *Biodrivmedelsanvändning i transportsektorn (inrikes) uppdelad på bränsleslag, 1997- [Biofuel use in the transport sector (domestic) by fuel type, 1997-],* https://pxexternal.energimyndigheten.se/pxweb/sv/Transportsektorns%20energianv%c3%a4ndning/Transportsektorns%20energianv%c3%a4ndning/EN0118_4.px/ (2022-11-15)

[83] BILSweden, http://www.bilsweden.se/statistik/nyregistreringar .

[84] Regeringen, *Ett bonus-malus-system för nya lätta fordon* [*A bonus-malus system for new light vehicles],* https://www.regeringen.se/rattsliga-dokument/departementsserien-och-promemorior/2017/03/ett-bonusmalus-system-for-nya-latta-fordon/ (2022-11-02)

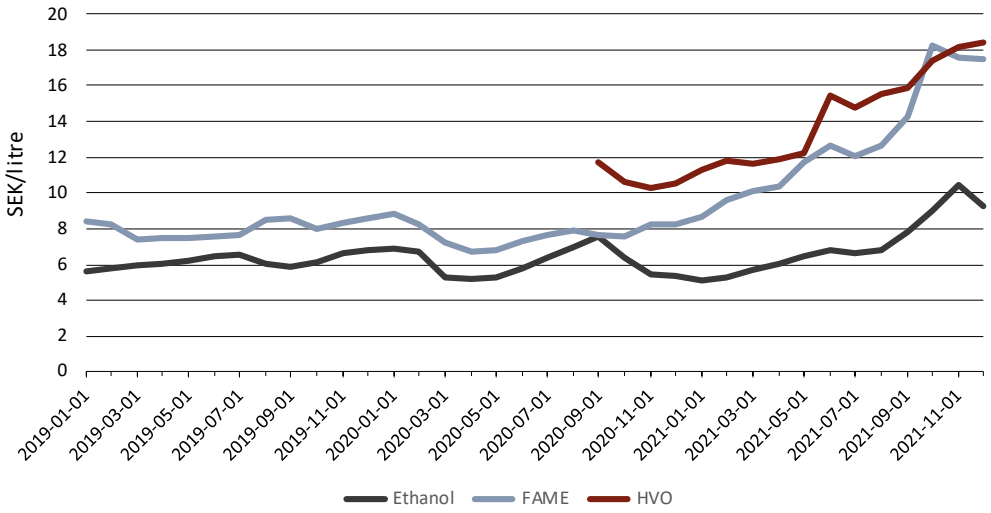

Figure 22. The price development for Ethanol, FAME and HVO 2019–2021.
Source: Argus Media

Most of the volume sold is FAME biodiesel since it is the most common form of biodiesel in Europe. The price of FAME increased on the market and was at a record high in 2021. The reasons for the high prices, among other things, were a high raw material price due to poor rapeseed harvest and delivery difficulties in within EU and a lack of catalysts needed for production of FAME.

The price of HVO followed the same development and increased during 2021. The reasons for the price increase were an increased demand for HVO for blending into diesel but also increased demand from the petrochemical industry.

Figure 23 shows the price development of palm oil and rapeseed oil used to produce PFAD-based HVO and FAME respectively.

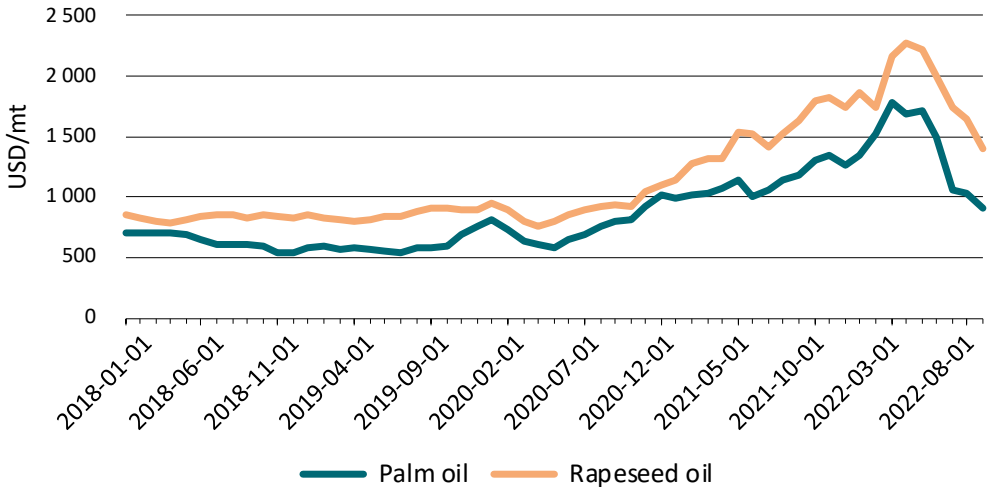

Figure 23. Price development for palm oil and rapeseed oil used to produce HVO, 2018–2021.
Source: The World Bank[85]

[85] The world bank, *Commodity Markets, Monthly prices*, https://www.worldbank.org/en/research/commodity-markets (retrieved 2022-11-03)

Increased use and production of biogas

The total production of biogas in 2021 amounted to 2 265 GWh. Which is an increase with 104 GWh compared to 2020. Most of the biogas is produced in anaerobic digestion facilities and sewage treatment works, see Figure 24. The most common areas of use are as vehicle gas and for heat production. Due to biogas being used in vehicles and supplied to the natural gas network, purification is required to remove corrosive substances, particles, and water, there is also an additional benefit that the energy value is increased by carbon dioxide being removed. The purification process is called upgrading and can be carried out with different purification techniques in an upgrading plant. When the biogas has been upgraded, it contains at least 97 per cent methane.

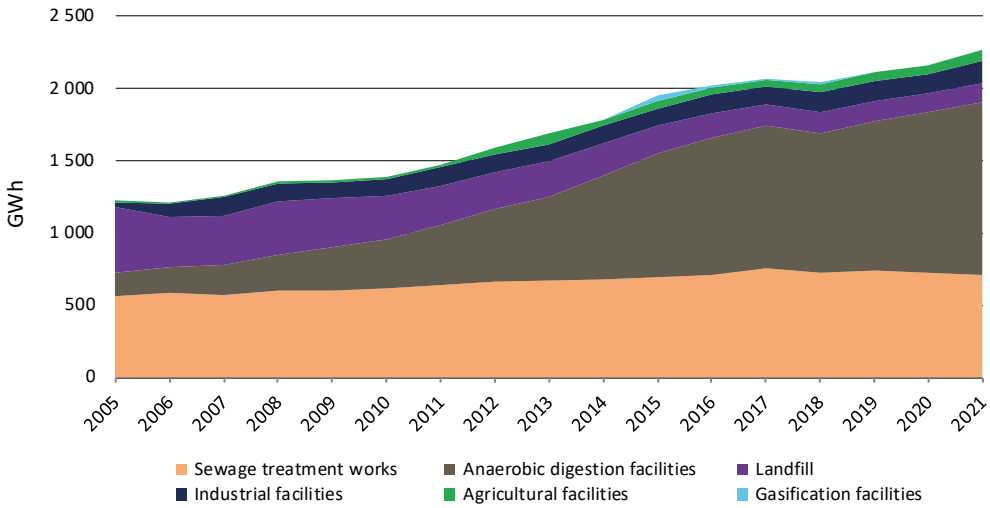

Figure 24. Production of biogas, by category of facility 2005–2021, GWh.
Source: Swedish Energy Agency.

Historically, biogas production in Sweden has increased annually from just under 1.3 TWh in 2005 to just over 2 TWh in 2016 and then leveled off. It is mainly in anaerobic digestion facilities the increase occurred. The production from agricultural facilities increased in the beginning of 2010s. Since then, the production from agricultural facilities has been around 50 GWh annually but increase slightly in 2021. Biogas production from industrial facilities have also increased in 2021. The extraction of biogas from landfills (landfill gas) has steadily decreased since the ban in 2005 on the landfilling of organic waste.

In 2021 biogas was produced from manure in 76 facilities in Sweden, were 52 were agricultural facilities and the rest anaerobic digestion facilities. The amount of manure that is digested to biogas and bio manure have increased sixfold since 2009. Two fifths are treated in agricultural facilities and the rest in larger anaerobic digestion facilities.[86] One of the reasons for the increasing amount of biogas from manure is due to support that was introduced in 2015 until 2023. Since 2021 there has also been a manure bonus which gives lower emissions for biogas produced from manure.[87]

[86] Energigas Sverige 2021, *Produktion av biogas och rötrester och dess användning år 2021 [Production of biogas and digestate and its use in 2021*]

[87] Drivmedel 2021, ER 2022:08, Energimyndigheten 2022

Biogas use in Sweden including biogas import

Complete statistics on the import and export of biogas in Sweden do not exist. The total biogas use in Sweden is estimated to biogas production and net imports of biogas from the West Swedish gas network through Denmark. Net import of biogas increased in 2021 from beaning 1.7 TWh in 2020 to 2.5 TWh in 2021.[88] The biggest share of imported biogas comes from Denmark and the rest from other EU countries and non-EU countries.[89]

The total biogas usage in Sweden is estimated to 4.8 TWh.[90] This is an increase of with 18 per cent compared to 2020. Since 2015 biogas usage has doubled, see Figure 25. This increase is attributed to increased biogas imports due to production during the same period only increased by 17 per cent.

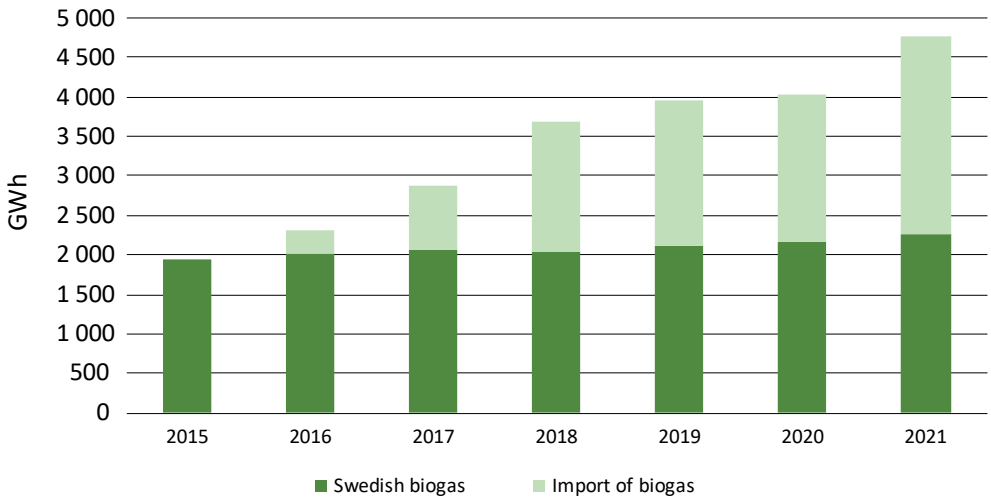

Figure 25. Total biogas use in Sweden 2015-2021 in GWh, including net import.
Source: Swedish Energy Agency.[91]

Policy measures, directives and regulations that affect the biomass market

Wood fuels

Sustainability criteria

The EUs revised renewable energy directive (RED II[92]) which applied during 2018 also included sustainability criteria for solid and gaseous biofuels. The government decided

[88] Energimyndigheten, *Produktion och användning av biogas och rötrester 2021* [*Production and use of biogas and digestate in 2021]*, https://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/Produktion-av-biogas-och-rotrester/ (retrieved 2022-10-27)

[89] Drivmedel 2021, ER 2022:08, Energimyndigheten 2022

[90] Energimyndigheten, *Produktion och användning av biogas och rötrester 2021* [*Production and use of biogas and digestate in 2021]*, https://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/Produktion-av-biogas-och-rotrester/ (retrieved 2022-10-27)

[91] Ibid

[92] Europeiska Unionen, *Europaparlamentet och rådets direktiv (EU) 2018/2001 av den 11 december 2018 om främjande av användningen av energi från förnybara energikällor (omarbetning), [Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the*

to amend the Act on Sustainability Criteria and the Act on Electricity Certificates on 15 June 2021[93]. The amendment implied new sustainability criteria for solid and gaseous biofuels used to produce electricity, heat and cooling and fuels in facilities with a total installed capacity at minimum 20 MW for solid biofuels and 2 MW for gaseous biofuels respectively. The sustainability criteria are required for tax reduction and for issuing electricity certificate. Restrictions on greenhouse gas emissions were also adopted. The amendment also implies that biofuels cannot come from land with high biological diversity or large carbon reserves.

Revision of the EU directive for renewable energy

The European Commission proposed to increase the EU's target for the share of renewable energy in 2030 from 32 to 40 per cent. The proposal also contains increased sub-goals for the heating and transport sectors, stricter requirements for sustainability criteria and increased reporting for bioenergy. The proposal means that the directive's binding overall goal by 2030 is adjusted to the EU's revised goal of reducing greenhouse gas emissions to at least 55 per cent by 2030. The Swedish government was critical of the proposal to increase regulation of how the targets for increased renewable energy would be achieved and that the new sustainability criteria need to be evaluated to see its effects. The new sustainability criteria have led to increased uncertainty around biomass combustion.

EU taxonomy

The EU taxonomy is a common classification system for renewable economic activities that applies from 12 July 2020. Its purpose is to increase renewable investments within the EU and to implement the EU's green deal. For an investment to be sustainable, at least one of six goals must be followed and not be detrimental to the other five goals.[94] Forestry and bioenergy are covered by the taxonomy and for them to be classified as sustainable additional requirements are set beyond sustainability criteria. Ten countries, including Sweden, indicated that they do not support introducing additional requirements for bioenergy within the taxonomy. These countries sent a joint letter to European Commission where they stated that it is crucial that bioenergy that meets sustainability criteria in the EU's renewable energy directive is also classified as a sustainable investment according to the taxonomy.[95]

Biofuels in transport sector

The reduction obligation

The reduction obligation for petrol and diesel was introduced on 1 July 2018 and from 1 July 2021 also for aviation fuel. The policy is that every year all fuel suppliers must reduce greenhouse gas emissions from petrol, diesel, and aviation kerosene by a certain

promotion of the use of energy from renewable sources] https://eur-lex.europa.eu/legal-content/SV/TXT/PDF/?uri=CELEX:32018L2001&from=EN (retrieved 20-03-20)

[93] Regeringen, *Hållbarhetskriterier – genomförande av det omarbetade förnybarhetdirektivet* [*Sustainability criteria – implementation of the recast Renewables Directive]*, https://www.regeringen.se/rattsliga-dokument/proposition/2021/04/prop.-202021185/ (hämtad 2022-10-31)

[94] European Commission, *EU taxonomy for sustainable activities*, https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en#200903 (retrieved 2022-10-31)

[95] Regeringen, *Revidering av EU:s direktiv för förnybar energi [Revision of the EU Renewable Energy Directive*], https://www.regeringen.se/faktapromemoria/2021/09/202021fpm-144/ (retrieved 2022-10-31)

percentage through a gradually increased use of biofuels. The reduction levels for 2021 to 2030 are shown in the table below.

Table 1. Percentage reduction levels 2021–2030 according to the Act on reduction obligations.

Year	Petrol	Diesel	Aviation fuel
2021	6	26	0,8
2022	7,8	30,5	1,7
2023[96]	7,8	30,5	2,6
2024	12,5	40	3,5
2025	15,5	45	4,5
2026	19	50	7,2
2027	22	54	10,8
2028	24	58	15,3
2029	26	62	20,7
2030	28	66	27

The reduction obligation shall contribute to achieving the national target of at least a 70 per cent emission reduction of greenhouse gases for domestic transport (excluding domestic flights) by 2030 compared to 2010. The new levels entered into force on 1 August 2021 in a legislative amendment on the Reduction Obligation Act[97]. The amendment also included changed in the wording of biofuels to renewable or fossil-free fuels to be able to use electric fuels to fulfill the reduction obligation. The reduction levels shall be reviewed at regular control points to ensure that the levels contribute both cost- and climate-effectively to the reduction of carbon dioxide emissions from petrol and diesel.

With the legislative amendment in August 2021, the Government has commissioned the Swedish Energy Agency to investigate whether the reduction levels for petrol, diesel, and aviation fuel for 2024–2030 should be changed and whether there should be any changes to the reduction obligation for aviation fuel. This is part of the checkpoint 2022 and is to be submitted December 15, 2022.[98] An interim report for petrol and diesel was published on 8 September 2022[99] where three alternatives to reduction levels for petrol and diesel are proposed. If none of these proposals are implemented, other instruments and measures are needed to reduce emissions. At the time of writing the aviation fuel report remains for publication.

The reduction obligation for aviation fuel may be affected by the so-called ReFuelEU Aviation initiative. The European Commission presented a so-called “fit for 55” package

[96] Reduction levels for petrol and diesel have been changed to 2022 levels, previously they were 10.1 for petrol and 35 for diesel respectively.

[97] Lag (2017:1201) om reduktion av växthusgasutsläpp från vissa fossila drivmedel [Act (2017:1201) on the reduction of greenhouse gas emissions from certain fossil fuels]

[98] Infrastrukturdepartementet 2021, *Uppdrag att ta fram underlag för kontrollstation 2022 inom ramen för system med reduktionsplikt på bensin, diesel och flygfotogen.* [*Assignment to develop a basis for a control station in 2022 within the framework of systems with a reduction obligation on gasoline, diesel and aviation kerosene]*

[99] Kontrollstation för reduktionsplikten 2022, Delrapport 1 av 2, ER 2022:07, Energimyndigheten 2022.

to reduce greenhouse gas emissions. In the package, the Commission proposed obligations for fuel suppliers to distribute sustainable aviation fuels (SAFs) and increase the share of SAFs over time.[100] The reduction obligation may be affected in such a way that the Government wants a similar system throughout the EU instead of having a reduction obligation for aviation fuel.

The Government submitted a proposal to pause the increase in the reduction obligation for petrol and diesel in 2023 due to the high fuel prices over the past year. The proposal means that the reduction level for petrol and diesel for 2023 will be the same level as for 2022 to avoid that the reduction obligation will lead to higher prices for petrol and diesel.[101]

Energy tax and carbon tax exemption 2022

The European Commission decided in September 2021 that pure and high-blend liquid biofuels will be exempt from carbon tax and energy tax in 2022. A new memorandum also proposes that the exemption from energy tax and carbon dioxide tax for liquid pure and highly mixed biofuels should be abolished. Pure and highly mixed biofuels will instead be subject to the reduction obligation.[102] The Government has also applied to the European Commission for the continued tax exemption for ten years.[103]

Biogas

Klimatklivet

Since 2015, investments in the biogas sector have mainly received support through Klimatklivet[104] at the Swedish Environmental Protection Agency. Klimatklivet has supported new investments that have increased biogas production by 1.5 TWh, which corresponds to 60 per cent of today's production.[105]

Investment support for biogas under the Agricultural Development Program

Farmers and other entrepreneurs in who want to invest in the production or upgrading of biogas or in digestate management have been able to apply for investment support since autumn 2015. The compensation can amount to 40 per cent of the investment. The investment support was initially part of the Agricultural Development Program

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100 Europa, *ReFuelEU Aviation initiative: Sustainable aviation fuels and the fit for 55 package, https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)698900* (Retrieved 2022-11-02

101 Regeringen, *Pausad höjning av reduktionsplikten för bensin och diesel 2023 [Paused increase in reduction obligation for petrol and diesel in 2023]*, *https://www.regeringen.se/rattsliga-dokument/proposition/2022/05/prop.-202122243/* (hämtad 2022-10-31)

102 Regeringen, *Reduktionsplikt för rena och höginblandade biodrivmedel [Reduction obligation for clean and highly blended biofuels],* https://www.regeringen.se/rattsliga-dokument/departementsserien-och-promemorior/2021/12/reduktionsplikt-for-rena-och-hoginblandade-biodrivmedel/ (hämtad 2022-10-31)

103 Svebio*, Nya möjligheter med tioårig skattebefrielse på biodrivmedel [New opportunities with ten-year tax exemption on biofuels],* https://www.mynewsdesk.com/se/svebio/pressreleases/nya-moejligheter-med-tioaarig-skattebefrielse-paa-biodrivmedel-3163131 (Retrieved 2022-11-03)

104 Naturvårdsverket, *Klimatklivet*, http://www.naturvardsverket.se/klimatklivet

105 Naturvårdsverket, *Klimatklivet vill se fler ansökningar inom biogas* [*Klimatklivet wants to see more applications in biogas],* https://www.naturvardsverket.se/om-oss/aktuellt/nyheter-och-pressmeddelanden/klimatklivet-vill-se-fler-ansokningar-inom-biogas/ (hämtad 2022-11-02)

2014-2020.[106] All countries in the EU had to develop a strategic plan that described the country's agricultural policy, and this included continued investment support for biogas. On 22 September 2022, the previous government decided on this plan and the European Commission made the decision on 28 October. Therefore, there will be continued investment support within the agricultural development program for biogas, valid from 2023 to 2027.[107]

Support for biogas production

Since May 1, 2022, it is possible to receive production support for biogas that will be upgraded to biomethane in gas or liquid form in 2022. The support can be up to 30 öre/kWh produced biogas if biogas is upgraded to biomethane. And no more than 45 öre/kWh if biogas is upgraded to biomethane and then liquefied. There is also a proposal for the support for 2023 and 2045.[108]

Support for biogas production from livestock manure

The purpose of the support is to increase the production of manure-based biogas which leads to a reduction in methane gas emissions from manure, and fossil energy sources can be replaced. Support for biogas production from livestock manure is a project that began in 2014 and ends in 2023. The support is paid on the part of the gas that comes from manure and the amount of support can be up to 40 öre/kWh. The support is calculated based on how much manure is digested in the plant and how much manure gas is produced.[109]

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[106] Jordbruksverket, *Investeringsstöd för biogas* [*Investment aid for biogas]*, https://jordbruksverket.se/stod/fornybar-energi/investeringsstod-for-biogas#h-Vemkanfastod (hämtad 2022-11-02)

[107] Jordbruksverket, Ny jordbrukspolitik 2023 – 2027, https://jordbruksverket.se/stod/stod-till-jordbruket-och-landsbygden-2023-2027/ny-jordbrukspolitik (hämtad 2022-11-03)

[108] Energimyndigheten, *Stöd för producenter av biogas som uppgraderas till biometan*,[*support for producers of biogas upgraded to biomethane*]https://www.energimyndigheten.se/fornybart/stod-och-bidrag-pa-fornybartomradet/stod-for-er-som-producerar-biogas-som-uppgraderas-till-biometan/ (hämtad 2022-11-02)

[109] Jordbruksverket*, Gödselgasstöd*, https://jordbruksverket.se/stod/fornybar-energi/godselgasstod (hämtad 2022-10-31)


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Fossil fuel market

Included in the fossil fuel markets are oil, coal, and natural gas. In Sweden, oil products are mainly used within the transport sector and coal is mostly used within industry. Natural gas accounts for a small proportion of Sweden's energy use and is mainly used for electricity and heat production, and in the industrial sector.

