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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 complement to the publication, the collection of statistics *Energy in Sweden – Facts and Figures* is available on the Agency's website, which contains all statistics from the publication in raw data. *Energy in Sweden – Facts and Figures* also contains additional statistics that are not presented in *Energy in Sweden*. *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 2017* also includes current events in the energy sector up to and including spring 2017. For forecasts of future developments, refer to the Energy Agency's latest short-term forecast[1] and the Agency's long-term scenarios regarding energy supply.[2]

About the statistics

The annual statistics from 2005 onwards mainly come from the Energy Agency's energy balances, also published on the Agency's website.

On some points, the energy balance in this year's publication differs from that which has been presented previously in Energy in Sweden, for example, through:

- the total supply now being lower because it no longer includes bunkering for international transport.
- the statistical difference is no longer included in the supply. This means that supply and use may differ.
- biofuel and other fuel (which includes peat and fossil waste) are presented separately. Statistics that are based on the energy balances extend up to and including 2015. Other statistics, such as price statistics, also cover 2016.

Further information about the statistics for which the Swedish Energy Agency is responsible, as well as the Agency's publications, is available on the Agency's website.

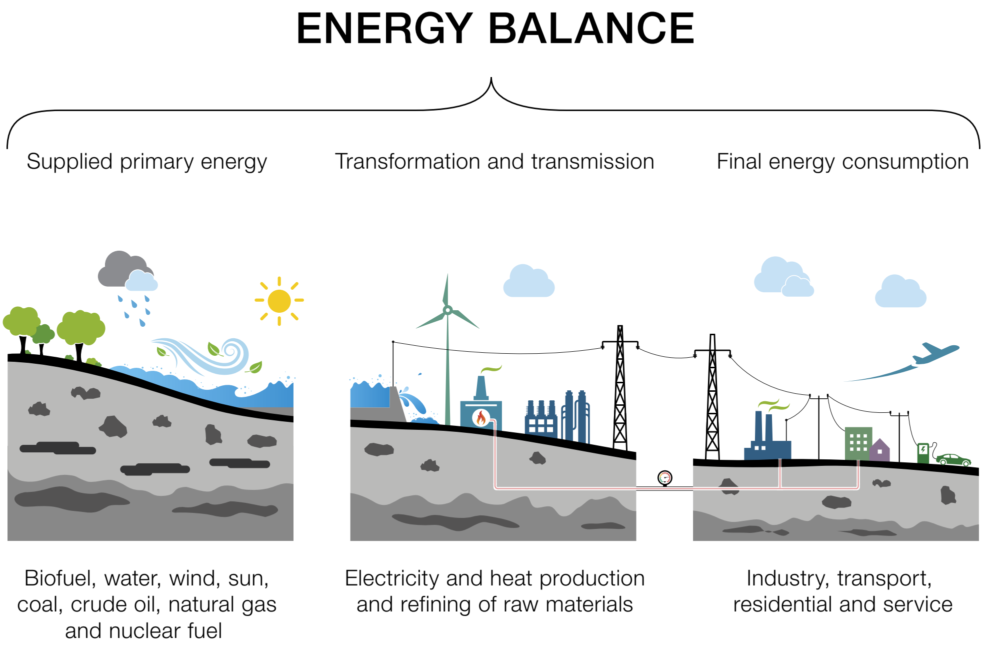
[1] Swedish Energy Agency, ER 2016:14, Kortsiktsprognos över energianvändningen och energitillförsel 2016 – 2018 [Short-term forecast for energy use and energy supply, 2016 – 2018].

[2] Swedish Energy Agency, ER 2017:6, Scenarier över Sveriges energissystem 2016 [Scenarios for Sweden's energy system 2016].

Content

Energy balance

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. In the industrial sector, energy is used to operate processes. This sector primarily uses biofuel and electricity. In the transport sector energy is used for transporting people or goods within the country. Energy use within transportation is dominated by oil derived products in the form of petrol, diesel and aviation fuel. Electricity and biofuels are also a growing source of energy within transportation. The residential and service sector mainly use energy derived from district heating, electricity, oil and biofuels.

The energy system is always in balance. The energy input is always equal to the energy used, including losses. Figure 1 gives a simplified overall view of the Swedish energy system, from supply to use.