Oil

Oil is the dominant source of energy globally and accounted for over 29 per cent of the world's total energy supply in 2020. Crude oil is used as a commodity in petroleum products and is one of the world's most traded commodities. The fossil energy markets are global, and the Swedish market is therefore affected by international developments. Supply and demand in the global oil market is affected by economic growth as well as production levels, but also by geopolitical and security policy factors, in addition to the weather and the amount currently in storage. The price is therefore also affected by these factors. Historically, the oil market has been characterized by large variations.

The use of oil products in Sweden has halved

Vehicle fuel currently represents the primary final use of oil products in Sweden. Since the 1970s, the use of oil products in Sweden has more than halved, and the past 30 years have seen a reduction in use of over 60 TWh, as shown in Figure 26 . It is primarily the use of fuel oils that has decreased, particularly in the detached housing. [110]

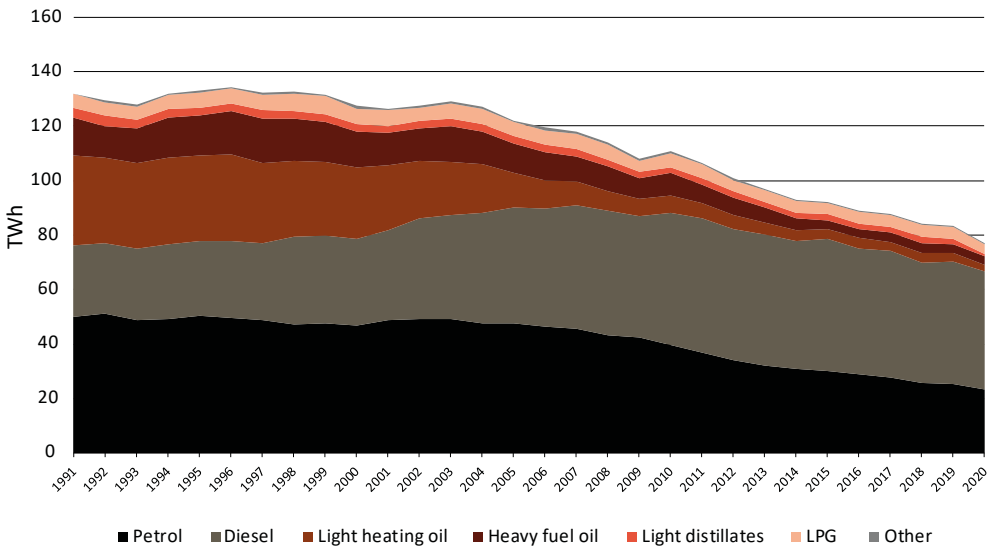

Figure 26. Final use of petroleum products, by product 1991-2020, TWh.

Source: Swedish Energy Agency and Statistics Sweden.

[110] See the chapters for each user sector for more information about what has led to decreased use.

Sweden imports crude oil and exports refined oil products

Sweden has a relatively large refinery industry with the capacity to produce more transport fuels and other refined oil products than is used in the country. This makes Sweden a net exporter of refined petroleum products. However, some of the transport fuels used in the country are imported. There are, for example, distributors of transport fuel that do not have their own refinery capacity and instead buy from other Swedish and foreign suppliers. Swedish transport fuel production is concentrated to the west coast, which means that imported refined products from countries such as Finland may have lower transportation costs to the Swedish east coast.

Since Sweden does not have its own extraction of crude oil, all crude oil supplies to the refineries come from imports. In 2021, 17.6 million tonnes of crude oil were imported. Figure 27 shows imports of crude oil broken down by country of origin.

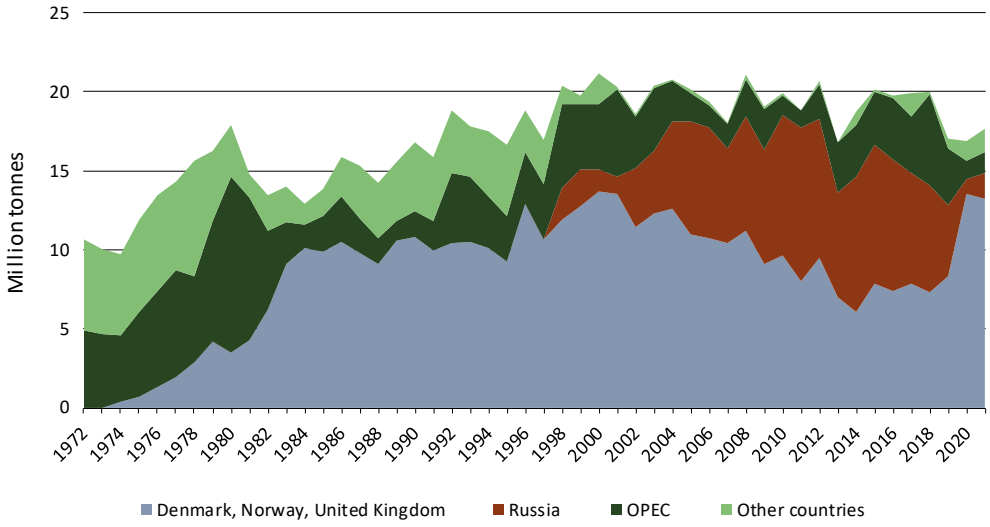

Figure 27. Swedish import of crude oil, by country-of-origin 1972–2021, million tonnes.

Source: Swedish Energy Agency and Statistics Sweden.

The crude oil that Sweden imports mainly comes from the North Sea. Sweden's crude oil imports from Russia increased during most of the 2000s while imports from the North Sea decreased. In recent years imports from Russia have decreased sharply.

Shale oil has increased supply on the global market

Shale oil is crude oil produced from oil shale through hydraulic fracturing or "fracking", which is the term in common usage. In recent years, there has been a major development in shale oil extraction in the United States.[111] The development has led to a significantly greater supply of oil in the global oil market.[112] Shale oil production in the U.S. has increased from less than 0.6 million barrels per day in 2010 to over 7 million barrels

[111] Shale oil extraction often also extracts natural gas as a by-product

[112] The oil extracted by hydraulic fracturing is often of so-called light oil grades, these can be compared to heavy to medium-heavy, more acidic crude oil grades exported from the Middle East.

per day in 2021 and most of the crude oil produced in the U.S. comes from shale.[113] The increased production has led to the country moving from net importer to net exporter of oil[114].

Reference oils serve as a basis for pricing

Brent is a type of crude oil that is extracted from the North Sea. It fills an important role as a reference price and constitutes the basis for setting the price of global crude oil. Like Brent, West Texas Intermediate (WTI) constitutes a basis for setting the price of global crude oil but is more reflecting the U.S market. The price in Dubai constitutes a reference for pricing global crude oil but is used mainly to set the price of crude oil export from the Persian Gulf to the Asian market. See Figure 28 for prices of crude oil. The prices are presented here in annual average values.

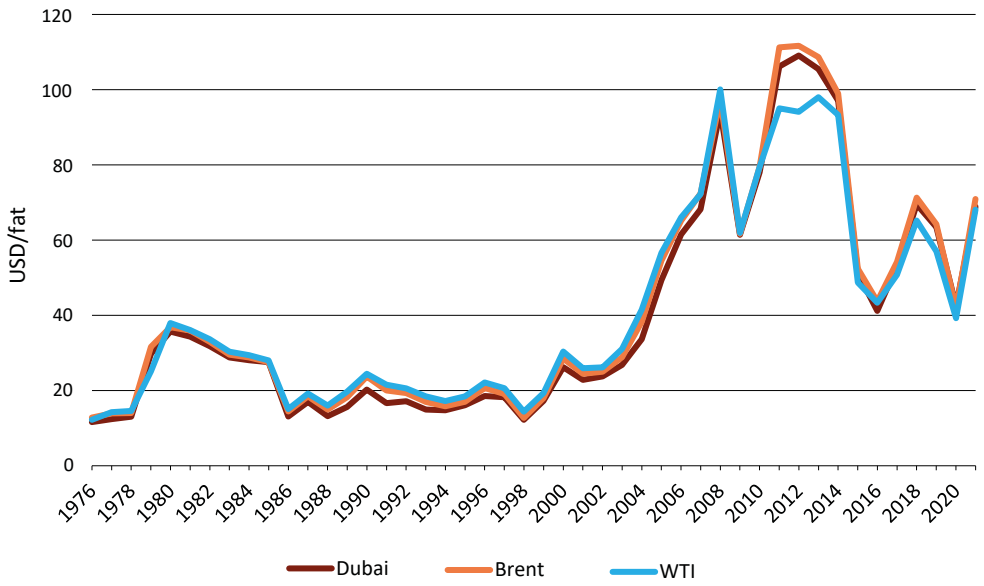

Figure 28. Crude oil prices 1976–2021, USD/barrel.

Historically, WTI has traded at a higher price against Brent. From 2010, the relationship between the reference oils changed when the price of WTI was sharply reduced relative to Brent. This was partly due to an increase in U.S. shale oil production and partly due to major infrastructure deficiencies that prevented the oil produced from reaching consumers. At the same time, the price of Brent was boosted by the Arab Spring and the nuclear accident in Fukushima, Japan. As the crude oil transportation pipeline system expanded in the U.S., the price of WTI has strengthened and the difference to Brent has narrowed.

[113] U.S. Energy Information Administration, *FREQUENTLY ASKED QUESTIONS (FAQS),How much shale (tight) oil is produced in the United States?,*https://www.eia.gov/tools/faqs/faq.php?id=847&t=6 (retrieved 2022-10-24)

[114] U.S. Energy Information Administration, *FREQUENTLY ASKED QUESTIONS (FAQS),How much shale (tight) oil is produced in the United States?,*https://www.eia.gov/tools/faqs/faq.php?id=847&t=6 (retrieved 2022-10-24)

The COVID-19 pandemic had a major impact on oil prices

After a few years of the lowest oil prices since the aftermath of the global financial crisis, prices increased in 2018. This happened largely because, despite disagreements between the countries, the oil producer group OPEC, together with other countries, decided to jointly reduce production to increase prices. However, in 2019, prices again decreased slightly, which can partly be explained by increased production of oil in the United States. In general, increased oil production in the United States and hence the country's reduced need to import oil have a significant impact on the oil market.

In 2020, oil prices were the lowest for approximately 15 years. The main cause of the low prices was the COVID-19 pandemic and the effect the pandemic had on the global economy, which in turn affected the use of oil. Not least, reduced travel and reduced transport affected the demand for oil. This affected pricing despite the oil producer group OPEC's attempts to raise prices through significant production reductions. The increased production of shale oil by the United States and the transition from net importer to net exporter led to greater supply of oil which also affected pricing.[115] In 2021, oil prices increased again to pre-pandemic levels, albeit with temporary fluctuations caused by the news flow around the pandemic, such as restrained or eased restrictions and virus variants.[116]

The price development in the global oil market affects everyone who operates or trades in the oil industry. Sweden is therefore affected by global price developments, but price effects are not always direct. For example, the price of crude oil is one of several factors that affect the fuel price at the pump, where a big part of the final price consists of national taxes. Other factors such as increased transport costs for imports and exchange rates can also affect the price on the Swedish market.

Security of oil and fuel supply

Today, there are several threats to the global, European, and Swedish oil and fuel supply. Since the market for oil is global, an event in another part of the world can have major consequences in Sweden as well. At the same time, the global market is part of the security of the system and thus contributes to a robust supply. With Russia's war in Ukraine and the sanctions adopted, the entire market and flows of crude oil and products have changed. Western countries have had so seek different supply routes, which has created an imbalance in the intricate supply chain that has been built up over many years. It will take time before the balance is restored based on the new conditions. The sanctions have not had a major impact on production in Russia, as the country is selling its oil at a lower price to states in Asia instead. Before the war, Sweden had an energy supply dependence on Russia due to the natural gas used in Sweden partly being from Russia.

Refinery capacity on medium distillates (diesel, fuel oil and jet fuel) is limited in the EU, making supply restricted. Fuel switching from gas to diesel and heating oil has begun and is expected to increase as gas prices increase. This makes the supply of medium distillates even more limited.

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115 Årskrönika energimarknader 2020, Energimyndigheten 2021

116 Årskrönika energimarknader 2021, Energimyndigheten 2022

Attacks on critical infrastructure also pose a potential threat to secure fuel supply to Sweden, directly and indirectly. An indirect impact is, for example, increased insurance costs for ships entering the Baltic Sea. The security of supply of oil and fuel can also be affected by disasters and accidents in the oil industry.

Coal

After oil, coal is the most common source of energy globally, accounting for 27 per cent of the world's energy supply in 2020. It is also the fossil energy source whose use increased the most globally during the 2000s, with China accounting for most of the increase. More specifically, China accounts for more than half of global demand for coal. Of the world's regions, Asia, which includes China and India, accounts for two-thirds of global demand.[117] Coal accounts for about 40 per cent of energy-related carbon dioxide emissions globally.[118] Globally, coal is mainly used as a fuel for electricity generation. Coal is also used in industry, especially for the manufacture of iron and steel, where it can be used both as an energy source and process raw material.

Coal is a term for several types of solid fossil fuels that contain high levels of the element carbon and that have been formed by the decay of organic matter and then transformed in the earth's crust for a very long time under high pressure. The energy content of coal varies depending on how long the conversion process has lasted. Lignite is a younger form of carbon that contains more liquid and therefore has a relatively low energy content, while coal that has been stored in the earth's crust for a long time has a higher energy content and less liquid.

Coal is used primarily within industry in Sweden

In Sweden, coal represents only a small part of the energy system today, where coal and coke together account for about 3 per cent of the total energy supply. Figure 29 shows the use of energy coal in Sweden. It is primarily the industrial sector that uses coal, where most of the coal consumption takes place in coking plants to produce coke. Which in turn is mainly used as a reductant in iron production. In coking plants, the process also causes the formation of energy-rich coke oven gas, which is used in heat and electricity production in the iron and steel works, as well as within the district heating and electricity sector. During blast furnace iron production, blast furnace gas is produced, which is also used for heat and electricity production, among other things.

[117] Coal 2021- analysis and forecast to 2024, International Energy Agency 2021

[118] Global Energy Review: CO2 Emissions in 2021, International Energy Agency 2021

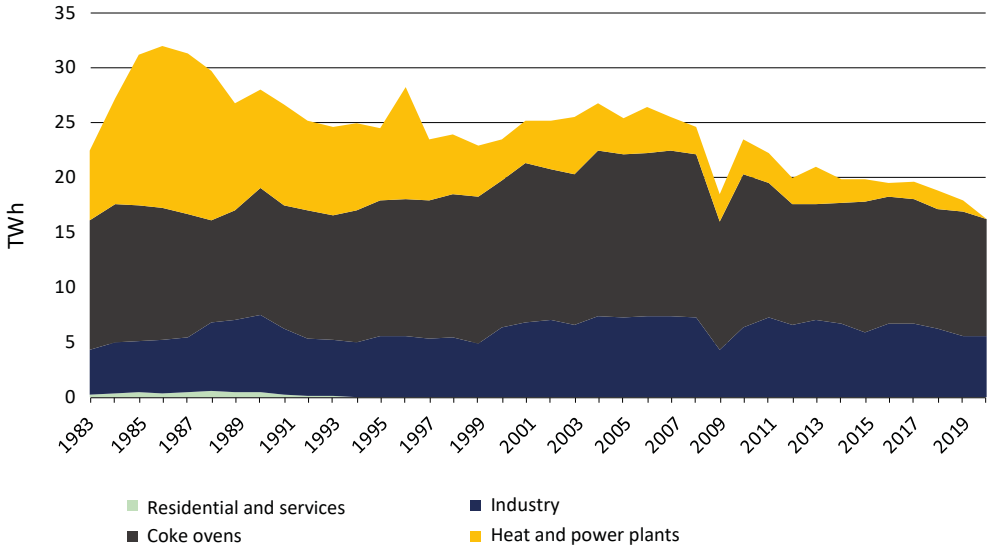

Figure 29. Use of coal by sector, 1983–2020, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

In the Swedish electricity and district heating sector, coal consumption decreased significantly during the 1990s as a result of carbon dioxide and sulphur taxes being introduced. However, combined heat and power plants still use some coal. One reason for this is that the tax regulations for combined heat and power production are more beneficial than to produce heat alone. The aim of this tax differential is to increase the competitiveness of combined heat and power plants compared to facilities that produce only electricity or only heat.

However, since August 2019 heat production from combined heat and power plants is taxed as high as other heat production. The new tax rules aim to reduce carbon dioxide emissions from Swedish combined heat and power plants and contribute to the transition to net zero emissions by 2045. The Government submitted a new proposal to abolish the carbon dioxide tax on fuel in combined heat and power plants of the EU ETS. The purpose of the tax relief is to stimulate increased electricity production in Sweden. The amendment is proposed to enter into force on 1 January 2023.[119]

Global coal consumption has increased

Global coal use increased every year for most of the 2000s. In 2015, coal use declined and continued to decline in 2016. This was due to reduced coal use in China and the United States. It is increased economic activity that drives coal use because coal is mainly used to produce electricity, not least in Asia.

In 2020, there was a decline in demand for coal in the wake of the COVID-19 pandemic, which affected pricing, see Figure 30. It was mainly the demand for coal in industry that fell. Towards the end of the year, demand increased and the price of coal rose, partly

[119] Government, *Tillfälligt sänkt skatt på drivmedel och sänkt skatt på bränslen i viss värmeproduktion* [*Temporarily reduced tax on fuel and reduced tax on fuels in certain heat production]*, https://www.regeringen.se/rattsliga-dokument/proposition/2022/11/prop.-20222317/ (Retrieved 2022-11-21)

because of colder weather, lower levels in European stocks, strikes in coal mines in Colombia (which affected supply) and increased demand from China (due to import bans for Australian coal).[120]

In 2021, demand for coal recovered and there were record high price levels during the year. High demand due to global economic recovery after COVID-19 pandemic contributed to the higher prices. The high natural gas prices also made coal-based power generation more economic compared to gas-based, which was one of the factors that led to the highest coal-based power generation globally ever in 2021.[121]

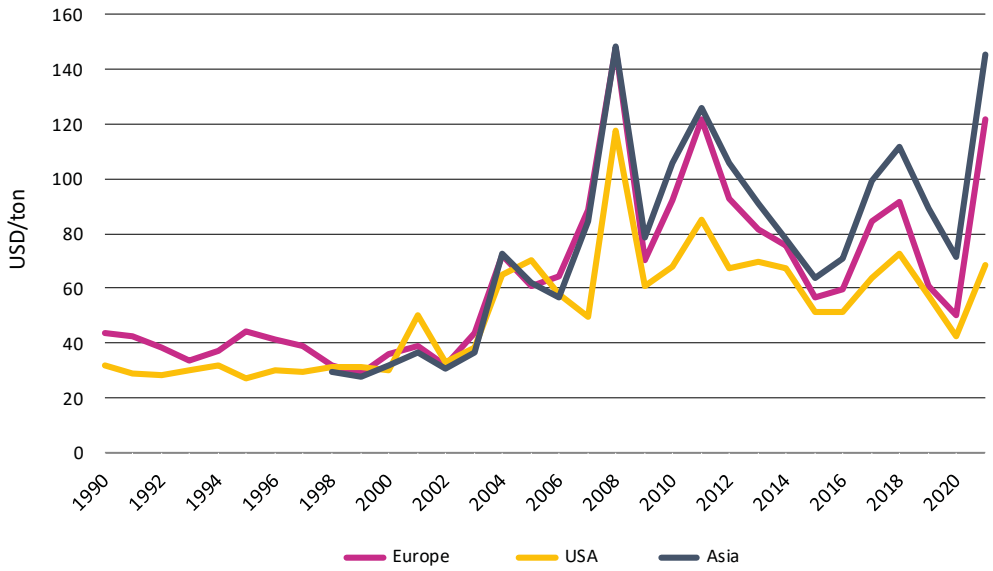

Figure 30. Coal prices in Europe, the USA and Asia 1990–2021, USD/tonne.
Source: BP, Statistical Review of World Energy 2021.

The industries that import coal in Sweden are affected by global coal prices as the price changes affect everyone who trades in the coal market. However, the impact may not be felt directly due to trading through long-term contracts occurs. In addition, other factors such as the EU's emissions trading system and national taxes on carbon dioxide influence the price in Sweden.

Natural gas

The third greatest after coal and oil is natural gas, which in 2020 accounted for 24 per cent of primary global energy use. Natural gas has gained a greater role in the global energy mix in recent years, mainly due to the rapid development of shale gas production in the USA but also as an initial step in the transition from oil and coal to renewable energy. Shale gas can be extracted with the same technology as for shale oil, as described in the previous section on oil. Over the past ten years, between 2010 and 2020, the global supply of natural gas has increased by over 20 per cent, which is a much greater increase compared to both oil and coal.

[120] Årskrönika energimarknader 2020, Energimyndigheten 2021

[121] Årskrönika energimarknader 2021, Energimyndigheten 2022

Natural gas accounts for a small part of Sweden's energy consumption

Natural gas, which was introduced in Sweden in 1985, accounts for a relatively small portion of the total energy supply; around 3 per cent in 2020. There are large regional differences in the use of natural gas depending on the reach of the natural gas network. Its use increased rapidly up until the beginning of the 1990s and then levelled off. In 2010, there was an increase in use once more, mainly due to investments in gas-fired combined heat and power coinciding with a cold winter. Total natural gas use has since decreased, partly because of a decrease in the use of fossil fuels in electricity and district heating. At present, natural gas is primarily used in industry and as a raw material in industrial processes (non-energy purposes). To some extent, natural gas is used by households connected to the gas network for heating and cooking purposes, and it is used within the transport sector as a vehicle fuel. For natural gas use by sector, see Figure 31.

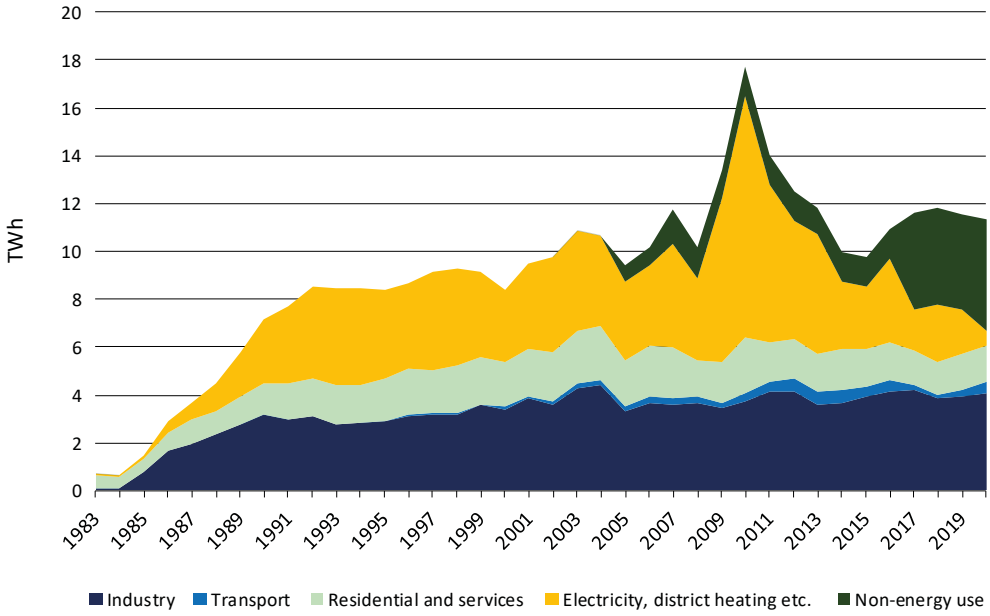

Figure 31. Use of natural gas and gasworks gas, by sector, 1983–2020, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

The Swedish natural gas network stretches from Trelleborg to Göteborg and branches off along the way, to places such as Gnosjö and Stenungsund. In this part of the country, natural gas accounts for 20 per cent of the primary energy supply. It is also nearby the natural gas network that most gas is used. Since Sweden does not produce any natural gas of its own, all of it comes from imports. Almost all imports come via pipeline from Denmark, where the Danish natural gas system in turn is linked to the continental gas network in Europe.

In addition, liquefied natural gas, so-called LNG, is imported, which is consumed by local customers and used in local gas networks. LNG is natural gas that has been cooled down to liquid form and is thus easier to load on, for example, tankers to be transported between markets that are not connected via pipelines. LNG is used in shipping and industry, among other areas.

Regional natural gas markets

The global trade in gas is less integrated and more regional than the trade in oil and coal. The supply situation looks different, depending on how developed the infrastructure is in the different regions. Trade between the regional markets has historically not occurred to any great extent, which has made the various markets isolated. A large proportion of the natural gas that was supplied to Europe came through pipelines from Russia, before Russia's invasion of Ukraine in 2022. In response to this, EU countries have increased natural gas imports from countries other than Russia. The USA is one of the countries that in 2022 entered into an agreement with the EU to replace gas supplies from Russia with LNG. In Asia, most of the natural gas is supplied as LNG using cargo ships.[122]

A large difference between the different markets is the price of gas. The gas prices in Asia are substantially higher than in both the USA and in Europe, see Figure 32. In the USA, the price of natural gas is primarily based on supply and demand and varies accordingly. Prices in Europe and Asia are instead often based on negotiated prices in bilateral long-term contracts. The price in the long-term contracts has often been strongly linked to the price of oil products in Europe and the crude oil price in Asia.

Over the past 10 to 15 years, spot markets for natural gas have emerged, primarily in Europe but also in Asia. Today, there are several European spot markets and Asian spot markets have also strengthened in recent years. In general, natural gas is often traded in a more flexible way today than in the past. Natural gas trading without long-term contracts has contributed to more transparent trade and convergent prices between markets.

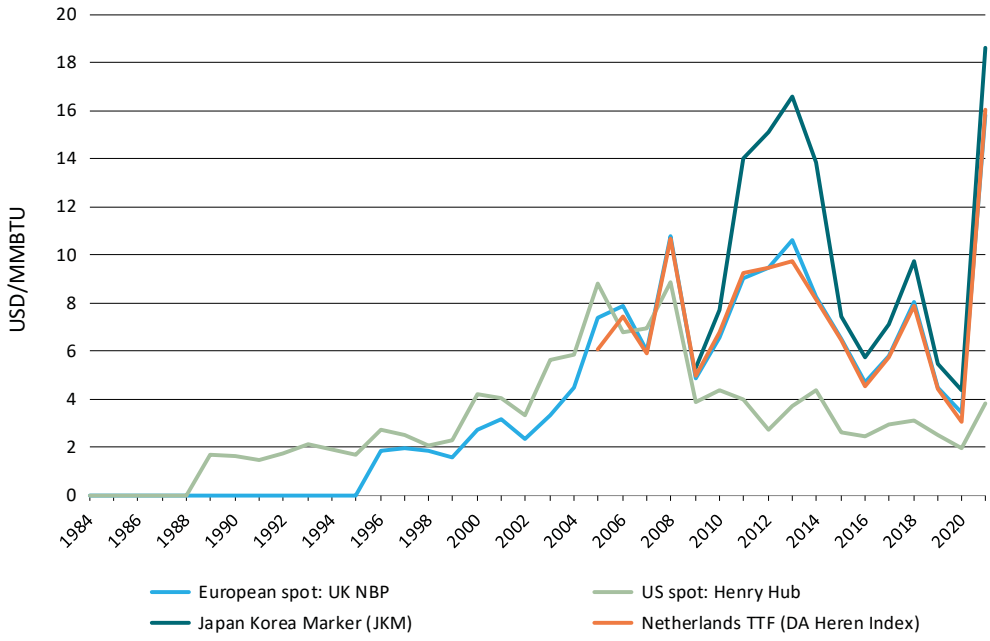

Figure 32. Average natural gas prices in Europe, the USA and Asia 1984–2021, current prices, USD/MMBTU[123]

Source: BP, Statistical Review of World Energy 2021.

[122] *Läget på de globala marknaderna vecka 39 [The situation in the global markets week 39],* Energimyndigheten 2022

[123] Million Metric British Thermal Units

Eventful years in the European gas market

Both 2020 and 2021 were marked by volatile prices. In 2021, the COVID-19 pandemic affected gas markets significantly, resulting in record low prices in the spring. During the autumn prices recovered as demand for natural gas increased, first in Asia and then in Europe. U.S. LNG exports also varied significantly in 2020, peaking in January 2020, and then falling by 62 per cent by July 2020. In December that same year, LNG exports reached were three times higher than in the summer.[124]

Natural gas prices began to rise in late spring and continued to increase through the summer and fall. The basis for the price increases was due to a cold and long winter and spring 2020/2021 in Europe, resulting in large withdrawals from gas stocks. The stocks could not be refilled, which is normally done in the spring. Strengthened demand for LNG in Asia due to the economic recovery after the COVID-19 pandemic had also an impact. Increased demand in Asia caused less LNG to reach Europe. This led to Europe started the heating season 2021/2022 with unusually low inventory levels.

Low gas flows from Russia contributed to high prices and an inability to raise inventory levels for the heating season. The low natural gas flows from Russia further fueled a concern in the market about the availability of gas going forward, which affected the pricing upwards.[125]

In 2022, natural gas prices rose further because of Russia's war against Ukraine and Russia's pressure on Europe by restricting the flow of gas. In July, the gas flow in Nord Stream 1 was stopped due to seasonal maintenance. Natural gas supplies resumed but with a lower flow than before. The cause, according to Russia, was a missing turbine that has been sent for repair. This argument was used for a long time until August 2022 when Russia announced that it was closing natural gas supplies via Nord Stream 1 due to the EU sanctions against the country.[126]

On September 26, pressure drops were suddenly detected on the Nord Stream 1 and 2 gas pipelines due to three leaks. It was found that the leaks were due to deliberate sabotage. Russia's announcement to pause natural gas supplies and destroyed natural gas pipelines pushed natural gas prices up to record highs. More European countries announced that they intend to build floating facilities for the storage and gasification of LNG. Many countries also signed agreements with Asia and the USA to buy LNG. The European Commission proposed and decided on emergency measures to reduce natural gas consumption by 15 per cent and a requirement for member states to have filled their natural gas storage to 80 per cent by November 1, 2022.[127] During the month of October, natural gas prices began to fall due to mild weather and well-stocked natural gas stocks in Europe.[128]

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[124] Årskrönika energimarknader 2020, Energimyndigheten 2021.

[125] Due to Russia's war against Ukraine and how the war affected Europe's and Sweden's energy situation, there is a great interest in more frequently updated information about the situation in the global energy markets. For the latest information, see the Swedish Energy Agency's market and current situation reports, which are published every two weeks. Energimyndigheten, *De globala energimarknaderna [Global Energy Markets]*, https://www.energimyndigheten.se/om-oss/press/prenumerera/laget-pa-energimarknaderna/de-globala-energimarknaderna/ (retrieved (2022-11-25)

[126] Läget på de globala marknaderna vecka 36 Energimyndigheten 2022.

[127] Läget på de globala marknaderna vecka 39, Energimyndigheten 2022.

[128] Läget på de globala marknaderna vecka 43, Energimyndigheten 2022.

Secure natural gas supply

Increased vulnerability with shutdown of the Tyra platform

Sweden has no large-scale domestic production of natural gas, and the entire volume of the West Swedish gas network is imported from Denmark via pipeline. The Swedish natural gas transmission system starts in Dragør in Denmark, crosses the Öresund via the Öresund pipeline to Klagshamn south of Malmö, from where the main line goes north to Stenungsund. This means that the Swedish natural gas system is entirely dependent on the Danish natural gas system. More than 90 per cent of Danish gas production comes from natural gas fields in the North Sea. The most important platform from which gas is transported to the Danish mainland is the Tyra platform. This platform is starting to reach the end of its operational lifespan and requires extensive investment for continued operations. Production was stopped on 1 December 2019 and is scheduled to resume in winter 2023/2024. During the period when the Tyra platform is not supplying natural gas, the gas storage in Denmark becomes very important for natural gas supply in Denmark as well as Sweden when demand for gas is greatest. This is because there are restrictions on transmission capacity between Germany and Denmark. Therefore, there is an increased risk that the situation may become strained in the Danish-Swedish gas market if production at the Tyra platform is stopped.

Increased security of supply with the new Security of Gas Supply Regulation

Regulation 2017/1938 on measures to ensure the security of gas supply, contains several actions that increase security of supply within the EU by, among other things, imposing greater requirements for cooperation between Member States, clearer requirements for solidarity, and increased transparency requirements in gas contracts for the import of gas. In addition to these the following regulations were added in 2022: (EU) 2022/1369 on coordinated action to reduce gas demand; and (EU) 2022/1032 amending Regulations (EU) 2017/1938 and (EC) No 715/2009 as regards gas storage. During the winter of 2022/2023 and 2023/2024, EU member states are thus now required to fill stocks to 90 per cent before the winter season and reduce national gas consumption by 15 per cent. In 2022 Sweden should have been able to reach a reduction of 26 per cent and have filled stocks to 96.6 per cent.

Policy, regulations, and directives in the fossil energy markets

Oil

New regulation of the sulfur level in bunker oil

The International Maritime Organization decided in 2016 that the global emission limit of 3.5 per cent sulfur dioxides in maritime bunker fuel will be reduced to 0.5 per cent from January 1, 2020. The new regulation entails a transition that directly affects shipping and the refinery industry but may also have consequences for all petroleum product users. This is because shipping is likely to increase the demand for medium distillates (for example, diesel) to replace heavy oil.

Natural gas

Gas market packages

In December 2021, as part of Fit for 55, the European Commission presented revised proposals for Directive 2009/73/EC concerning common rules for the internal market in natural gas and Regulation 715/2009 on conditions for access to the natural gas transmission networks. The new proposals on common rules for renewable gas, natural gas, and hydrogen and regulation on the internal markets for renewable gas, natural gas, and hydrogen, have started to be negotiated in 2022 with an aim to decarbonize the EU gas market by facilitating the use of renewable and low-carbon gases, including hydrogen. In 2022, two additional EU regulations on gas storage and consumption reduction requirements have also been developed.

Residential and service sector

The residential and service sector accounts for almost 40 per cent of the total energy use in Sweden. In 2020 the energy use in the sector was 140 TWh. The sector includes households, public administration, commerce, agriculture, forestry, fishing, and construction. The distribution of energy use between the various sub-sectors has been relatively stable, and in Figure 33 the energy use for 2020 is shown. Public administration and commerce mainly consist of non-residential buildings, but also street lighting, sewage treatment works as well as water works. Households and non-residential buildings account for approximately 90 per cent of the energy usage in the sector.

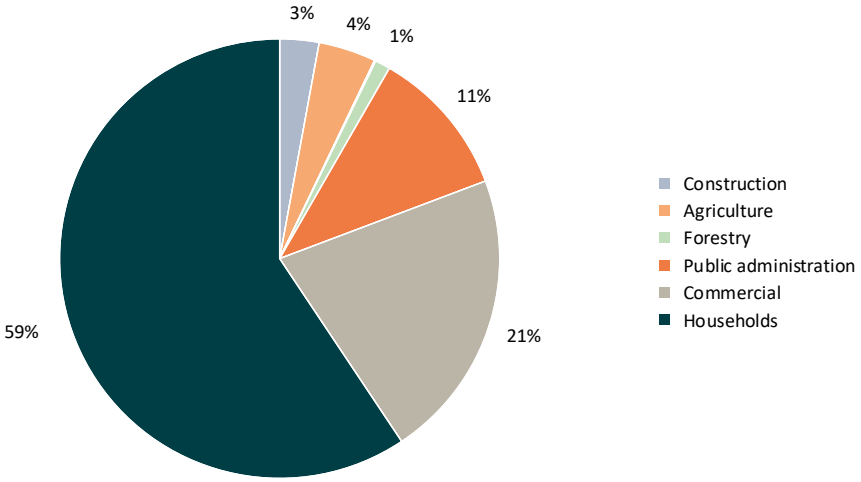

Figure 33. Distribution of different sub-sectors energy use in the residential and service sector, 2020.

Source: Swedish Energy Agency and Statistics Sweden.

Note: The category Fishing amounted to 0 TWh in 2020 and is therfore not included in the pie chart.

Decreased energy use during the 21st century

There has been a decreasing trend of the total energy use in the sector since the mid-1990s, see Figure 34. In some years however, for example in 2010, the energy use increased, mainly due to lower outdoor temperatures that year. Since then, both the total energy use and the distribution between different fuels have been somewhat constant. The use of petroleum products, which previously accounted for most of the energy use in the sector, has since the mid-1980s been replaced by district heating, electricity, and biofuels. In the last three years, the total energy use in the sector decreased by 3 TWh annually. In 2020, the energy use in the sector was 140 TWh.

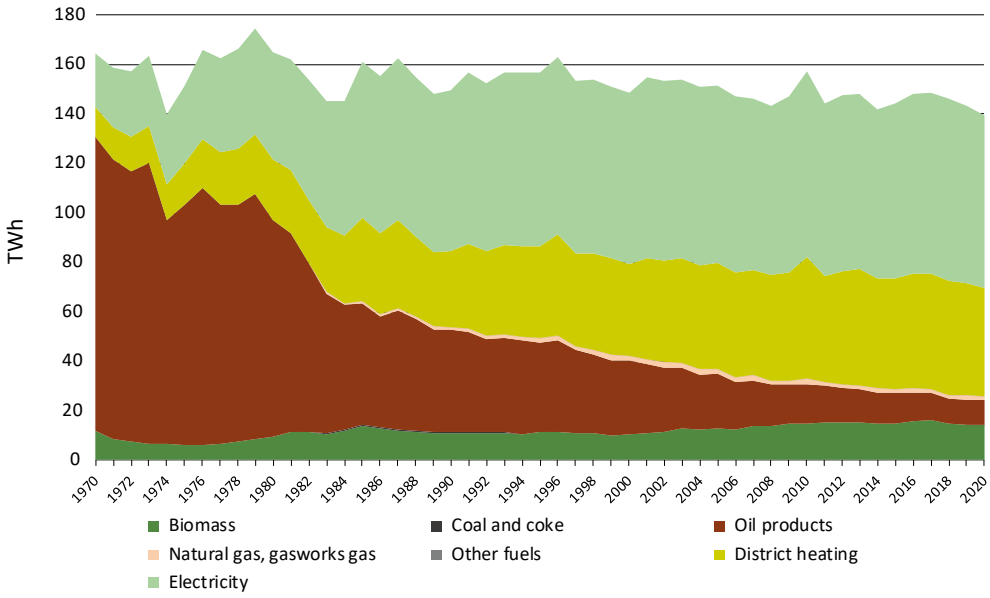

Figure 34. Energy use in the residential and service sector 1970–2020, TWh.[129]

Source: Swedish Energy Agency

Note: The figure shows the actual energy use and not the temperature corrected energy use.

More than half of the energy use in the sector goes to heating and hot water. Heating requirements are affected by the outside temperature and can lead to large variations in energy use between different years. A cold winter results in more energy used for heating, whereas a warm winter results in less energy use. A temperature correction is often made to compare different years independently of outdoor temperatures. In 2020, which was a warmer year compared to normal, the temperature-corrected energy use for heating and hot water in the sector amounted to 80 TWh. This can be compared with the actual energy use for heating and hot water at 74 TWh in 2020.[130]

In recent decades, the supplied energy for heating and hot water has decreased, largely due to oil being replaced by heat pumps and district heating. When electricity or central district heating replaces oil, the conversion and transmission losses are moved from the residential and service sector to the electricity and heat production sectors.

As of 2018, the total use of oil products in the sector was 10 TWh per year, which is a 92 per cent decrease since 1970. Most of this oil use goes to work machinery, while only 0,8 TWh goes to heating and hot water. Since the 1990s, the number of heat pumps has increased a lot and led to a reduction in energy use for heating and hot water in buildings. A heat pump delivers considerably more energy than the energy the heat pump uses. The energy heat pumps deliver is not included in the calculation of the sector's total energy use. Additional energy saving measures such as insulation and window replacements in older housing also contributes to reduced energy use.

[129] The figure for coal and coke is zero and thus cannot be seen in the graph.

[130] Energimyndigheten, *Energistatistik för småhus, flerbostadshus och lokaler* [*Energy statistics for detached houses, apartment buildings and premises],* https://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/energistatistik-for-smahus-flerbostadshus-och-lokaler/ (Retrieved 2022-11-24)

Electricity use has been stable the last 20 years

Electricity use in the sector increased steadily from the 1970s to the mid-1990s. Around the 1960s, the use of electricity for heating purposes in houses began, but this trend slowed down in the mid-1980s, both due to falling oil prices and the expansion of district heating. Since the early 1990s, electricity use in the sector has been around 70 TWh, and the shares divided between the various areas of use have largely been the same. Figure 35 shows the total electricity use in the sector since 1970, divided into household electricity, business electricity and electric heating (which includes direct-acting electricity, electric boilers, and heat pumps).