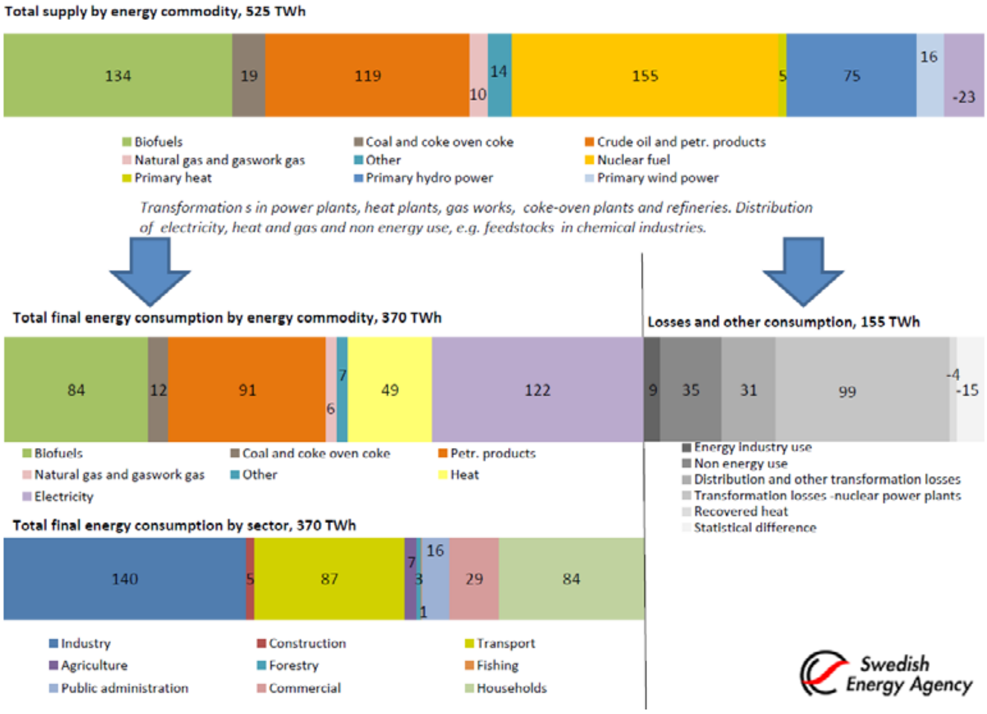


Figure 1 Energy supply and use in Sweden 2015, TWh.

Source: Swedish Energy Agency and Statistics Sweden.

Notes: 1. Heat refers to large heat pumps in the energy sector.

2. Nuclear power energy quantity figures are reported gross, i.e., as supplied nuclear fuel energy in accordance with UNECE guidelines (the United Nations Economic Commission for Europe).

3. Net imports of electricity are counted as supply.

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 2015, the total energy supplied amounted to 548 TWh, of which 23 TWh electricity were exported to other countries. Figure 2 shows an increasing supply of renewable energy commodities, such as hydropower, wind power and biomass, while the supply of fossil energy commodities, such as crude oil and oil products, are decreasing.

Almost thirty per cent of the supplied energy, 155 TWh, came from nuclear fuel in 2015. 56 TWh of this was transformed into electricity while the rest were transformation losses. The supply of nuclear fuel was increasing during the 1970s and continued until the mid-1980s, yet has been relatively stable since. In 2015 the supplied nuclear fuel was 13 per cent lower than in 2014.