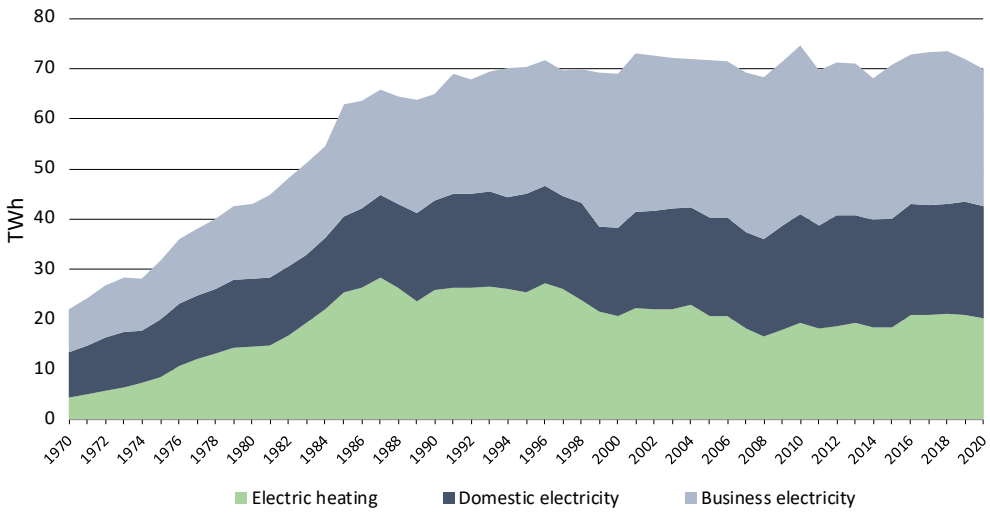

Figure 35. Electricity use in the residential and service sector 1970–2020, TWh.
Source: Swedish Energy Agency

The use of *electric heating* in households and non-residential premises increased from 4 to 28 TWh between 1970 to 1987. After that, the use of electric heating gradually decreased. In 2020, the use of electric heating was 20 TWh, corresponding to a decrease of 30 per cent since the peak in 1987. The reduced use of electric heating can be explained by many people replacing direct-acting electricity with more cost-effective alternatives such as heat pumps, district heating and pellets.

The use of *household electricity* has increased from 9 to 23 TWh between 1970 and 2020. A greater number of households and more electric appliances is the main reason for the increase during the 1970s and 1980s. Two opposing trends affect the electricity use in household today. Development is moving towards more energy-efficient devices, which leads to reduced energy use. At the same time, the number of households and electric appliances in households, as well as the number of functions on many appliances is increasing, thus counteracting the efficiency trend.

Business electricity use in non-residential premises has increased from 8 to 27 TWh between 1970 and 2020. One reason for this is that the total heated area has increased. Business electricity is a combination of the electricity used in fixed installations in a building, such as ventilation systems, lifts, escalators, and lighting as well as the electricity for the activities carried out in office and commercial buildings such as computers, appliances, and lighting.

Half of the energy is used for heating

Energy that was used for heating, including hot water in households and local buildings, was 74 TWh in 2020, corresponding to 53 per cent of total energy use in the sector. Households can be divided into single-family houses and multi-dwelling buildings. One- and two-dwelling buildings houses refer to detached houses and terraced houses, while multi-dwelling buildings comprise of apartments. Figure 36 shows the energy used for heating and hot water for one- and two-dwelling buildings, multi-dwelling and non-residential buildings and premises for 2020.

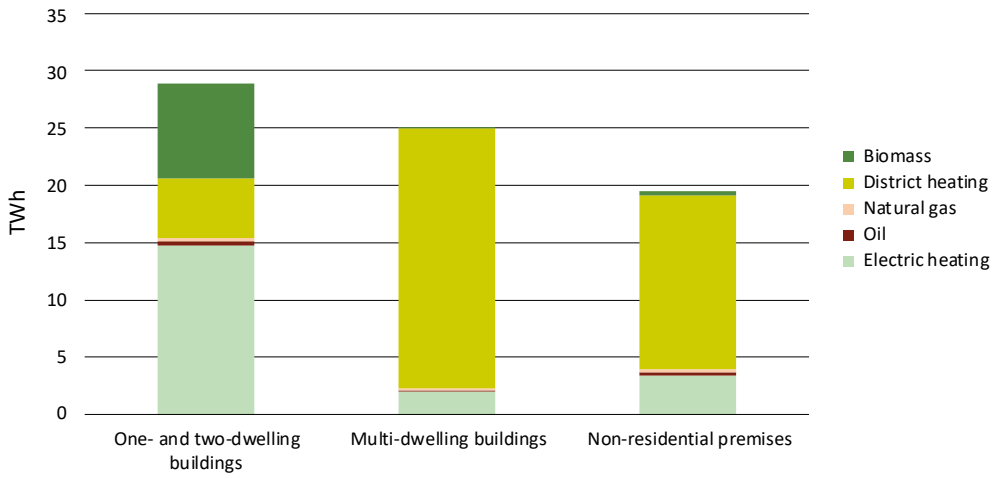

Figure 36. Energy use for heating and hot water in one- and two-dwelling buildings, multi-dwelling buildings and non-residential premises 2020, TWh.
Source: Swedish Energy Agency.

In one- and two-dwelling buildings houses electricity in the form of heat pumps, electric boiler and direct-acting electricity is most common for heating and hot water, adding up to 15 TWh in 2020. In multi-dwelling buildings and non-residential premises, district heating is the most common for heating and hot water, adding up to a total of 23 and 15 TWh respectively in 2020.

Since the 1990s the number of one- and two-dwelling buildings with heat pumps increased steadily. In 2020, there were a total 1.22 million heat pumps in one- and two-dwelling buildings in the country, corresponding to 60 per cent of all one- and two-dwelling buildings.[131] The solid line in Figure 37 shows how the purchased energy for heating and hot water has decreased since the early 2000s. The dotted line shows the energy use for heating and hot water when both purchased energy and energy absorbed by heat pumps is considered. The large growth in heat pumps is one of the reasons why purchased energy has decreased, as they replace electric radiators and absorb heat energy from the outdoor environment.

[131] Energimyndigheten, *Energistatistik för småstadshus 2020* [*Energy statistics for small town houses 2020]*, https://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/energistatistik-for-smahus/?currentTab=0#mainheading (Retrieved 2022-11-25)

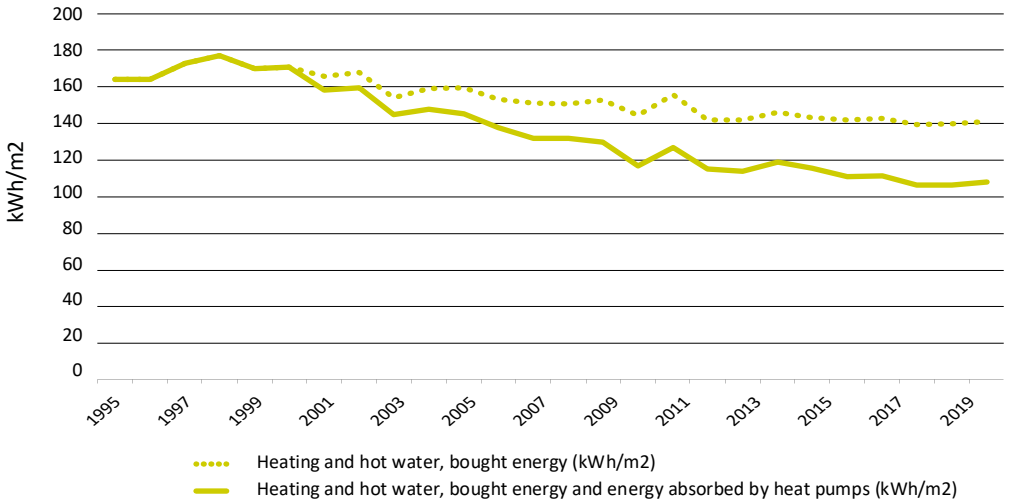

Figure 37. Temperature corrected energy use for heating and hot water in one- and two-dwelling buildings, kWh/m2, 1995–2020.

Källa: Energimyndigheten.

Energy prices for household customers have increased

Energy prices for household customers were relatively stable during the second half of the 1990s and then had a strong increase throughout the 2000s, see Figure 38. Increased fuel prices and taxes on energy are the main reasons for the rising prices. High average temperatures during the 2019/2020 heating season and the COVID-19 pandemic were some of the reasons that led to prices falling for all types of energy in 2020. In 2021, record high prices for both electricity and natural gas was recorded. More information behind the energy price increase can be found in chapter The electricity market and Fossil fuel market.

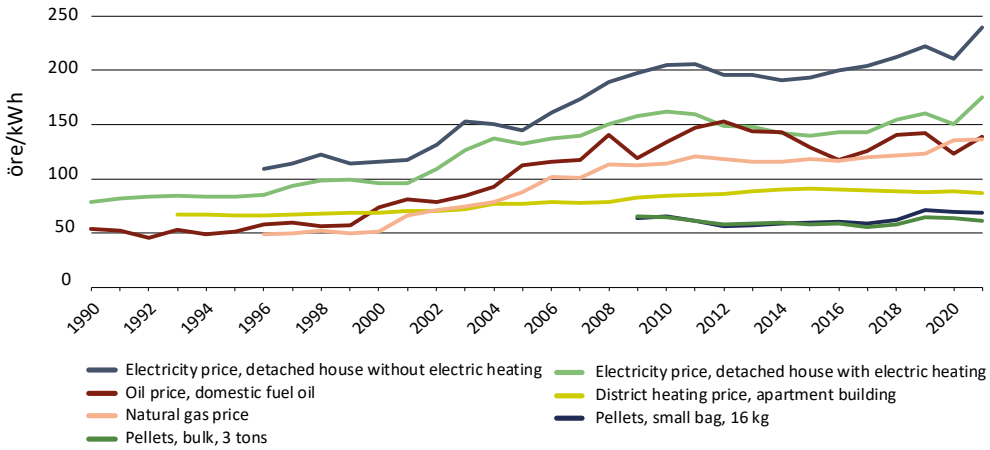

Figure 38. Energy prices for households and premises 1970–2021, at the 2021 price level, penny/kWh.

Source: Swedish Energy Agency, Statistics Sweden,, Nordic Trade Associacion, Pellets Alliacne.
Note: Prices are based on an annual average[132].

[132] SCB

After 2010, there was a slight decrease in the electricity price, both for customers with only household electricity and for those who live in detached houses with electric heating. Since then, the electricity price has increased again. Electricity price paid by a household customer are based on electricity trading costs and network costs, but also include taxes and fees.[133] The electricity price for household customers rose in 2021 to 239 öre/kWh compared to 210 öre/kWh in 2020, which corresponds to an increase of 14 per cent. The price increase is mainly caused by the increase of electricity trading cost. In comparison, network cost have increased marginally.[134] Read more about the price of electricity in the chapter The electricity market.

The oil price in Sweden follows the world market price of crude oil, which has risen during the 2000s until the peak in 2012. Read more on this in the chapter on Fossil fuel market The crude oil market price is thus reflected in the price that households must pay for domestic fuel oil. The green tax change, meaning that taxes on electricity and fossil fuels are gradually increasing, is also a contributed factor for the oil price increase and is one of the reasons why many households have converted from oil to other heating methods since the 1990s. After 2012, oil prices became slightly lower and then fell sharply in 2015 to then increase once again. For household customers, the fuel oil price increased from 123 öre/kWh to 139 öre/kWh between 2020 and 2021.

For multi-dwelling buildings, the energy price changes have meant that district heating has gained larger market shares. For one- and two-dwelling buildings houses, it is mainly heat pumps that have increased from the rising prices. Higher energy prices have also meant that energy efficiency measures have become more profitable to implement in buildings. The price of district heating for multi-dwelling buildings has increased throughout the early 2000s until 2015 and has since remained at around 90 öre/kWh in relation to the 2021 price level. The differences between various municipalities can be large, as district heating in Sweden consists of multiple local district heating systems. Therefore, it is difficult to draw any general conclusions about the reasons for the price change in district heating. However, increased fuel prices are a contributing factor to higher district heating prices.

The price that households pay for natural gas has stabilized somewhat in the 2010s. Between 2020 and 2021, the price of natural gas was 136 öre/kWh, which is a 10 per cent increase from 124 öre/kWh in 2019. Read more about the natural gas market in the chapter Fossil fuel market.

Biomass such as firewood and pellets are also important energy carriers for household consumers. Differences in pellet prices is mainly geographical, where lower prices commonly occur in the central parts of Sweden. Due to higher average temperatures in 2019/2020 the need for heating decreased and thus also the heating fuels demand, which contributed to lower prices. Read more about the price development of solid biofuels under the chapter The biomass market.[135]

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133 Energiföretagen, *Kundens elkostnader* [*Customer electricity costs]*, https://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/energistatistik-for-smahus/?currentTab=0#mainheading (Retrieved 2022-11-25)

134 The figure applies to electricity prices at national level and not to any particular bidding zone.

135 Årskrönika energimarknader 2020, Energimyndigheten 2021

Policy measures, regulations, and EU directives that affect the residential and service sector

The Energy Performance of Buildings Directive

The Energy Performance of Building Directive [136] aims to improve the energy performance of buildings. It sets out minimum requirements and a common framework for EU countries to calculate energy performance, while considering local climate conditions. In 2018, the directive was revised, with the aim of accelerating the renovation of existing buildings in a cost-effective manner and that new buildings should be so-called nearly zero-energy buildings. The revised directive has been in force since 9 July 2018 and has been law in the EU countries since 10 March 2020. The Member States are free to decide what definition applies to a nearly zero-energy building in each country. In the new definition, Sweden has among other things, replaced the term "specific energy use" with a so-called "primary energy number". With it, the maximum allowable energy for heating for different building types has also been tightened. In February 2022, additional proposals for further revision of the directive as a part of the Fit for 55 package was announced and is currently under negotiation. The main objectives of the revision are that all new buildings should be zero-emission buildings by 2030, and that existing buildings should be transformed into zero-emission buildings by 2050.[137]

Energy Efficiency Directive

On 1 June 2022, the amendments to the Energy Efficiency Directive entered into force, which was submitted to Parliament on 17 February 2022. The proposal includes a new district cooling law, new definitions on energy measurements in buildings, and amendments to the district heating act. The law on district cooling contains instructions on measurements and billing of district cooling, as well as information requirements on energy use and billing. According to new measurement requirements, domestic hot water use in new apartment buildings must be measured at the apartment level or in the residential area in buildings with both a residential and non-residential part. The new law on energy measurements also contains rules on providing information about billing and energy use.[138]

Climate declaration for new buildings

As of January 1, 2022, requirements that new buildings must be climate declared with the aim of reducing the climate impact from the construction phase. This means that developers must report a buildings climate impact from construction. The requirement only applies to those buildings whose permit began as the same date as the requirements and onwards.[139]

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[136] European Union. Directive (EU) 2018/ *844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency*.

[137] Faktapromemoria 2021/22:FPM59, *direktivet om byggnaders energiprestanda [Energy Performance of Buildings Directive]*

[138] Regeringens proposition 2021/22:124, Genomförande av ändringar i energieffektiviseringsdirektivet om värme, kyla och tappvarmvatten för hushållsbruk Boverket, *Lagändring i PBL om klimatdeklaration* [Implementation of amendments to the Energy Efficiency Directive on heating, cooling and domestic hot water for domestic use

[139] The Swedish National Board of Housing, Building and Planning, *Legislative amendment in PBL on climate declaration]*, https://www.boverket.se/sv/PBL-kunskapsbanken/nyheter-pa-pbl-kunskapsbanken/klimatdeklaration1jan/ (Retrieved 2022-11-25)

Green Technology Tax Credit

In 2020, the previous investment support of 20 per cent that was paid when installing photovoltaics expired. On January 1, 2021, a tax reduction was introduced instead for installation of green technology. The reduction applies to all costs related to labor and materials when hiring a company for the installation. For installation of photovoltaic, deductions of 15 per cent apply, while for the installation of systems for energy storage of self-generated electricity and charging points for electric vehicles, deductions can be given up to 50 per cent.[140]

In October 2022, proposals were made to further increase the tax reduction for green technology. The new proposal means that the tax reduction for installation for photovoltaics will be increased to 20 per cent instead of 15 per cent. The proposal is intended to take place from 1 January 2023.[141]

[140] Skatteverket, *Så fungerar skattereduktion för grön teknik* [*How tax reduction for green technology works*] https://www.skatteverket.se/privat/fastigheterochbostad/gronteknik/safungerarskattereduktionenforgronteknik.4.676f4884175c97df4192870.html (Retrieved 2022-11-25)

[141] Regeringskansliet, *Förslag om förstärkt skattereduktion för installation av solceller [Proposal for enhanced tax reduction for the installation of solar cells]*, https://www.regeringen.se/pressmeddelanden/2022/10/forslag-om-forstarkt-skattereduktion-for-installation-av-solceller/ (Retrieved 2022-11-25)


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och
personal

The industrial sector

The energy use in the industrial sector was 136 TWh in 2020. This is 4 per cent lower than the use in 2019 and corresponds to 38 per cent of the total final energy use in the user sectors of Sweden in 2020. The largest share of energy used goes to industrial manufacturing processes. Despite a growth in production from industry, energy use has remained relatively unchanged since the 1970s. However, over the past 10 years, the use of energy has been slightly declining. The is mainly due to structural changes in various industrial branches and more energy efficient manufacturing processes.

Biomass and electricity are the dominating energy carriers

Biomass and electricity are the primary energy carriers within Swedish industry. In 2020, 43 per cent of the sector's final energy use originated from biomass and 34 per cent was electricity use. Coal and coke accounted for 9 per cent whereas petroleum products accounted for 6 per cent. District heating, natural and gasworks gases, and other fuels accounted for the remaining 8 per cent. Fossil fuels, i.e., natural gas, petroleum products, coal, and coke, as well as other fuels, accounted for a total of 20 per cent of the sector's final energy use. Figure 39 shows the final energy use of the industrial sector per energy carrier between 1970 and 2020.

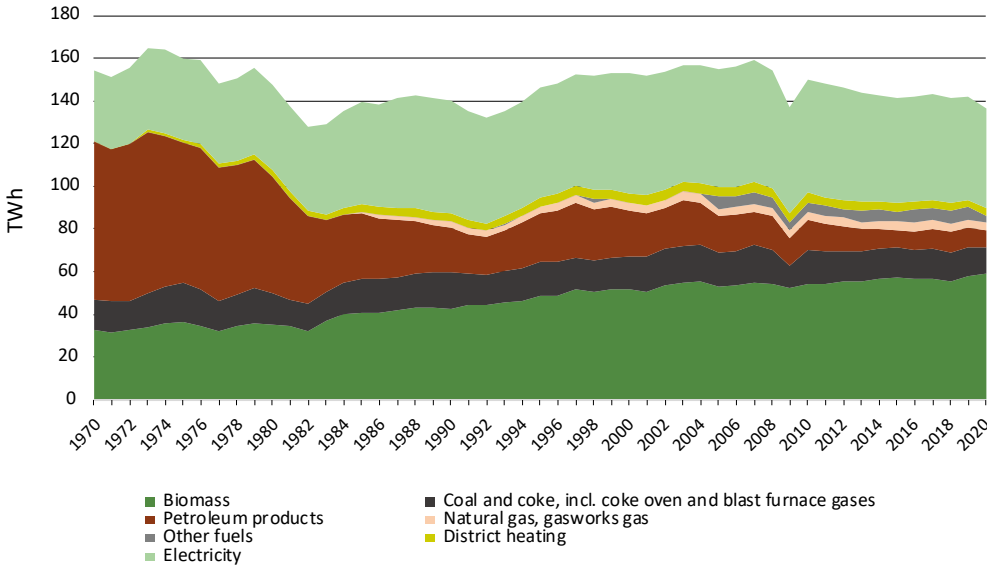

Figure 39. Final energy use in the industrial sector by energy carrier, 1970–2020. TWh.
Source: Swedish Energy Agency and Statistics Sweden.[142]

Biomass is the energy carrier that has increased the most between 1970 and 2020. The use of biomass has increased from 33 TWh in 1970 to 59 TWh in 2020. The increase can partly be explained by a gradual transition from oil products to biomass, particularly within the pulp and paper industry, which accounts for almost 90 per cent of the industrial sector's total biomass use.

[142] SCB

Industrial use of electricity has increased from 33 TWh in 1970 to 47 TWh in 2020. This can partly be explained by the transition from oil products to electricity which occurred in most parts of the industrial sectors due to the oil crisis in the 1970s. The increase can also be explained by the increased production of pulp during the 1980s, which is an electricity intensive process. Electricity use peaked in 2007, with just over 57 TWh and has since decreased gradually to 47 TWh. The recent years decrease is, among other things, a result of the transition to more energy-efficient manufacturing processes and effects of the COVID-19 pandemic.

The use of coal and coke, including coke oven and blast furnace gases, has decreased slightly over the past 20 years, apart from the recession in 2009 where a noticeable drop of the use occurred to then fall back to pre-recession levels the following year. Coal and coke, including coke oven and blast furnace gases, are primarily used by the iron and steel industry, where coke is mainly used as a reducing agent[143] whereas coal is mainly used in the mining industry. In 2020, the use of coal and coke, including coke and blast furnace gas, was 12 TWh.

The use of petroleum products has decreased from 74 TWh in 1970 to 8 TWh in 2020. It is mainly the use of heavy fuel oil used for heating in industrial processes that has decreased, a result of other heating alternatives becoming more cost effective.

Six industries account for a large share of the sector's energy use

The pulp and paper industry accounts for most of industrial total energy use, see Figure 40. In 2020, the industry accounted for 54 per cent, followed by iron, steel and metal works and the chemical industry, which accounted for 15 and 7 per cent each. The mechanical engineering industry, the timber industry and the mining and quarrying industry accounted for about 5 per cent each of the final energy use. Other industries accounted for 10 per cent. Other industries include the food industry, textile industry, graphic industry, non-metallic minerals industry (e.g., manufacturing of glass, cement, and lime), as well as those industries that are usually classified as smaller industries.

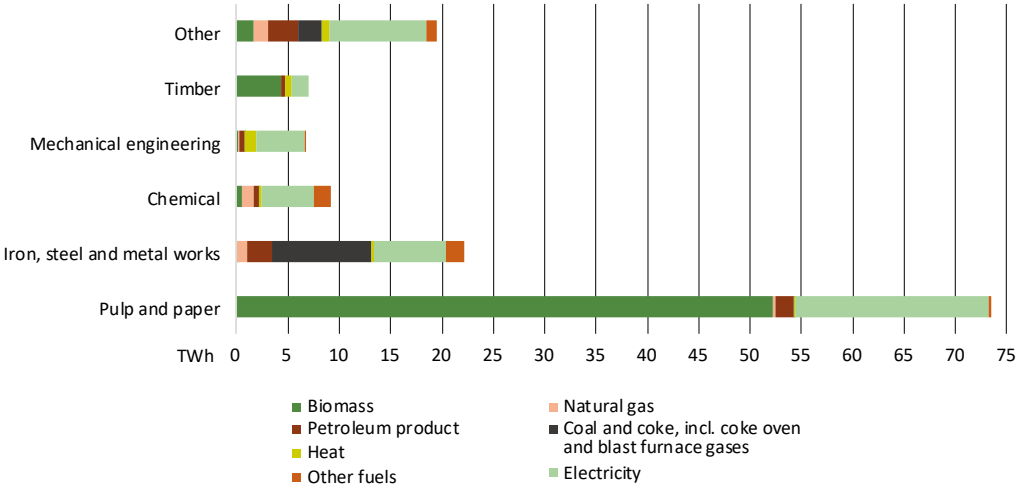

Figure 40. Final energy use of the industrial sector by industry and energy carrier 2020, TWh.
Source: Swedish Energy Agency.[144]

[143] Simplified, a reducing agent is something that binds oxygen atoms.

[144] More details about which energy carriers' different industries use can be found in the Swedish Energy Agency's publication *Energy in Sweden facts and figures* and in the web tool Energy Balance.

For the pulp and paper industry, energy use amounted to 73 TWh in 2020, of which just under 52 TWh consisted of biofuels and 19 TWh of electricity. The most common biofuels are recycled liquors (also called liquors) and wood fuel. Recycled liquors are what remains when the wood fibers are removed when boiling paper pulp and then incinerated in the factories' soda boilers. The heat extracted during combustion is then used in the industrial processes.

Iron, steel, and metal works used 20 TWh in 2020. The main energy carriers are coal, coke, and electricity. Steel is made either from iron ore or from scrap. In iron ore-based steel manufacturing, coke and coal are used to reduce the oxygen content of the iron oxide (reduction). In scrap-based steelmaking, an electrically intensive electric arc furnace is used to melt the steel scrap. Electricity is also used for the electrolysis process in the production of copper, aluminum, and zinc. Of the industry's total energy use, electricity accounted for just under seven TWh and fossil fuels for 13 TWh (of which 10 TWh were coal and coke , including coke and blast furnace gas).[145]

For the chemical industry, energy use amounted to just over nine TWh in 2020, of which five TWh were electricity. The chemical industry mainly uses electricity for electrolysis. Other common energy carriers are classified as other fuels, which are usually fossil process gases of various types. Petroleum products, natural gas and LPG are also used.

The timber industry (excluding the manufacture of furniture) consists largely of sawing and planning of wood as well as the manufacture of processed wood products and drying. Together, the industry accounted for 7 TWh of energy use in 2020. The main energy carrier of energy for the timber industry is biomass, with 4 TWh.

The mechanical engineering industry is not usually counted among energy-intensive industries[146], yet it accounted for the same share of total energy use in the sector as the timber industry. Almost 7 TWh were used in 2020, of which 5 TWh were electricity use. Most of the electricity use goes into mechanical manufacturing processes. The comparatively high energy use is due to the large number of such companies in Sweden.

The mining industry accounted for just over 6 TWh of energy use in 2020. In the mining industry, of which the greatest proportion is electricity at almost 4 TWh followed by petroleum products and coal products at 1 TWh each.

Other industries used 13 TWh of energy in 2020, of which electricity use amounted to just over 5 TWh. Some of these industries are energy-intensive, e.g., cement manufacturing, but their individual energy use is relatively low. The non-metallic mineral industry used the most fossil fuels of the other industries, just under 3 TWh in 2020.

[145] Energimyndigheten, *Årlig energibalans [Annual energy balance],* https://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/arlig-energibalans/ (Retrieved 2022-11-25)

[146] There are several definitions of energy-intensive companies. In the Energy Taxation Directive (2003/96/EC) use the definition that a company is energy-intensive if its costs for purchasing energy are at least 3 per cent of the production value or if the company's energy, carbon dioxide and sulfur taxes are at least 0.5 per cent of the value added.

Industry's energy prices are rising

The industry's energy prices have historically been characterized by large fluctuations. Fossil fuel prices have varied, but with an underlying increasing trend since the mid-1990s. The price for wood chips has remained approximately static for almost ten years. Unlike fossil fuel prices, the electricity price has fallen since 2012 until 2016 when it started to rise again, see Figure 41.

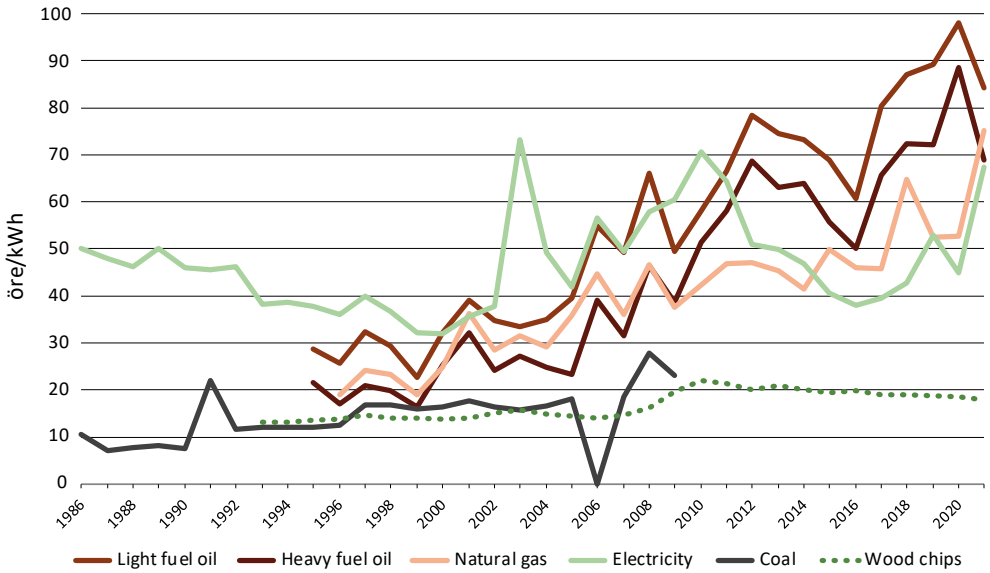

Figure 41. Energy prices for industrial companies, 1986–2021, öre/kWh at 2021 years' price level.

Source: Swedish Energy Agency, Statistics Sweden, European Commission (Oil bulletin).

Note 1: The prices of natural gas and heating oils include, in addition to the price of crude oil, also energy and carbon taxes. For heavy fuel oil, sulfur tax is also included. [147] Prices are calculated taking into account the industry's general tax exemption and apply to installations that are not part of the EU Emissions Trading System (EU ETS).

Note 2: Up until 1996, the price of electricity applies to an industrial customer with an annual electricity consumption of 50,000 MWh and from 1997 to 2018, the price applies to an industrial customer with an annual electricity consumption between 70,000 and 150,000 MWh.

Note 3: The price of coal has not been accounted for since 2009 due to changes in confidentiality regulations.

Note 4: Electricity and natural gas prices for 2021 are based on an annual average. Prices for the years before 2021 are based on an average for the first half of the year.

Note 5: The prices for fuel oil 1 and fuel oil 2-6 are based on the first week of January. Crude oil prices can be seen in the fossil energy markets chapter.

The reduced use of petroleum products since the late 1990s can partly be explained by the increased prices of fuel oils, as well as establishing a carbon dioxide tax in 1991, which has been raised successively over the years. Between 1996 and 2012, the prices of fuel oils increased threefold to later fall again slightly. In 2016, prices for light and heavy fuel oil increased as the price of crude oil increased. In 2018, the price continued to increase despite crude oil prices not increasing at the same pace. This can be explained by the industry no longer receiving a reduced carbon tax for fuel in the manufacturing process as of 2018.

[147] The various components of energy prices are described in more detail in the Swedish Energy Agency's publication *Energiindikatorer 2022*.

Industrial natural gas price developed in a similar way to the fuel oil prices until 2010. This is because the natural gas prices historically have followed the trend of crude oil price. In recent years, the connection between the two prices has weakened. The price development of fuel oil and natural gas is described in more detail in the chapter Fossil fuel market.

The electricity price for industrial customers is usually linked to the volume of electricity use in the sector. Electricity-intensive industries often pay a significantly lower price per kWh than small electricity users.[148] After several years of falling electricity prices, it has increased in the last five years, apart from 2020. The development of electricity prices is described more in depth in the chapter The electricity market.

The price for wood chips increased slightly during the 1990s, with a significant increase between 2008 and 2010. Since then, it has slowly decreased. The price development of wood chips is further described in the chapter The biomass market.

Policy measures, regulations, and EU directives that affect the industry sector

Energy taxation and carbon emission certificates to reduce emissions from the industrial sector

In 2018, the tax reduction was abolished, and industries have since paid full carbon tax on fuels. In May 2021, the Swedish Parliament decided to also abolish the existing tax reduction of 70 per cent for fuels used in industry for heating and stationary engines in the manufacturing industry. The changes were implemented in two stages where the tax reduction changed from 70 to 35 per cent from July 1, 2021, followed by the complete removal of the tax reduction on January 1, 2022. However, the fuels used in metallurgical and mineralogical processes in the steel and mining industries, as well as the production of energy products, are not affected by the change. [149] The industrial sector also has a reduced energy tax on electricity, meaning that they pay 0,6 öre/kWh instead of 39,2 öre/kWh.

Industriklivet (The Industrial Leap)

Large and complex technological leaps are required in several industries to achieve the climate goals. To support the transition and promote innovation, the Swedish Government decided in 2018 on the long-term investment Industriklivet (The Industrial Leap). Within the Industrial Leap, grants can be given to feasibility studies, research, pilot and demonstration projects and investments in the areas: greenhouse gas emissions from industry processes, negative emissions, and strategically important efforts in industry. The budget for the Industrial Leap 2022 amounted to approximately SEK 909 million and can finance projects that run until 2029. Since 2021, The Industrial Leap has been part of the green restart of a climate-smart society after the COVID-19 pandemic and is part of the EU's Recovery and Resilience Facility (RRF). RRF is a feature of NextGenerationEU that, among other things, will contribute to a more environmentally friendly EU, better adapted to current and future challenges.

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[148] Read more about how the price of electricity varies between different type customers in the Swedish Energy Agency's publication Energyindicators 2022.

[149] Riksdagen, *Slopad nedsättning av energiskatt på bränslen i vissa sektorer* [*Abolition of reduction of energy tax on fuels in certain sectors]*, https://www.riksdagen.se/sv/dokument-lagar/arende/betankande/slopad-nedsattning-av-energiskatt-pa-branslen-i_H801SkU24 (Retrieved 2022-11-25)

Additional legislation affecting the industrial sector

The industrial sector is also affected by other cross-sectoral legislation, such as the Act concerning ecological design[150], research support, the Act on Energy Auditing in Large Companies[151], and the Environmental Code's requirements for energy conservation[152]. The sector is also affected by the emission trading system, the EU ETS. However, the companies covered by the EU ETS are not subject to the carbon tax and vice versa. Read more about the EU ETS in the chapter Energy and climate policy.

[150] SFS 2008:112, Lag om krav på ekodesign för och energimärkning av produkter.

[151] SFS 2014:266, Lag om energikartläggning i stora företag.

[152] According to the Environmental Code (1998:808), all operators must strive to use renewable energy sources and use energy sparingly.

The transport sector

The transport sector's energy use was 112 TWh in 2020. Domestic transport accounted for 79 TWh, corresponding to just over a fifth of Sweden's total energy use. The remaining 33 TWh were used in foreign transport[153].

The transport sector is divided into road transport, rail transport, aviation, and shipping. Road traffic is the subsector that uses the most energy. In 2020, road transport accounted for 74 TWh, corresponding to 66 per cent of total energy use in the transport sector. Figure 42 shows the total energy consumption in the transport sectors 2020 broken down into domestic and foreign transport subsectors.

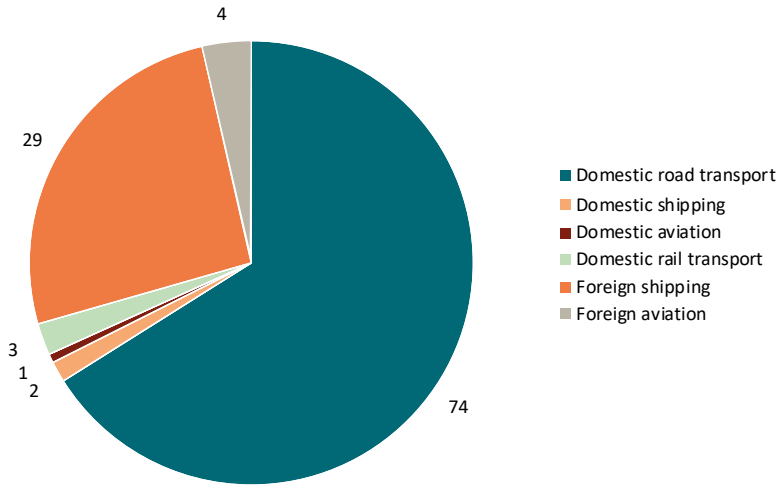

Figure 42. Final energy use of the transport sector in 2020, divided into domestic and foreign transport and subsectors, TWh.

Source: Swedish Energy Agency.

Energy use in transport is declining

The general trend since the 1970s has been that energy use in domestic transport has increased, see Figure 43. In 2004, energy use reached its highest level of 90 TWh. Since then, energy use in domestic transport has decreased by of 13 per cent to 80 TWh by 2020.

[153] Foreign transport within shipping includes traffic between Swedish and foreign ports as well as traffic between two foreign ports. In aviation, foreign transport is defined by fuel purchased in Sweden but used for flights between foreign destinations. Road and rail traffic are not included as foreign transport

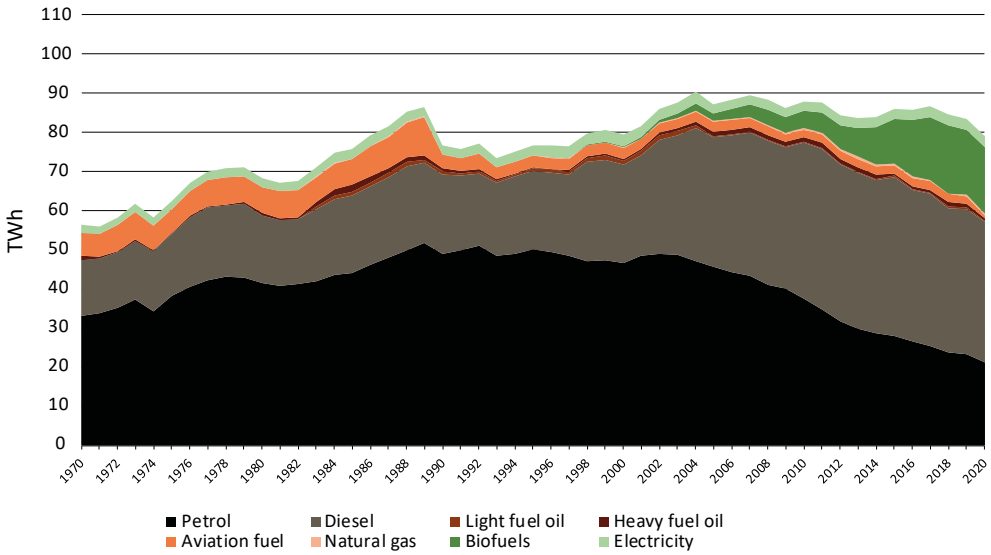

Figure 43. Final energy consumption in transport, domestic, 1970–2020, TWh.

Source: Swedish Energy Agency, Statistics Sweden and the Swedish Transport Agency.

Note: Until 1989, all aviation fuel was included in domestic flights, but from 1990 onwards a division was made for aviation fuel between domestic and foreign energy use. As a result of the change, domestic energy use fell sharply in 1990, when a larger part of the energy use was allocated to foreign aviation.

Road traffic

In road transport, a long-term trend towards reduced petrol usage and increased diesel use can be seen. This is a consequence of diesel cars taking a larger market share and many older petrol cars reaching their end of life, as well as a transition towards diesel within the truck fleet. Since 2010, diesel has been the most common fuel in the transport sector in terms of final energy use. For petrol, diesel, ethanol and gas-powered passenger cars, traffic[154] has decreased over the past three years, while traffic for plug-in hybrid and electric vehicles has increased. Traffic for light-duty trucks has increased on average over the past three years, while traffic for heavy-duty trucks has decreased. For the total number of trucks, both light-duty and heavy-duty trucks included, traffic has decreased on average.[155]

New car sales of electric vehicles registered in Sweden is increasing at a rapid pace. In September 2022, there were just over 400,000 electric vehicles, quadrupled to the amount in 2019. Of these, 58 per cent are plug-in hybrids and 42 per cent are battery electric vehicles.[156] However, electricity use in road transport still accounts for a marginal share of the transport sector's total energy use, around 0.5 TWh in 2020.[157] Behind Norway at

[154] Traffic is described in the unit vehicle-km and describes the distance a vehicle is moved

[155] Körsträckor 2020 [Traffic 2020] (trafa.se)

[156] Power Circle, *Sveriges nationella statistik för elbilar och laddinfrastruktur* [*Sweden's national statistics for electric cars and charging infrastructure]*, https://www.elbilsstatistik.se/ (retrieved 2022-10-18).

[157] Energimyndigheten, Elanvändningen hos vägtransporter ökade 2020 [Use of electricity in road transport grew in 2020], https://www.energimyndigheten.se/nyhetsarkiv/2021/elanvandningen-hos-vagtransporter-okade-2020/#:~:text=Totalt%20anv%C3%A4ndes%20drygt%20495%20gigawattimmar,f%C3%B6r%20med%20460%20GWh%20el (Retrieved 2022-11-25)

86 per cent and Iceland at 72 per cent, Sweden, with 43 per cent, had the third highest share of new car sales of electric passenger cars in Europe in 2021.[158]

The number of newly registered passenger cars that can run on ethanol has on averaged been around 1000 per year until 2019. In 2020 that number was reduced to 70 but then returned to pre-pandemic levels at a 1000 per year in 2021 and 2022. The number of light-duty trucks that can run on ethanol has more than doubled between 2018 and 2021. The number of heavy-duty trucks that can run on ethanol has also increased slightly between 2018 and 2021, but from lower levels. Read more about the number of newly registered ethanol cars in chapter The biomass market. The number of gas-powered cars and gas- powered trucks has also increased since 2010.[159]

Rail traffic

Rail transport[160] accounted for 3 per cent of the total domestic energy use in the transport sector in 2020. Electricity use in rail transport varied marginally in the early 2000s. Within rail transport, the railway accounts for most of the electricity use, almost 89 per cent, followed by the metro and tramway which account for 8 and 3 per cent, respectively. For freight traffic on railways, electricity use has decreased since 2008 from 1142 GWh to 736 GWh in 2020. However, the electricity use for passenger transport on railways has increased since 2008 from 1087 GWh to 1417 GWh in 2020. The electricity use of passenger transport on tramway and metro has changed marginally compared to the railway. In 2020, electricity use for tramway was 78 GWh and for metros the use was 193 GWh. The use of diesel in rail transport is small in relation to electricity use and the long-term trend is that diesel use is decreasing.[161]

Aviation traffic

Domestic and foreign aviation accounted for 1 and 3 per cent of the total energy use in the transport sector respectively. Energy use in domestic aviation has been around 2 TWh for the past two decades until 2019, however decreased in 2020 to 0.7 TWh. Energy use for foreign aviation has historically increased and in was 10 TWh in 2019. By 2020, energy use in foreign aviation decreased to 4 TWh. When it comes to foreign air travel the decrease can be explained by travelling restrictions due to the COVID-19 pandemic. For domestic air travel within Sweden, the decrease can also be explained by factors such as economic slowdown, a heighten interest in the climate, the aviation tax, and behavior changes when it comes to business travel. [162] The fuel used within the aviation traffic is aviation fuel.