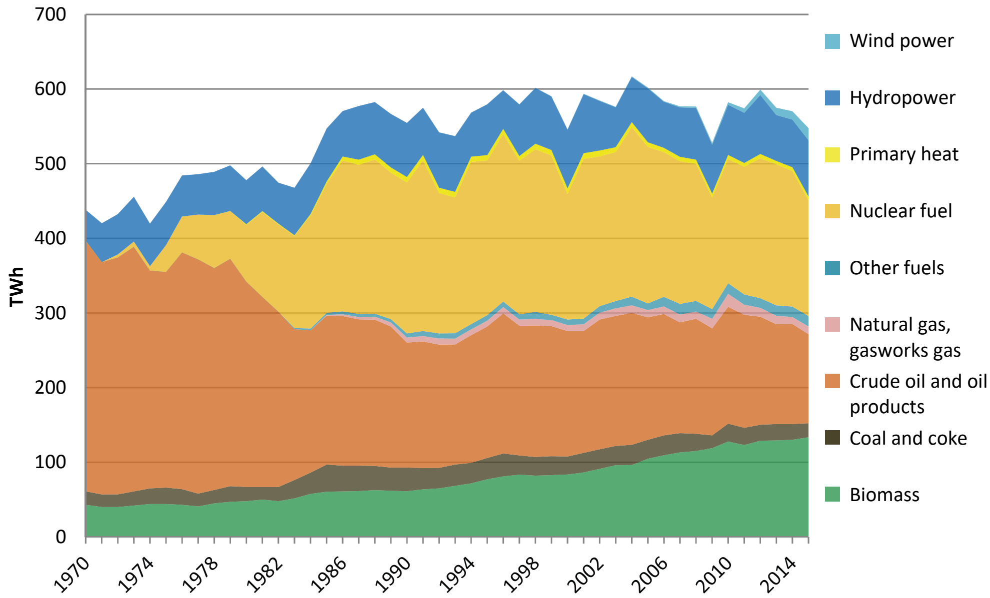


Figure 2 Total energy supply by energy commodity 1970–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

Fossil fuels in the form of oil products, natural gas, gasworks gas, coal and coke accounted for 148 TWh of the energy supplied in 2015. This resulted in 111 TWh of usable energy and the remainder is accounted for by losses and non-energy purposes. The supply of energy from fossil fuels, primarily crude oil and oil products, has fallen sharply since the early 1980s. During 2015, 134 TWh of the energy supplied came from biomass, continuing an increasing trend. The district heating sector and the industrial sector are the major users of biomass, accounting for 70 per cent of biomass use in 2015. The remaining 30 per cent was accounted for by electricity generation, the transport sector and the residential and service sector. The supply of biomass has more than tripled over the last forty years.

Hydropower produced 75 TWh of electricity and wind power generated 16 TWh of electricity in 2015. Electricity production from wind power has increased significantly in recent years, more than quadrupling since 2010. Hydropower is a source of power in the energy system producing electricity at a relatively constant 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.

Total final energy use is decreasing

In 2015, the total final energy use in the user sectors amounted to 370 TWh, which is a further reduction compared with recent years but an increase of 2 TWh compared to 2014. The industry sector and residential and service sector accounted for 140 TWh and 143 TWh respectively, while energy use in the transport sector amounted to 87 TWh, as shown in Figure 3.

For both the residential and service sector and the industrial sector, energy use was at approximately the same level as in previous years. 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 transport sector, energy use has decreased from 2007 to 2015. This is due to improved energy efficiency within the sector partly through a transition to more fuel-efficient vehicles.

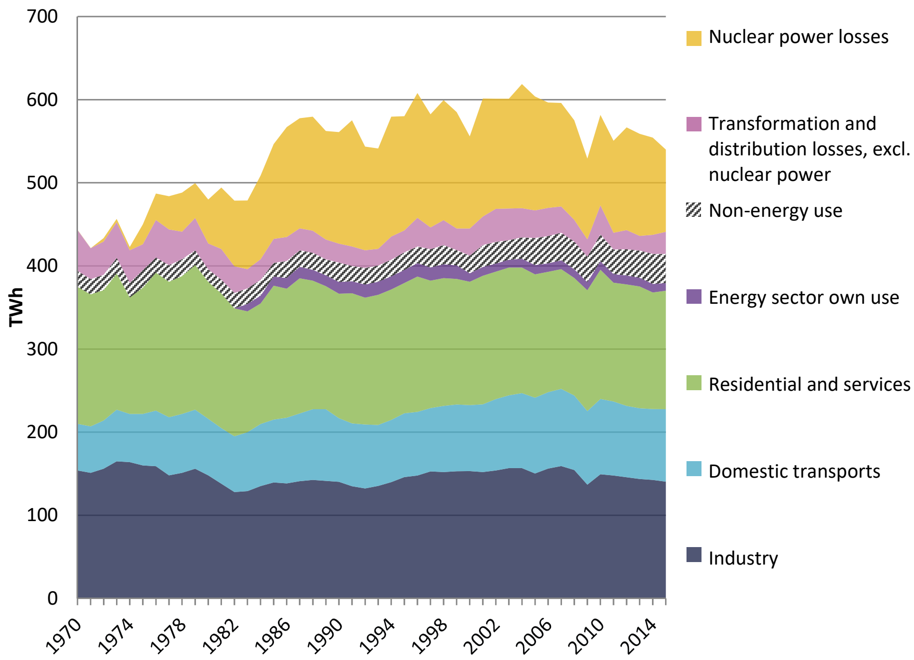


Figure 3 Total energy use, by final energy, losses etc. 1970–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