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158 Global EV Outlook 2022, International Energy Agency, 2022.

159 Fordon 2021, Trafikanalys, 2022

160 Rail traffic includes railway, metro and tramway traffic.

161 Energimyndigheten, *Transportsektorns energianvändning* [*Transportsektorns energianvändning*.] https://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/transportsektorns-energianvandning/?currentTab=0#mainheading (Retrieved 2022-11-25)

162 Transportstyrelsen, *Kraftig nedgång för flyget under pandemin [Kraftig nedgång för flyget under pandemin]*, (Retrieved 2022-11-17)

Maritime traffic

Shipping accounted for 27 per cent of the transport sector's total energy use in 2020, of which foreign shipping accounted for the largest share of 29 TWh while energy use for domestic shipping was 2 TWh. Since 2010, energy use for foreign shipping has increased while the use for domestic shipping has remained constant. In foreign shipping, heavy fuel oil is the dominant energy carrier, while in domestic shipping there has historically been a more even split between light fuel oils, diesel, and heavy fuel oils.

Use of biofuels in transport is declining

The use of biofuels in the transport sector increased steadily until 2018 but has slowed down in recent years, see Figure 44. Biofuels consist primarily of biodiesel, ethanol, and biogas.

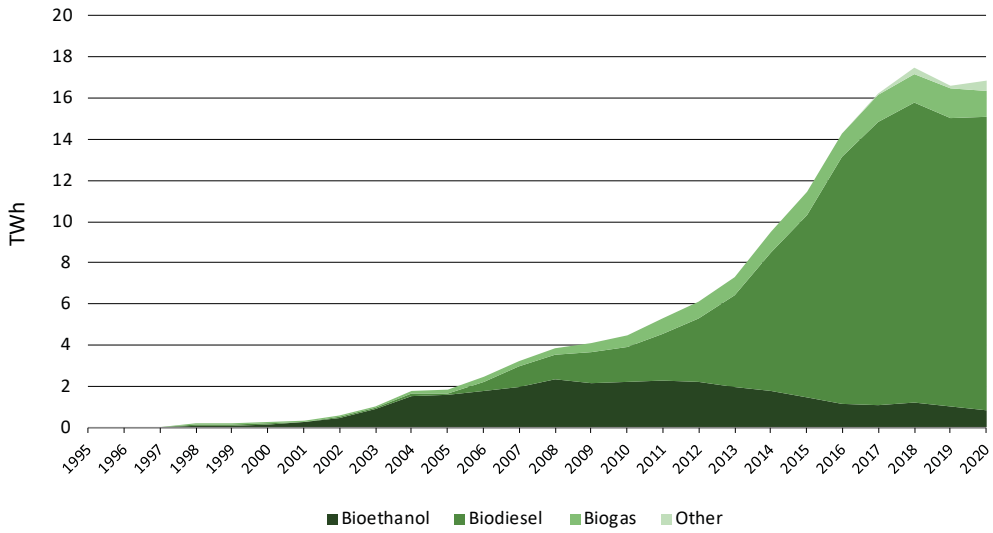

Figure 44. Use of biofuels in the transport sector, domestic, by fuel type, 1997-2020, TWh.
Source: Swedish Energy Agency.

In total, biofuels accounted for 21 per cent of final energy use in domestic transport in 2020.[163] Biodiesel, which accounts for the largest share, increased between 2005 and 2018 from 0.1 TWh to 15 TWh. In 2020, the use was 14 TWh, which represents 85 per cent of the total volume of biofuel use within the sector. The use of bioethanol decreased from 2.3 TWh to 0.8 TWh in between 2011 and 2020. The use of biogas has also increased, although not to the same extent. In 2019, biogas use reached 1.5 TWh and then decreased to 1.3 TWh in 2020. In addition to this, the portion of bio-petrol blended in petrol has increased. The implementation of the greenhouse gas reduction mandate for petrol, diesel and aviation fuel is an important driver for the increase in biofuels. Read more about the greenhouse gas reduction mandate for petrol, diesel, and aviation fuel in the chapter The biomass market.

[163] Biofuels plus electricity accounted for 25 percent of total domestic energy use in transport sector 2020.

The prices of transport fuels continue to rise

In 2021, the average price of petrol increased to SEK 16.4 per liter from SEK 14.5 per liter in 2020. For diesel, the price increased slightly more, and in 2021 the price was SEK 17.1 per liter compared to 2020 when the price was SEK 14.8 per liter. The price increase in 2021 correlates to increasing fuel oil prices. The price of ethanol (E85) also increased in 2021 to an average of SEK 13.4 per liter compared to 2020 when prices were SEK 12.3 per liter. Figure 45 shows fuel prices at the pump for petrol, diesel and E85 over time in Sweden, measured in SEK per liter. Read more about fuel prices in the report Energy indicators 2022.[164]

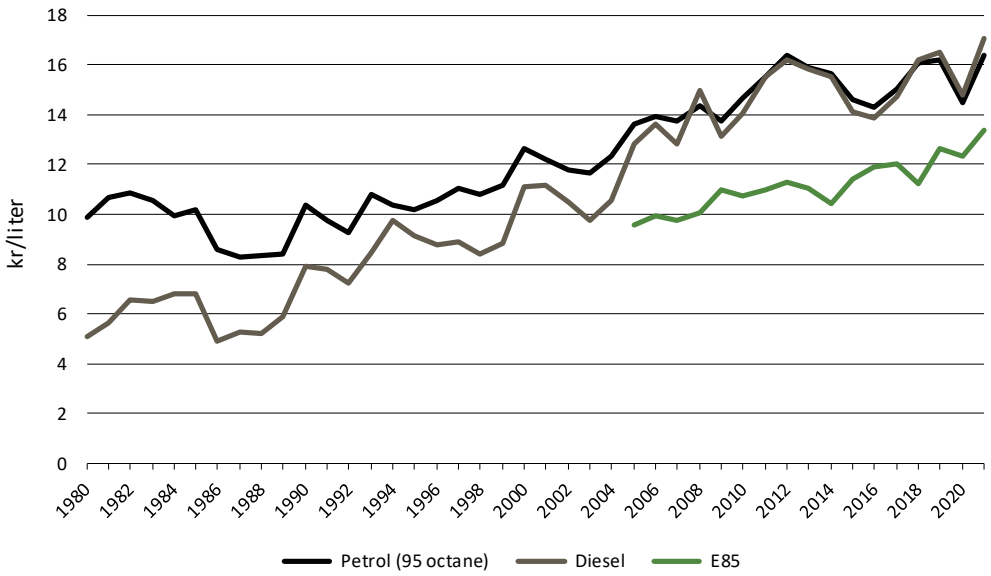

Figure 45. Fuel prices at pump, 1980–2021, SEK/liter, 2021-years price level.

Source: Swedish Energy Agency and Drivkraft Sverige.
Note: The graph shows the annual average price for each year.

Fuel prices can also be measured in SEK per energy content, see Figure 46. The diesel price has historically been lower than the price of petrol. In recent years, however, the price gap has tightened. The liter price of E85 has usually been lower than the price of petrol and diesel, but in terms of the actual energy content, the price of E85 has followed the price of petrol. A deciding factor as to why diesel and petrol prices are approaching each other is that the proportion of taxes in the diesel price that has increased more than its equivalent portion in the petrol price. After a temporary decline in 2018, E85 once again overtook gasoline in 2019 as the most expensive fuel per energy content.

[164] Energiindikatorer 2022, Energimyndigheten 2022

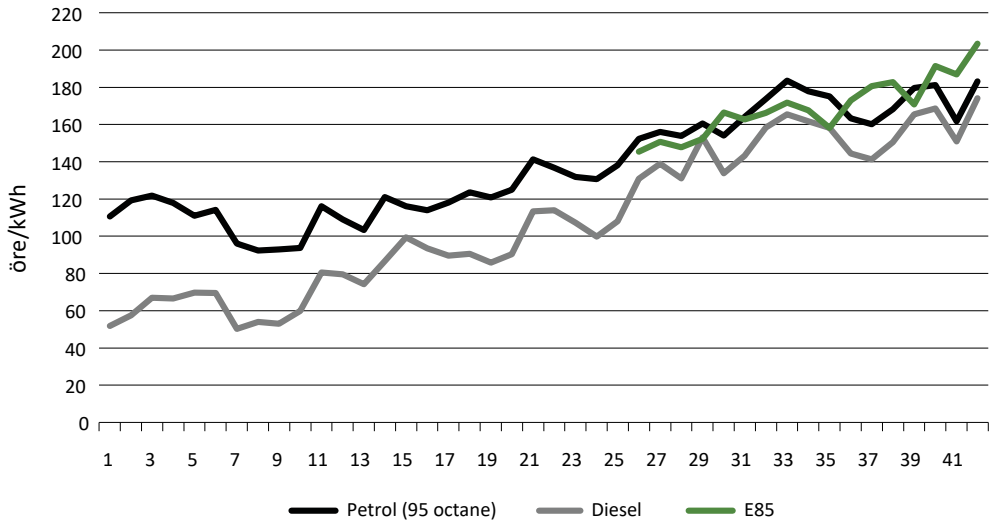

Figure 46. Fuel prices by energy content, 1980–20 21,öre/kWh, 20 21 years price level.
Source: Swedish Energy Agency and Drivkraft Sverige.
Note: The graph shows the annual average price for each year

Even though E85 at the pump has historically been cheaper than petrol, in terms of liter price, its use has decreased since 2011. Additionally, new car sales of passenger cars that can run on E85 have fallen sharply over the past five years. Read more about various factors affecting the price of biofuels in the biofuel in the chapter The biomass market.[165]

Policy measures, regulations, and EU directives that affect the transport sector

The greenhouse gas reduction mandate for petrol, diesel, and aviation fuel

The greenhouse gas reduction mandate for petrol, diesel, and aviation fuel was introduced on 1 July 2018. The policy instrument means that all fuel suppliers must reduce greenhouse gas emissions from petrol and diesel by a certain percentage each year with a gradually increasing blend of biofuels. For more information about the policy instrument, see the chapter The biomass market.[166]

Bonus-malus system

The bonus-malus system was introduced on July 1, 2018, replacing the previous super green car premium and the five-year vehicle tax exemption for green cars. The system only affects new cars and means that light-duty cars as well as light-duty buses and trucks with low carbon dioxide emissions are rewarded at the time of purchase through a bonus. Vehicles with high carbon dioxide emissions, on the other hand, are charged with a higher vehicle tax (malus) during the first three years from the time the vehicle

[165] Fordon 2021, Trafikanalys, 2022

[166] SFS 2017:1201, *Lag om reduktion av växthusgasutsläpp genom inblandning av biodrivmedel i bensin och dieselbränslen*. [*Act on the reduction of greenhouse gas emissions by blending biofuels into petrol and diesel fuels]*.

became taxable.[167] As of 2020, new rules of the bonus-malus began to be applied. The new rules mean that the EU's new measurement method, WLTP[168], will form the basis for calculations of emissions.

In April 2022, the government decided to tighten the levels of the bonus malus system for new cars starting June 1, 2022. The amendment means that the lower and upper limit for when the increased amount of carbon dioxide is taken out is reduced from 90 to 75 grams of carbon dioxide per kilometer and 130 to 125 grams of carbon dioxide per kilometer, respectively.[169] In November 2022, the government decided to abolish the climate bonus completely starting from November 8, 2022. However, the increased vehicle tax for cars with high carbon dioxide emissions was left unchanged.[170]

Climate premium

As of 2020, the previous electric bus premium[171] was converted into a climate premium. This means that, in addition to electric buses, it is possible to apply for support for electric trucks and other environmentally friendly trucks. Also, the premium applies to electric work machines that, together with the continued support for electric buses, aim to promote the market introduction of these vehicles.[172] For electric buses, the applicant can receive a maximum of 20 per cent of the bus's purchase price and the amount may not exceed 100 per cent of the price difference between the electric bus and the closest comparable bus.[173] For green trucks, electric work machines or environmental work machines, a maximum support of 20 per cent of the purchase price of the environmentally friendly vehicle also applies and may not exceed 40 per cent of the price difference between the environmentally friendly vehicle and the closest comparable diesel vehicle. The support is expected to be available until 2024.

Existing support for charging infrastructure

Various types of financial support for charging infrastructure are available for both private individuals, companies, and public organizations with the aim of promoting electrification in the transport sector. Read more about what support can be applied for on the Swedish Energy Agency's website.[174]

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167 Proposition. 2017/18:1, *Budgetpropositionen för 2018*.

168 WLTP stands for Worldwide Harmonised Light Vehicle Test Procedure which is the new driving cycle applied for light vehicles.

169 Riksdagen, *Skärpt miljöstyrning i bonus malus-systemet* [*Stricter environmental management in the bonus malus system]*, https://www.riksdagen.se/sv/dokument-lagar/arende/betankande/skarpt-miljostyrning-i-bonus-malus-systemet_H901SkU20#stepForslag (Retrieved 2022-11-25)

170 Riksdagen, *Klimatbonusen upphör den 8 november [Climate bonus ends on 8 November]*, https://www.regeringen.se/pressmeddelanden/2022/11/klimatbonusen-upphor-den-8-november/ (Retrieved 2022-11-25)

171 SFS nr: 2016:836, *Förordning (2016:836) om elbusspremie*

172 SFS nr: 2020:750, *Förordning (2020:750) on statligt stöd för vissa miljöfordon*

173 Closest comparable bus according to klassificering I utsläppsklass Euro 6 according to 30 or 31 § avgasreningslagen (2011:318)

174 Energimyndigheten, *Stöd att söka [Support to apply for]*, https://www.energimyndigheten.se/klimat--miljo/transporter/energieffektiva-och-fossilfria-fordon-och-transporter/laddinfrastruktur/stod-att-soka/ (Retrieved 2022-12-06)

Environmental information on fuels

According to the Fuel Regulation,[175] fuel suppliers must inform about greenhouse gas emissions, raw materials and origin of fuel sold to consumers. The information shall be based on annually reporting's in accordance with the Fuel Act[176] and shall be presented on the supplier's website as well as be informed by the pumping stations or other fuel refilling stations. It shall also be clear that the information relates to historical data. From 1 October 2021, there is a requirement that environmental information about fuel must be presented using a sticker visible by the fuel pump. Environmental information makes it easier for consumers to compare different fuels and fuel products.[177]

CORSIA – Global instrument for international flights

In October 2016, the United Nation's organization for civil aviation, ICAO, decided upon a new global instrument for reducing climate-affecting emissions from international aviation called CORSIA – *Carbon Offsetting and Reduction Scheme for International Aviation*.[178]. The decision rules that carbon dioxide emissions from international aviation is to be stabilized at the level of 2020, either through the reduction of emissions via the use of alternative fuels and/or through climate compensation via the purchase of emission units. The system applies from 2021 with a voluntary phase, and from 2027 the system will be applied to all countries. As 2020 was a year where aviation had very low emission levels due to the restrictions during the COVID-19 pandemic, 2020would not have made an effective reference year. Taking this into account, changes have been made to the design of the control agent. Read more about how the COVID-19 pandemic has affected CORSIA on the ICAO website.[179]

Renewable Energy Directive

The second version of the Renewable Energy Directive (RED II) was decided in December 2018 and entered into force in June 2021. For the transport sector, the revised directive requires fuel suppliers to achieve a renewable share of at least 14 per cent by 2030. There are also requirements for a certain proportion of so-called advanced biofuels[180], at least 0.2 per cent in 2022, 1 per cent in 2025 and 3.5 per cent in 2030. New fuels, e.g., electrofuels[181], are also included and can be used to achieve the 14 per cent target. There are also restrictions on the maximum proportion of biofuels coming from crops to not exceed 7 per cent of final energy consumption in the transport sector.

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175 SFS 2019:123. Förordning om ändring i förordningen (2018:1517) om ändring i drivmedelsförordningen (2011:346).

176 SFS nr: 2022:1125, *Drivmedelslag (2011:319)*

177 Energimyndigheten, *Miljöinformation om drivmedel* [*Environmental information on fuels]*, https://www.energimyndigheten.se/fornybart/hallbarhetskriterier/miljoinformation-om-drivmedel/ (Retrieved 2022-11-28)

178 LANE (Carbon Offsetting and Reduction Scheme for International Aviation).

179 ICAO *COVID-19 impacts and 2022 CORSIA periodic review*, https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-and-Covid-19.aspx (Retrieved 2022-12-01)

180 Produced from waste and residues, for more information read Annex 9 of the *Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast)*.

181 Electrofuels are created from carbon dioxide, water and electricity.

EU legislation on emission requirements for new light-duty vehicles

In 2019, emission requirements were decided at EU level for, passenger cars and vans. The requirements mean that emissions from new passenger cars should be reduced by 15 per cent by 2025 and 37.5 per cent by 2030 compared to 2021 levels. For light-duty trucks, the requirements mean a 15 per cent reduction by 2025 and a 31 per cent reduction by 2030 compared to 2021 levels.[182]

EU legislation on emission requirements for new heavy-duty vehicles

In 2019, requirements were introduced for heavy-duty vehicles, which mean that carbon dioxide emissions from heavy-duty vehicles should be reduced by 15 per cent by 2025 and by 30 per cent by 2030 compared to 2019.[183]

New legislative proposals under the EU's Fit for 55 climate package

The Fit for 55 package includes several legislative proposals relating to the transport sector with the aim of achieving the EU's target of reducing net greenhouse gas emissions by at least 55 per cent by 2030. [184] Negotiations at various stages are currently taking place in all areas of Fit for 55. The package includes proposals for the revision of the Renewable Energy Directive (RED III)[185], revision and increased requirements for directives on the energy performance of buildings (EPBD) [186], further tightening of emission requirements and a new emission reduction target for new light-duty vehicles, additional regulations on sustainable fuel blending requirements in aviation (ReFuelEU Aviation)[187]and maritime transport (FuelEU Maritime)[188] , the inclusion of shipping in the EU Emissions Trading System (EU ETS) [189], as well as proposals for a new regulation for the deployment of alternative fuels infrastructure (AFIR) replacing the current Directive (AFID).[190] For more information on the Fit for 55 package, see the energy and climate policy chapter.

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[182] European Commission, *CO2 emission performance standards for cars and vans (2020 onwards)*, https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en (Retrieved 2020-03-19).

[183] Regeringskansliet, *EU:s miljöministrar överens om utsläppskrav på lastbilar*, [*EU environment ministers agree on emission requirements for lorries*] https://www.regeringen.se/artiklar/2018/12/eus-miljoministrar-overens-om-utslappskrav-pa-lastbilar/ (retrieved 2020-03-19).

[184] European Council *55% package,* https://www.consilium.europa.eu/sv/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/#what (Retrieved 2022-11-25)

[185] Revidering av EU:s direktiv för förnybar energi Fakta-pm om EU-förslag 2020/21:FPM144 COM (2021) 557 - Riksdagen

[186] Faktapromemoria 2021/22:FPM59, direktivet om byggnaders energiprestanda

[187] Europeiska rådet, *Första förslaget om 55 %-paketet nu godkänt: strängare mål för CO2-utsläpp från nya personbilar och lätta lastbilar* [*First proposal for the Fit for 55 package now approved: stricter targets for CO2 emissions from new passenger cars and vans]*, https://www.consilium.europa.eu/sv/press/press-releases/2022/10/27/first-fit-for-55-proposal-agreed-the-eu-strengthens-targets-for-co2-emissions-for-new-cars-and-vans/ (Retrieved 2022-11-25)

[188] Europeiska rådet, *Infografik - 55 %-paketet: ökad användning av grönare bränslen inom luft- och sjöfart [Infographic - Fit for 55 package: increasing the use of greener fuels in air and maritime transport*] https://www.consilium.europa.eu/sv/infographics/fit-for-55-refueleu-and-fueleu/ (Retrieved 2022-11-25)

[189] Europaparlamentet, *Infografik - 55 %-paketet: ökad användning av grönare bränslen inom luft- och sjöfart*, [*Emissions from aircraft and ships: an overview of EU action]*, https://www.europarl.europa.eu/news/sv/headlines/society/20220610STO32720/minska-utslappen-fran-flygplan-och-fartyg (Retrieved 2022-11-25)

[190] Europeiska kommissionen*, Förslag till EUROPAPARLAMENTETS OCH RÅDETS FÖRORDNING om utbyggnad av infrastruktur för alternativa bränslen och om upphävande av*

An international perspective

There are large differences in energy use between countries, both in use per capita and per type of energy. The differences are due to the countries' different conditions in terms of access to energy, economic development, infrastructure, and climate. It is important that countries' energy needs can be met as this affects both global economic growth and national development.

Energy use continues to rise in the world

Total global energy use in 2020 was approximately 100,000 TWh, which is almost 5 per cent lower compared to the previous year. The decrease can be linked to the COVID-19 pandemic and its effects on the global economy. Apart from the decrease in 2020, the long-term trend is for the global energy use to increase, as can be seen in Figure 47.

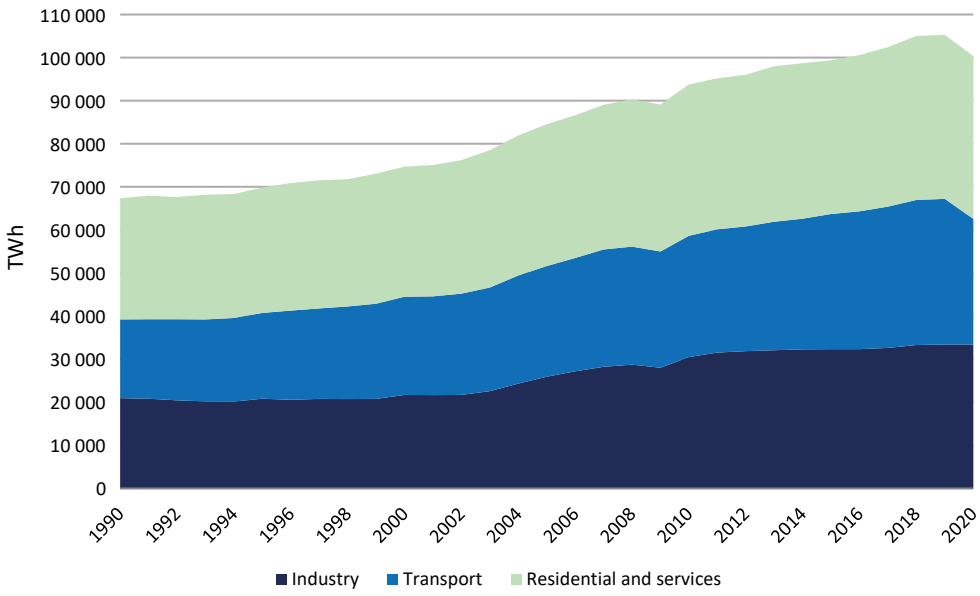

Figure 47. Global energy use by sector, 1990–2021, TWh.
Source: IEA.

Global energy use has increased by 49 per cent from 1990 to 2020. The largest increase during this period was in the transport sector, which increased by 60 per cent. The residential and service sector accounted for 38 per cent of the global energy use in 2020. The industrial sector and the transport sector accounted for 33 per cent and 29 per cent

Europaparlamentets och rådets direktiv 2014/94/EU [Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the deployment of alternative fuels infrastructure and repealing Directive 2014/94/EU of the European Parliament and of the Council], https://eur-lex.europa.eu/resource.html?uri=cellar:dbb134db-e575-11eb-a1a5-01aa75ed71a1.0012.02/DOC_1&format=PDF (Retrieved 2022-11-29)

respectively. In 2020, global energy use in the transport sector decreased by almost 14 per cent due to the COVID-19 pandemic. [191] In contrast to the transport sector, energy use in the industrial sector was almost unchanged in 2020 compared to 2019. In the residential and service sector, energy use decreased by 1 per cent.

Energy use differs greatly between different parts of the world, see Figure 48. The energy use per capita is highest in the US, followed by Russia. The total energy use per capita in Sweden is higher than the EU average. The US, Russia, the EU, Africa, and Sweden have all reduced the energy use per capita in 2020 compared to 1990. The largest decrease has been in Sweden, where energy use per capita decreased by 18 per cent. In other regions, energy use per capita has increased during the same period. The largest increase has been in China, where energy use per capita has more than doubled since 1990. In India the energy use per capita has also increased a lot, by the equivalent of 75 per cent.

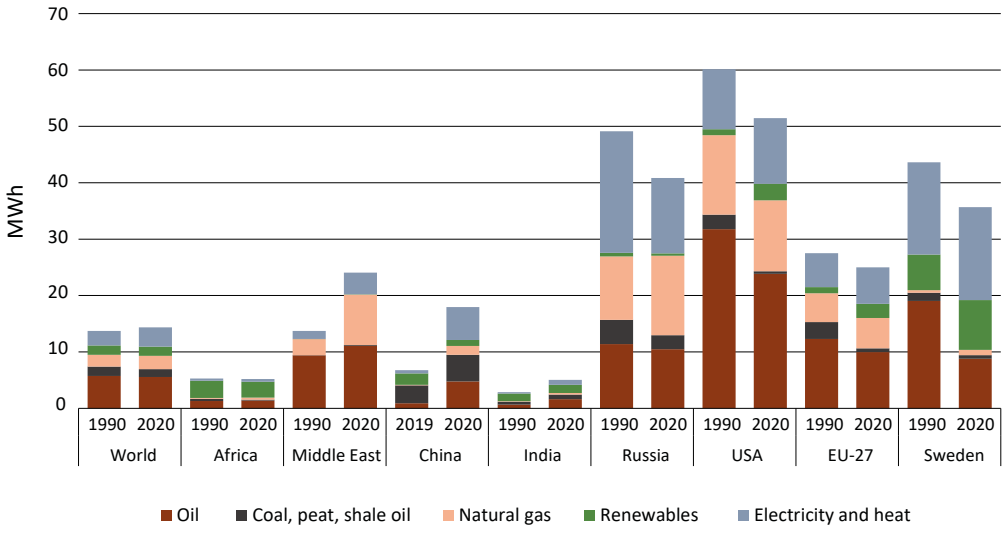

Figure 48. Global energy use per capita, MWh/capita and year.
Source: IEA.

Fossil fuels dominate the global energy supply

The global energy supply in 2020 amounts to just over 162,000 TWh, see Figure 49. This accounted for just under 80 per cent of the total global supply in 2020. Oil dominates with 29 per cent followed by coal and natural gas with 27 and 24 per cent of the global supply, respectively. Read more about fossil fuels in the chapter Fossil fuel market. In 2020, the share of renewable fuels (including waste) amounted to 15 per cent and nuclear power accounted for 5 per cent of the energy supply.

[191] By comparing the change in total energy use between 1990 and 2019, the increase is 56 percent instead for 49 percent when looking at the change between 1990 and 2020. This indicates that the change in 2020, linked to the COVID-19 pandemic, has a significant impact on the total percentage change.

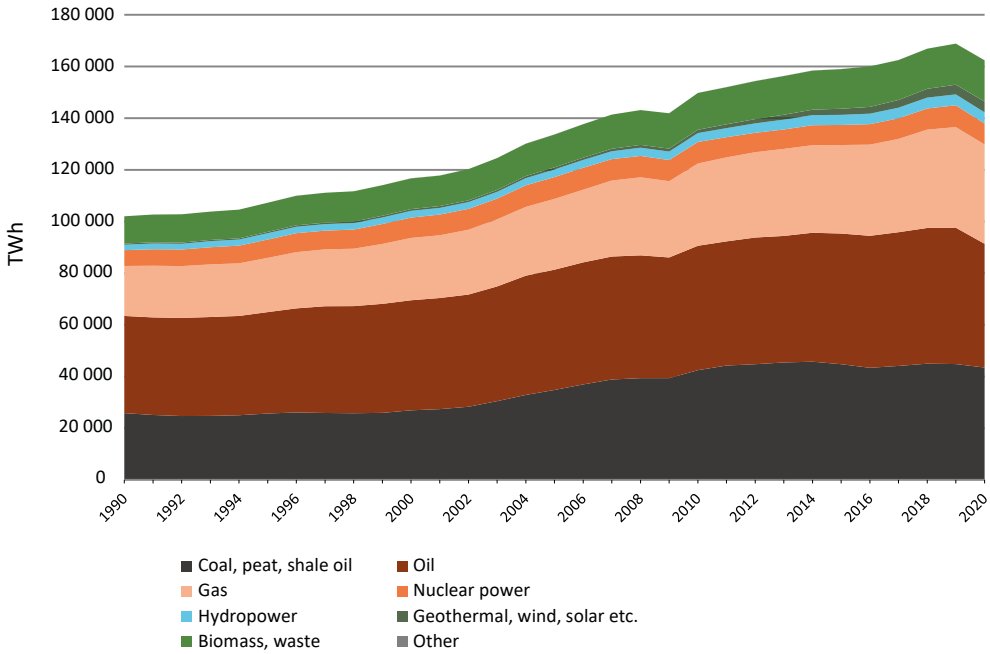

Figure 49. Global total primary energy supply by fuel, 1990–2020, TWh.
Source: IEA.

The absolute increase in energy volumes has been greatest in terms of fossil fuels. Fossil fuels accounted for 79 per cent of the total energy supply increase occurring between 2000 and 2020, where coal, peat and oil shale represented the largest increase in terms of energy volume. Wind, solar and geothermal power, on the other hand, have accounted for the largest percentage increase since 2000 with a fivefold increase but from a lower level.

Between 2019 and 2020, the global energy supply decreased by 4 per cent. The only other time a reduction in energy supply has taken place since 1990 was between 2008 and 2009. In both cases, the changes were linked to negative economic growth globally. In 2009, it was the global financial crisis that affected the energy supply and in 2020 it was the COVID-19 pandemic. The global growth during these years fell by 1.3 per cent and 3.3 per cent, respectively, according to data from the World Bank.[192]

The global supply of renewable energy continues to increase

In 2020, renewable energy accounted for about 24,500 TWh or 15 per cent of the world's energy supply. The global supply of renewable energy has continued to increase, see Figure 50. However, it still only constitutes a limited part of the global energy supply.

[192] The World Bank, https://www.worldbank.org/en/home

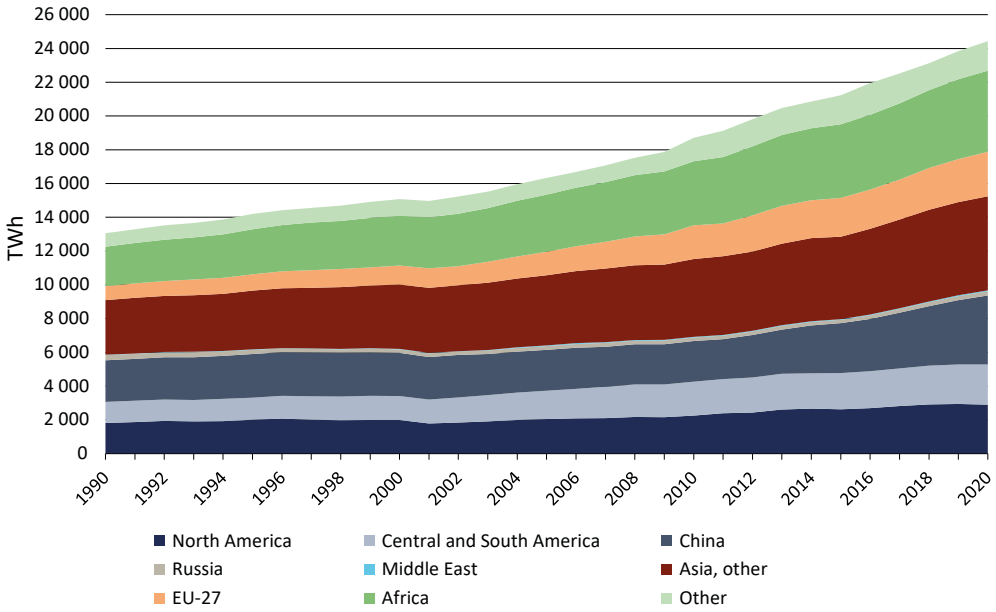

Figure 50. Global supply of renewable energy by region, 1990–2020, TWh.
Source: IEA.

Compared to 2019, the global share of renewable energy supply only increased by about 2 percentage points in 2020. While solar, wind and geothermal power accounted for just under 3 per cent of the global energy supply in 2020, installed power from solar and wind power increased by 21 and 18 per cent, respectively, between 2019 and 2020. The installed power of geothermal power increased by 2 per cent.[193]

The renewable energy supply increased in almost all regions between the years 2019 and 2020, see figure 50. The continent with the largest share of global renewable energy supply in 2020 was Asia (excluding China and Russia) with about 23 per cent. The corresponding share for the EU is about 11 per cent. The single country with the largest share of the global renewable energy supply was China, with about 17 per cent in 2020. Between 2019 and 2020 China had its greatest increase in overall renewable energy supply of about 260 TWh. In comparison, the increase in the EU was 81 TWh. In addition to economic factors, the development of renewable energy is influenced by political decisions, where major driving forces are goals, such as reducing greenhouse gas emissions and reducing dependence of fossil fuels.

[193] International Renewable Energy Agency (IRENA), Renewable Capacity Statistics 2021

Fossil fuels dominate the global electricity production

The world's production of electricity amounted to approximately 26,800 TWh in 2020, see Figure 51.

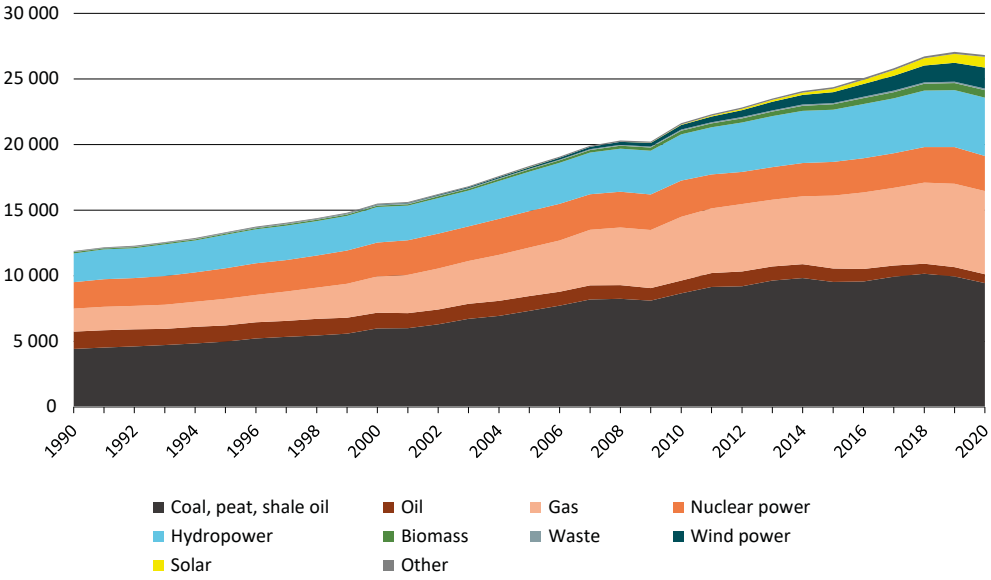

Figure 51. Global electricity generation by energy source, 1990–2020, TWh.
Source: IEA.

Globally, burning fossil fuels remains the most common way of producing electricity. Coal, peat, oil shale, oil and natural gas accounted for about 61 per cent of the global electricity generation mix in 2020, which is two percentage points less than in 1990. By contrast, the amount of these fossil fuels measured in TWh used for electricity production has more than doubled during the same time. In 2020, coal, peat and oil shale accounted for 35 per cent of the global electricity generation mix, while natural gas accounted for 24 per cent. The usage of these fuels has increased over time, but the largest relative increase has occurred for natural gas. In contrast to coal, peat, and oil shale, as well as natural gas, the use of oil for electricity generation has decreased to about half of the 1990 level. After fossil fuels, hydropower and nuclear power are the most common energy sources for electricity production, with shares of which amounted to 17 and 10 per cent, respectively in 2020. Over time, the share of nuclear power in global electricity production has decreased, from almost 17 per cent in 1990 to 10 per cent in 2020. The share of hydropower has also decreased, but not to the same extent as nuclear power. Electricity produced from biofuels, waste, solar and wind power has increased sharply. However, in 2020 they accounted for just under 12 per cent of the electricity generation mix combined.

Energy and climate policy

Sweden has established a climate framework with future climate goals, and in conjunction with the Energy Agreement[194], new goals were also established for energy policies. Swedish energy and climate policy is today largely governed by international climate negotiations and the policies conducted within the EU. The UN Framework Convention on Climate Change (UNFCCC), the Paris Agreement and the Global Sustainable Development Goals (SDGs).

The UNFCCC and the Paris Agreement

Sweden has ratified (confirmed) the UN Framework Convention on Climate Change (UNFCCC), which entered into force in 1994 with the goal of stabilizing the concentration of greenhouse gases in the atmosphere at a level where human influence on the climate system would not be dangerous. Sweden has also ratified the Paris Agreement, as with its predecessor the Kyoto Protocol[195], which is linked to the Climate Convention. 194 of the 197 countries that are parties to the Convention, have signed the Paris Agreement, and of these, 193 countries have so far (September 2022) ratified the agreement and thus become parties to it.[196] The Paris Agreement is the first legally binding climate agreement that all countries in the world will contribute to implement.

The main points of the Paris Agreement are to keep the global temperature increase well below 2 degrees compared to pre-industrial levels with an effort not to exceed 1.5 degrees. Additionally, support should be provided to developing countries from industrialized countries. The agreement includes texts on emission reductions, continued support through climate financing, technology transfer, capacity building, and climate adaptation. The agreement also requires countries to progressively strengthen their commitments as well as renew or update them every five years. A global review of the overall commitments will also take place every five years, starting in 2023.

Every year, a Conferences of the Parties (COP), are held for the countries that have signed the Climate Convention. Simultaneously, meetings are held for those countries that have also ratified the Paris Agreement and the Kyoto Protocol, respectively. COP27 (i.e., the 27th in order) was held in Sharm el-Sheikh, Egypt in November 2022. The focus of the meeting in Egypt was adaptation solutions to climate change and how to ensure reduced vulnerability to a changing climate.[197] At the meeting, the countries agreed to establish a new fund for damages and losses. Exactly how the fund will be financed and how to qualify for compensation is yet to be decided.[198]

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194 Regeringen, *Energipolitikens inriktning* [*The direction of energy policy]*, https://www.regeringen.se/rattsliga-dokument/proposition/2018/04/prop.-201718228/ (retrieved 2022-11-23)

195 The Kyoto Protocol was signed in 1997 and entered into force in 2005, and unlike the Paris Agreement, it only means that a small proportion of the parties to the Protocol are required to reduce greenhouse gas emissions.

196 United Nations Climate Change, *Paris Agreement - Status of ratification*, https://unfccc.int/process/the-paris-agreement/status-of-ratification (hämtad 2022-10-31)

197 Energimyndigheten, *Energimyndigheten medverkar på COP 27* [*The Swedish Energy Agency participates at COP 27]*, https://www.energimyndigheten.se/nyhetsarkiv/2022/energimyndigheten-pa-plats-pa-cop-27/ (retrieved 2022-11-21)

198 Energimyndigheten, *COP27 FN:s klimatmöte 2022*, https://www.energimyndigheten.se/klimat--miljo/internationella-klimatinsatser/fns-klimatkonferenser/cop27/ (retrieved 2022-11-21)

Agenda 2030

In 2015, the 2030 Agenda was adopted by countries of the world, containing 17 new goals for sustainable development, balancing the three dimensions of sustainable development: economic, social, and environmental. To combat climate change, which is one of the goals, has intermediate goals, such as integrating climate action into policies, as well as strategies and planning at national level. Other goals are sustainable energy for all, eradicating poverty, and hunger, ensuring clean water for all, and conserving and utilizing of the oceans and marine resources.

Energy and climate policy in the EU

In addition to the international climate agreements and climate negotiations, the EU also sets a framework for Swedish climate and energy policy. The EU has ratified the Paris Agreement as a union, meaning that the EU has a common goal for all member states to achieve the climate goal in line with the Paris Agreement. All countries within the EU must be involved and contribute to achieving the EU goals.[199]

Current EU energy and climate targets for 2022

The EU climate and energy policy framework includes the following quantitative targets for 2030[200]:

- Reduce greenhouse gas emissions by 55 per cent compared to 1990.
- The share of renewable energy shall be at least 32 per cent of the total energy use as well as the share of renewable energy in the transport sector shall represent at least 14 per cent of the total use of transport fuels, of which the contribution of so-called advanced biofuels shall be at least 3.5 per cent.
- Reduce energy use by 32.5 per cent through energy efficiency improvements.

Please note that these are current energy and climate targets for 2030, which were decided in 2018 and 2021. Intensive work is underway to tighten the targets, which is presented below.

The EU Green Deal and Fit for 55 – a green strategy and a toolbox for the transition in the EU

The European Green Deal was announced in December 2019 and is one of six strategic priorities for the European Commission chaired by President Ursula von der Leyen, who serves between 2019 and 2024. The Green Deal puts an extra focus on EU energy and climate legislation with the overall aim of making the EU a climate-neutral region by 2050, helping to strengthen the EU's global competitiveness.

One of the key points of the Green Deal is a new climate law, which was presented in March 2020 and entered into force in July 2021. With the Climate Change Act, there is a legally binding target of net zero emissions of greenhouse gases into the atmosphere

[199] For more on the EU's climate and energy policy objectives, see also the Swedish Energy Agency's annual report Energiindikatorer: https://www.energimyndigheten.se/statistik/energiindikatorer/

[200] European commission, *Renewable energy targets*, https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en (retrieved 2022-11-21)

by 2050. The Climate Change Act also means that the target for reduced emissions by 2030 will be raised from the previous 40 to at least 55 per cent compared to 1990-levels. A target for 2040 will also be proposed by the Commission. After 2050, the target is to achieve negative emissions. In addition to reducing emissions, the Green Deal also focuses on how the climate transition should be financed and how it will be implemented fairly and with solidarity *between* member states as well as *within* member states.