Electricity is the dominant form of energy used in Sweden, and the total final electricity use in 2015 was 122 TWh. The residential and service sector used the largest amount of electricity, followed by the industrial sector. Oil products are the next largest energy carrier after electricity, and the total final use amounted to 91 TWh, which represents a continued decline in recent years. In Sweden, the use of oil products is found almost exclusively in the transport sector. Biomass is the third largest energy carrier. Final energy use of biomass amounted to 84 TWh in 2015, continuing an increase over recent years.

Reduced losses in the energy sector

The difference between supplied and used energy consists of losses, own use in the energy sector and uses for non-energy purposes. The development of these items is shown in Figure 3.

In 2015, the item losses and other uses amounted to 171 TWh, which shows a reduction over the past five years. Over half of these losses, 99 TWh, came from energy loss due to 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. Losses also arise in final use. The energy balance includes these losses in the respective user sectors.

The use for non-energy purposes, such as raw materials for the chemical industry and lubricants and oils for building and construction work, amounted to 35 TWh in 2015.

Own use in the energy sector amounted to 9 TWh in 2015 and include the use of energy products for the operation of conversion plants. This includes use for heating, lighting and business electricity.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Residential and service sector

The residential and service sector accounts for almost 40 per cent of the total energy use in Sweden. The sector includes households, public administration, commerce, agriculture, forestry, fishing and construction. The distribution has been relatively stable and the energy use in 2015 is shown in Figure 4. Public administration and commerce are mainly made up by non-residential buildings, but also street lighting, sewage treatment works, power stations and water works. Households and non-residential premises stand for roughly 90 per cent of the energy use in the sector.

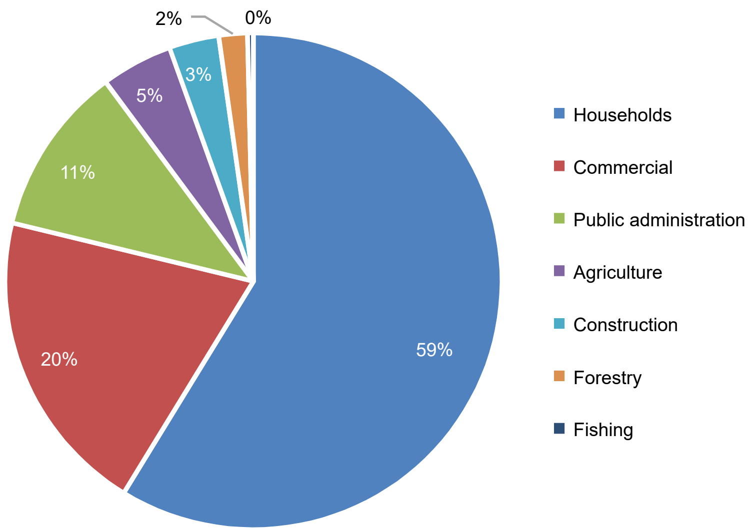

Figure 4 Distribution of different sub-sectors energy use in the residential and service sector, 2015.

Source: Swedish Energy Agency and Statistics Sweden.

Decreased energy use during the 2000s

In 2015, energy use in the sector was 143 TWh. Figure 5 shows how energy utilization in the sector decreased between 2000 and 2009 and then increased distinctly in 2010. This increase was mainly caused by the cold temperatures that year. In 2015, energy use was at the same level again as it was before 2010.

It is primarily the added energy for heating and hot water that decreased. The development is mainly explained by the fact that electricity or central district heating have replaced oil and the number of heat pumps has increased. 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. In 2015, the total use of oil products in the sector was 12 TWh, which is a 90 per cent decrease from 1970.