Within the framework of the Green Deal, the package *Fit for* 55, is also being negotiated. The name refers to the above-mentioned target of reducing emissions by 55 per cent by 2030 compared to 1990-levels. In short, Fit for 55 is a package of legislative proposals to adapt the EU's climate, energy, transport and tax policies with the aim of reaching the emissions reduction target of 55 per cent. Currently, all parts of Fit for 55 are being negotiated at different stages.

REPowerEU – a new energy policy action plan for increased energy security

Following Russia's invasion of Ukraine at the end of February 2022, the European Commission presented on 8 March[201] an initiative for a new energy policy action plan, REPowerEU, and two months later, in May, a more concrete plan was presented. [202] In short, REPowerEU is the Commission's plan to phase out the EU's dependence on energy imports from Russia as soon as possible. The plan includes several legislative proposals aimed at accelerating the green transition beyond what currently exists under Fit for 55.

With REPowerEU, the Commission proposes to further increase the share of renewable energy target in the EU by 2030 to 45 per cent, from the proposal currently being negotiated under Fit for 55. Other proposals include requirements for photovoltaic installations on certain buildings and measures to streamline the permit granting process for renewable energy. Before the proposals in REPowerEU can become a reality, negotiations between Member States and the other EU institutions are required.

In addition to the above proposals, the EU has also agreed on a series of crisis measures to address the current situation. Among other things, the EU energy ministers have agreed on voluntary and mandatory measures to reduce electricity use. The European Commission has also presented proposals for the gas market. [203]

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[201] European commission, *REPowerEU: Joint European action for more affordable, secure and sustainable energy*, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511 (retrieved 2022-11-21)

[202] European commission, *REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition**, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131 (retrieved 2022-11-21)

[203] Europeiska unionens råd, *Rådet enas om krisåtgärder för att sänka energipriserna*, https://www.consilium.europa.eu/sv/press/press-releases/2022/09/30/council-agrees-on-emergency-measures-to-reduce-energy-prices/ (retrieved 2022-11-21)

Sweden's Environmental Objective System and Climate Policy Framework

Sweden's Environmental Objective system address the international ecological dimension of the global sustainability goals in Agenda 2030. The overall goal of the Environmental Objective system is determined by the so-called Generational Goal, which means that Sweden "*should hand over to the next generation a society in which the major environmental problems have been solved, without increasing environmental and health problems outside Sweden's borders".* To concretize the generational goal, the Swedish Parliament has decided on 16 environmental quality goals. To facilitate governance and follow-up, interim targets have been linked to the environmental objectives. The environmental objective *Limited climate impact* was decided by the Swedish Parliament in 1999 and specified in 2017 to limit the global average temperature to well below 2 degrees compared pre-industrial levels in accordance with the Paris Agreement. [204]

In 2017, the Swedish Parliament adopted a climate policy framework[205] for Sweden with the aim of creating a clear and coherent climate policy and ensuring long-term conditions for business and society. The climate policy framework is a key component in Sweden's efforts to reach the Paris Agreement. The framework consists of climate goals, a climate law that stipulates that the government's climate policy should be based on the climate goals and how the work should be conducted, as well as a climate policy council that has the task of evaluating the government's policy in relation to the climate goals.

The Swedish climate goals include the following:

- By 2045, there will be no net emissions of greenhouse gases into the atmosphere, to subsequently achieve negative emissions. It is possible to achieve parts of the goal through complementary measures, such as increased greenhouse gas uptake in forests or by investing in various climate projects abroad. However, the remaining emissions from operations within Swedish territory must be at least 85 per cent lower compared to 1990-levels.
- By 2030, emissions in the sectors that will be covered by the EU's Effort Sharing Regulation (ESR), i.e., those not included in the EU ETS, should be at least 63 per cent lower than emissions in 1990, and at least 75 per cent lower by 2040. The emissions covered are mainly from domestic transport (excluding domestic aviation which is part of the EU ETS), machinery, small industrial and energy plants, housing, and agriculture. Here, it is also possible to achieve parts of the targets through complementary measures (a maximum of 8 and 2 percentage points of the emission reduction targets in 2030 and 2040, respectively).
- Emissions from domestic transport, excluding domestic flights that are part of the EU ETS, are to be reduced by at least 70 per cent by 2030 compared to 2010. The reason for having a specific target for the transport sector is, among other things, that it accounts for about half of the emissions in the sector that doesn't trade in emissions certificates. Furthermore, the Swedish Parliament, already in 2009, endorsed the long-term priority that Sweden should have a vehicle fleet that is independent of fossil fuels by 2030.

[204] Prop. 2016/17:146, bet. 2016/17:MJU24, rskr. 2016/17:320

[205] Prop. 2016/17:146, bet. 2016/17:MJU24, rskr. 2016/17:320

The objectives of Swedish energy policy

The overall goal Swedish energy policy in the short and long term is to secure the supply of energy on competitive terms.[206] Energy policy must create conditions for efficient and sustainable energy use and a cost-effective Swedish energy supply with a low negative impact on health, the environment, and the climate, and facilitate the transition to an ecologically sustainable society.

To ensure a holistic view of energy supply, the Swedish Parliament decided on an overall goal that involves combining the three pillars of *security of supply, competitiveness, and ecological sustainability*. The challenges in energy policy largely consist of balancing these three pillars.

As a result of the Energy Agreement[207] concluded in 2016, the following energy policy objectives[208] were decided:

- *By 2040, 100 per cent of the electricity generation should be renewable*, (which is a goal and not a cut-off date that prohibits nuclear power).
- *By 2030, energy consumption should be 50 per cent more efficient compared to 2005*, expressed in terms of energy input in relation to gross domestic product (GDP).

In addition to these, a few energy policy goals for 2020 were decided:[209]

- *The share of renewable energy in 2020 should be at least 50 per cent of total energy consumption.*
- *The share of renewable energy in the transport sector by 2020 should be at least 10 per cent.*
- *By 2020, energy use should be 20 per cent more efficient compared to 2008*, expressed in terms of energy input in relation to GDP.

All the above-mentioned 2020-targets were reached by a good margin and several well in advance. To read more about the follow-up of the Swedish energy policy goals, see the report *Energiinikatorer* that the Swedish Energy Agency publishes annually.[210]

In addition to the energy policy objectives, there are policy goals in other areas with clear links to security of supply. This applies, for example, to goals on society's crisis preparedness and civil defense planning, various environmental goals, as well as goals linked to health and social security. In its national security strategy, the Swedish Government placed particular emphasis on the need for a well-functioning energy supply in a modern society. A prerequisite for a secure energy supply is robust energy systems and well-functioning energy markets with clear and long-term strategies. In a constantly changing society and world the energy supply will also change.

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206 To read more about the follow-up of the Swedish energy policy goals, see the report *Energiindikatorer* published annually by the Swedish Energy Agency.

207 In December 2019, the Moderates and Christian Democrats announced that they were leaving the energy agreement. In an agreement that came along with the change of government in 2022, so called "Tidöavtalet", the was changed from 100 per cent renewable to 100 per cent fossil-free to include nuclear power.

208 Prop. 2017/18:228

209 Prop. 2008/09:163

210 Energiindikatorer 2022, *HE 2022:10*, Swedish Energy Agency 2022.

Cross-sectoral instruments

The following sections present policies and measures that are of a cross-sectoral nature related to energy. Policy instruments regarding a specific sector or market can be found in the respective chapters.

Emissions trading – a key instrument in the Union's climate action

The EU ETS is one of the most important instruments for achieving the emission reduction targets available within the Union. The EU ETS mainly covers emissions from energy-intensive industry, as well as electricity and district heating production.[211] As of 2012, it also covers air operators flying within the EU.[212] Around 13,000 facilities are currently part of the EU ETS, of which about 750 are in Sweden, and cover about 45 per cent of the total volume of the EU's greenhouse gas emissions.[213] The EU ETS is designed with an upper limit for emissions allowed from each participant in the system, the so-called emission ceiling, which will gradually be reduced. Between 2021 and 2030, the system is designed to decrease by 2.2 per cent per year, which is a faster reduction rate compared to the period 2013-2020 when the ceiling reduced by 1.74 per cent per year. To emit greenhouse gases, participants must have a valid permit with an associated monitoring plan and emission rights (which give the right to emit 1 tonne of carbon dioxide equivalent). The facilities are either allocated allowances free of charge or are purchasable via an auction procedure. After each year, an operator who is part of the EU ETS must surrender an emission allowance for every tonne of carbon dioxide equivalent they emitted in the previous year. In a case where operators do not have enough allowances to cover their emissions, measures must be taken to reduce emissions or allowances must be obtained on the market, by auction or from other participants in the scheme.

Three trading periods have been carried out since the system was introduced in 2005. Now, in 2021-2030, the fourth is underway. During the current trading period, 57 per cent of the total number of emission allowances will be auctioned, while the rest will be allocated free of charge, mainly to industries that are identified to be exposed to international competition and thus where there is a risk of so-called carbon leakage. Carbon leakage means that activities move from countries with ambitious emission reduction targets to countries with less ambitious emission reduction targets. As previously mentioned, a different and higher annual reduction factor applies in the fourth trading period, 2.2 per cent compared to 1.74 per cent in the previous period.[214] The aim of an increased reduction factor is to achieve the target of emission reduction of 43 per cent by 2030 for the activities included in the EU ETS. In the third trading period, in 2019, a so-called Market Stability Reserve (MSR) was also introduced. MSR means that there is an automatic adjustment of the amount of emission rights auctioned and thus redistributed over time. The purpose of the reserve is to provide additional momentum for the transition by avoiding an oversupply of allowances and thus low prices.

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[211] Sectors outside the EU ETS currently include agriculture, transport, and small-scale industry.

[212] ICAO, *Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx (retrieved 2022-11-23)

[213] In Sweden, most of the energy plants connected to a district heating network are included. It also includes mineral oil refineries, coke ovens, iron and steel industry, mineral industry (cement, glass, ceramics), pulp and paper industry, aluminum production, and aerospace activities within the EEA.

[214] Energimyndigheten, *Utsläppshandel i EU*, [*EU emission trading system]*, https://www.energimyndigheten.se/klimat--miljo/handel-med-utslappsratter/om-utslappshandel/utslappshandel-i-eu/ (retrieved 2022-11-08)

In the fourth trading period, revenues for actions amounting to 600 million of emission rights will go to EU funds aimed at supporting innovative technologies for lower emissions and to support the modernization of the energy sector in some Member States, in particular countries in eastern Europe.[215]

Energy research and innovation are an important part of energy policy

Government-funded energy research, development and demonstration has been an important part of energy policy since its establishment as a special policy area in the early 1970s. Over the years, work on energy research and innovation has been guided by so-called energy research bills that have been established by the Riksdag. The most recent covered the period 2017–2020.[216] The Swedish Energy Agency submitted documentation for a new energy research bill for 2021–2024 in 2019.[217] However, a new energy research bill has not yet been decided by the Riksdag.

Current energy taxes in 2023

Energy taxation is a collective term for excise duties on fuels and electricity. Energy taxation has transitioned from a primarily fiscal function to having a more targeted influence on, for example, environmental impact, energy efficiency and the promotion of biofuels. Energy tax and carbon dioxide tax are typically paid for fuels used for engines or heating. There is also an energy tax on electricity use (but not on electricity production), as well as a sulphur tax for certain fuels containing sulphur. Energy, carbon dioxide and sulphur taxes are regulated in the Energy Taxation Act (1994:1776).

Energy, carbon dioxide and sulphur tax on fuels

Energy tax is paid on most fuels and is based energy content, among other things. Carbon dioxide tax is paid per one kilogram of a fuel's emitted carbon dioxide. For peat or fuelwood (e.g., firewood or pellets), neither energy tax nor carbon dioxide tax is normally paid. Other biofuels are generally also exempt from tax in whole or in part. Tax exemptions or reductions are also provided for certain specific uses, see Table 2 below. The table shows current tax exemptions/reductions from January 1, 2023. 100 per cent corresponds to full tax exemption and 0 per cent corresponds to no tax exemption.

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[215] Naturvårdverket, *Resultat och effekter [Resultsand effects]*, https://www.naturvardsverket.se/amnesomraden/utslappshandel/om-utslappshandel/resultat-och-effekter/ (retrieved 2022-11-08)

[216] Prop. 2016/17:66

[217] Energimyndigheten, *Våra prioriteringar inom forskning och innovation [Our priorities in research and innovation]*, https://www.energimyndigheten.se/forskning-och-innovation/vara-prioriteringar-inom-forskning-och-innovation/ (retrieved 2022-11-24)

Table 2. Areas of tax exemption/reduction for fuels.[218]

Exemption/reduction areas for fuels	Reduction of energy tax	Reduction of carbon tax
Fuel used in the manufacture of products in industrial activities of the EU-ETS.219	0 %	100 %
Unlabeled diesel consumed in agriculture, forestry, or aquaculture.220	2 111 SEK/cubic meter	2 292 SEK/cubic meter
Labeled diesel consumed in agriculture, forestry, or aquaculture.221	0 %	2 292 SEK/cubic meter
Fuel consumed in the production of cogeneration within the EU-ETS.222	0 %	100 %
Unlabeled diesel consumed in professional greenhouse cultivation.	2 111 SEK/cubic meter	2 292 SEK/cubic meter
Fuel consumed to produce heating or cooling supplied to, e.g., the manufacturing process in industrial activities, professional agricultural, forestry, greenhouse cultivation or aquaculture activities.223	100 %	100 %
Fuel consumed in shipping, not including private purposes.224	100 %	100 %
Fuel consumed in an aircraft, not including private purposes.	100 %	100 %

For solid and gaseous fuels, the sulphur tax amounts to SEK 30 per kilogram of sulphur in a fuel. For liquid fuels, the wtax amounts to SEK 27 per cubic meter for every tenth of a per cent of sulphur content by weight. Liquefied or gaseous fuels with a maximum sulphur content of 0.05 per cent by weight are exempt from sulphur tax.

Energy tax on electricity

The general energy tax on electricity from 1 January 2023 is 39.2 öre/kWh. The energy tax on electricity depends, among other things, on the type of activity in which the electricity is consumed as well as whether the consumption takes place in southern or northern Sweden. For electricity consumed in some municipalities in northern Sweden (i.e., households and companies in the service sector), deductions can be made with 9.6 öre/kWh.

For certain uses, a reduction or exemption of energy tax on electricity can be made. These uses are compiled in Table 3 below. The table shows current tax exemptions/reductions from January 1, 2023. 100 per cent corresponds to full tax exemption and 0 per cent corresponds to no tax exemption.

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218 Skatteverket, *Verksamheter med lägre skatt [Businesses with lower taxes],* https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/verksamhetermedlagreskatt.4.15532c7b1442f256baebb93.html (retrieved 2023-01-18).

219 Lower taxes are not allowed for gasoline or highly taxed oil.

220 Diesel consumed in work vehicles, shipping, and some boats.

221 Fuel oil consumed for heating and in stationary engines.

222 Does not apply to the consumption of highly taxed oil. For fuel consumed in the production of cogeneration outside the EU-ETS, no tax exemption is granted since 1 August 2019.

223 All these activities do not receive tax exemptions/reductions on fuel but only part of them, see https://skatteverket.se/foretag/skatterochavdrag/punktskatter/energiskatter/aterbetalningavskattpaelochbransle.4.109dcbe71721adafd252816.html

224 No tax exemption is granted for the use of unmarked fuel oil.

Table 3. Areas of tax exemption/reduction for electricity[225]

Areas with tax exemptions/reductions for electricity[226]	Reduction of energy tax for electricity
Electricity consumed in the manufacture of products in industrial activities.	38.2 öre/kWh[227]
Electricity consumed to produce heating or cooling supplied to, e.g., manufacturing processes in industrial activities, professional agricultural, forestry, aquaculture activities, crop production or data center.	38.2 öre/kWh, 100 %[228]
Electricity consumed in professional greenhouse cultivation.	38.2 öre/kWh
Electricity consumed in professional agriculture, forestry, or aquaculture activities.	38.2 öre/kWh
Electricity consumed when producing energy products (e.g., biogas) or other products where tax has occurred for the manufacturer.	100 %
Electricity consumed in a data center.229	38.2 öre/kWh
Electricity consumed in metallurgical processes or in the manufacture of mineral products.	100 %
Electricity consumed for chemical reduction or electrolytic processes.	100 %
Electricity consumed for the operation of trains or other rail-based means of transport (e.g., tram and metro).	100 %
Electricity consumed by ships located in ports.230	38.2 öre/kWh

If the electricity is produced from renewable sources in a small facility with an installed generator power less than 100 kW and consumed in the same place as it was produced, no energy tax will be paid after 1 July 2021.

General energy and carbon taxes in 2023

Table 4 below presents the general tax rates for energy and carbon taxes on fuels, transport fuels, and electricity use, respectively, from 1 January 2023 (converted to öre/kWh).

[225] Skatteverket, *Återbetalning av skatt på el och bränsle [Refund of tax on electricity and fuel] https://skatteverket.se/foretag/skatterochavdrag/punktskatter/energiskatter/aterbetalningavskattpaelochbransle.4.109dcbe71721adafd252816.html* (retrieved 2023-01-18).

[226] Electricity is also not taxable if it is produced and consumed on ships or other means of transport, consumed during the production of electrical power, or produced in a backup power supply unit and has not been transferred to a grid covered by a grid concession.

[227] That is, you pay only 0.6 öre/kWh i energiskatt.

[228] For some activities and processes, a 100 per cent tax exemption for carbon tax and energy tax apply, while some may pay only 0.6 öre/kWh (may be reduced)

[229] Regeringen, *Avskaffad avfallsförbränningsskatt och slopad energiskattenedsättning för datorhallar [Abolition of waste incineration tax and abolition of energy tax reduction for data centres],* https://www.regeringen.se/rattsliga-dokument/departementsserien-och-promemorior/2022/09/avskaffad-avfallsforbranningsskatt-och-slopad-energiskattenedsattning-for-datorhallar/ (retrieved 2022-11-10). From July 1, 2023, there is no possibility to get a refund.

[230] Applies to ships of at least 400 ton in gross weight and that the voltage of the electricity transferred is at least 380 volts that is not used in private use.

Table 4. General energy and carbon taxes from 1 January 2023, öre/kWh, excluding VAT

	Energy tax	Carbon tax	Sulphur tax	Total tax
Fuels				
Fuel oil 1 (<0.05% sulphur)	2.8	38.1	-	40.9
Fuel oil 5 (0.4% sulphur)	2.6	35.3	1.0	38.9
Coal (0.5% sulphur)	10.1	43.7	2.0	55.7
LPG	10.1	31.3	-	41.4
Natural gas	9.3	23.8	-	33.0
Crude pine oil	45.0	-	-	45.0
Peat, 45% moisture content (0.24% sulphur)	-	-	1.4	1.4
Transport fuels				
Petrol, unleaded, environmental class 1	38.5	32.1	-	70.6
Low-blended ethanol	59.0	49.2	-	108.2
Low-blended biopetrol	44.7	37.3	-	82.1
Ethanol in E85	-	-	-	-
Diesel, environmental class 1	16.1	25.4	-	41.6
Low-blended FAME	17.3	27.2	-	44.4
Low-blended HVO	16.8	26.4	-	43.1
High-blended FAME	-	-	-	-
High-blended HVO	-	-	-	-
Natural gas/methane	-	29.3	-	29.3
Gasol	-	31.3	-	31.3
Electricity use				
Electricity, northern Sweden	29.6	-	-	29.6
Electricity, rest of Sweden	39.2	-	-	39.2
Electricity use, industrial processes, etc.	0.6	-	-	0.6

The agreed carbon and energy tax rates for fuels and transport fuels have generally been increasing in recent years. Energy tax rates on electricity use have also risen compared to previous years.

Exceptions are biofuels, where the rules changed in connection with the introduction of the reduction obligation in 2018. As of 1 July 2018, the possibility of deducting certain biofuels will be limited. For deductions to be made, biomass must account for more than 98 per cent of the fuel volume. As a result, biofuels that are low-blended in petrol and diesel are now fully taxed. Highly mixed FAME and ethanol in E85, on the other hand, are completely tax-exempt since January 1, 2018.[231]

[231] Read more on Skatterverkets website: *Skattebefrielse för biodrivmedel [Tax exemption for biofuels],* https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/energiskatterpabranslen/skattebefrielseforbiodrivmedel.4.2b543913a42158acf800021393.html (retrieved 2020-01-30).

Affordable and Clean Energy

The Swedish Energy Agency is leading society's transition to a sustainable energy system.

We contribute with facts, knowledge, and analysis of supply and use of energy in the society, as well as work towards security of energy supply.

Research on new and renewable energy technologies, smart grids, as well as vehicles and transport fuels of the future receives funding from us. We also support business development that allows commercialisation of energy related innovations, and ensure that promising cleantech solutions can be exported.

Official energy statistics, and the management of instruments such as the Electricity Certificate System and the EU Emission Trading System, are our responsibility.

Furthermore, we participate in international collaboration with the aim of attaining Swedish energy and climate objectives, and develop and disseminate knowledge for a more efficient energy use to households, industry, and the public sector.

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