The number of heat pumps has increased a great deal since the 1990s, which has led to a decrease in the measured energy use for heating and hot water in buildings. A heat pump delivers considerably more energy than the heat pump uses. The energy that the heat pump delivers is not included in the total energy use of the sector. Energy saving measures such as additional insulation and replacing windows in old houses also contribute to a reduced energy use.

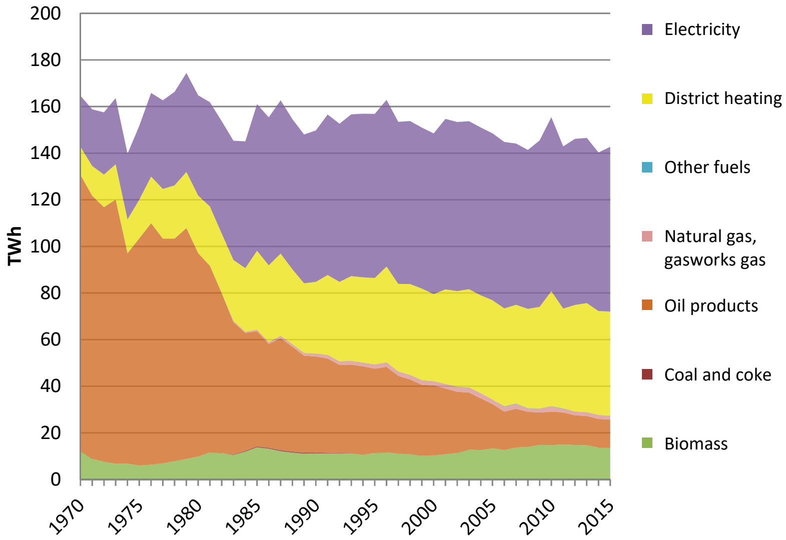

Figure 5 Energy use in the residential and service sector 1970–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

More than half of the energy use in the sector goes to heating and hot water. The heating requirement is affected by outdoor temperatures, which can lead to large variations in energy use from year to year. A cold winter will require more energy for heating whereas warmer winters require less energy for heating. To compare the use between different years, independently of outdoor temperatures, a temperature correction is often introduced. 2015 was almost 12 per cent warmer than a normal year and the temperature corrected energy use was 152 TWh. Compared to the temperature corrected energy use from earlier years this was a decrease, which means that the energy use not associated with heating was lower.

Use of electricity has been stable the last 20 years

The use of electricity in the sector increased steadily from the 1970s to the middle of the 1990s. Figure 6 shows the total electricity use in the sector, divided into business electricity, household electricity and electric heating since 1970.

Electric heating in households and non-residential premises increased from 5 TWh 1970 to 28 TWh 1987. After the peak in the end of the 1980s, the use has decreased. In 2015 the use of electric heating was almost 19 TWh. An important reason for the decrease was the relatively high electricity prices, which gave strong incentives to convert to heat pumps, central district heating or pellets.

The use of *household electricity* increased from 9 to 22 TWh between 1970 and 2015. A greater number of households and more appliances explain the main reason for the increase during the 1970s and 1980s. Two opposite trends affect the use of household electricity. The development towards more energy efficient appliances is leading to decreased energy use. However, the number of households, the number of appliances per household and the number of features in the appliances is increasing, which counteracts the efficiency trend.

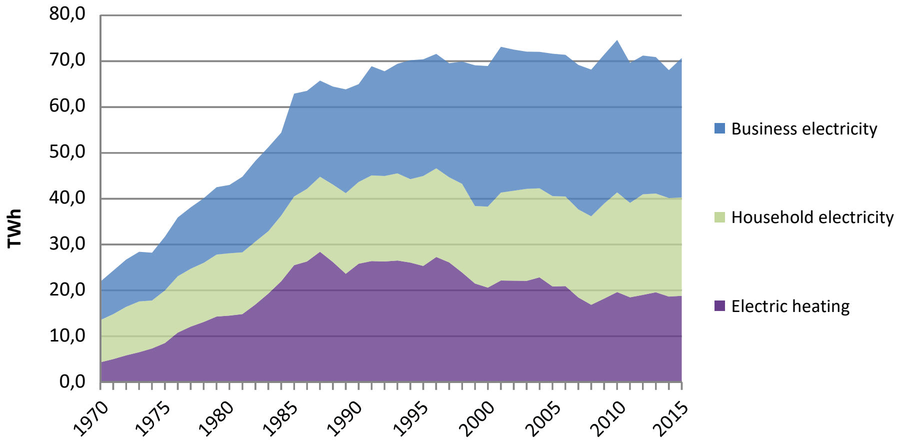

Figure 6 Electricity use in the residential and service sector 1970–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

Business electricity in non-residential premises has increased from 8 to 30 TWh between 1970 and 2015. Business electricity is a merger of electricity used in buildings and business activities. Electricity to permanent installations in buildings include use for ventilation, lifts, escalators and lighting for public buildings, for example in stairwells. Business electricity includes the use of electricity for business conducted in office and commercial buildings, such as for computers, appliances and lighting in spaces where the business is conducted, such as offices. Between 2005 and 2011 the Swedish Energy Agency conducted studies of the electricity use in different non-residential buildings, Stil2.[3] A common trait for the investigated buildings was that lighting and fans account for a large portion of the electricity use.

Half of the energy is used for heating

The energy use was 76 TWh for heating and hot water in households and non-residential premises in 2015, which corresponds to 53 per cent of the total energy use in the sector. Households can be divided into single family houses and multi-dwelling buildings, single family houses correspond to detached houses and terrace houses, while multi-dwelling buildings comprise of apartments. Figure 7 shows the energy used for heating and hot water for single family houses, multi-dwelling buildings and non-residential premises in 2015.

[3] Swedish Energy Agency, ER 2007:34, Inventories of offices and administrative buildings. ER 2007:11, Energy use and indoor environment in schools and preschools. ER 2008:09, Energy use in care-giving buildings. ER 2009:10, Energy use in sports facilities. ER 2010:17, Energy use in commercial buildings. ER 2011:11, Energy use in hotels, restaurants and assembly halls.

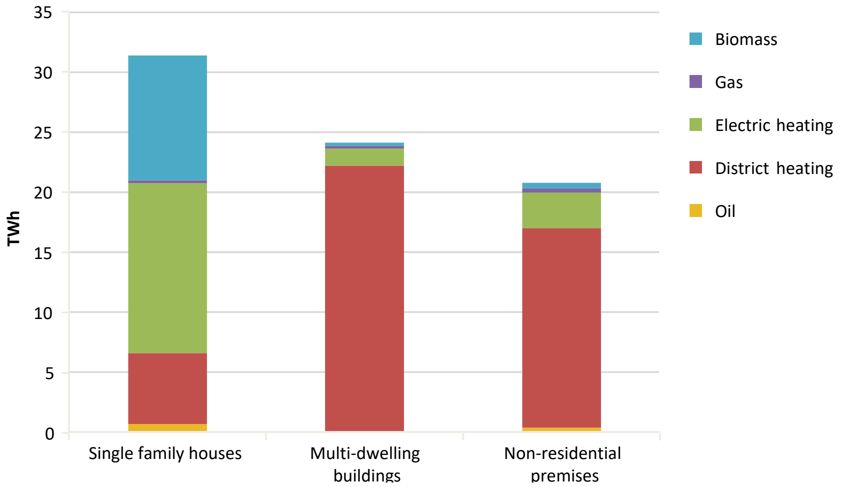

Figure 7 Energy used for heating and hot water in single family houses, multi-dwelling buildings and non-residential premises 2015, TWh.

Source: Swedish Energy Agency and Statistics Sweden.

In single family houses electricity is the most common energy carrier for heating and hot water, adding up to 14 TWh in 2015. The use of biomass such as firewood wood chips, saw dust and pellets has decreased since 2009 and in 2015 was just over 10 TWh. District heating accounted for almost 6 TWh. Oil for heating continued to decrease and was only 0,8 TWh in 2015.

During the 1990s and forward the number of single family houses with heat pumps have increased steadily. In 2014 there were 993 000 heat pumps in single family houses in the country, which is equal to 51 per cent of all single-family houses. Figure 8 shows, with the continuous line, how the purchased energy for heating and hot water has decreased since the beginning of the 2000s. The dotted line shows the energy use for heating and hot water when both purchased energy and energy absorbed by heat pumps is taken into consideration. The large addition of heat pumps is one of the reasons why purchased energy has decreased, since they replace electric radiators and absorb heat energy from the outdoor environment.

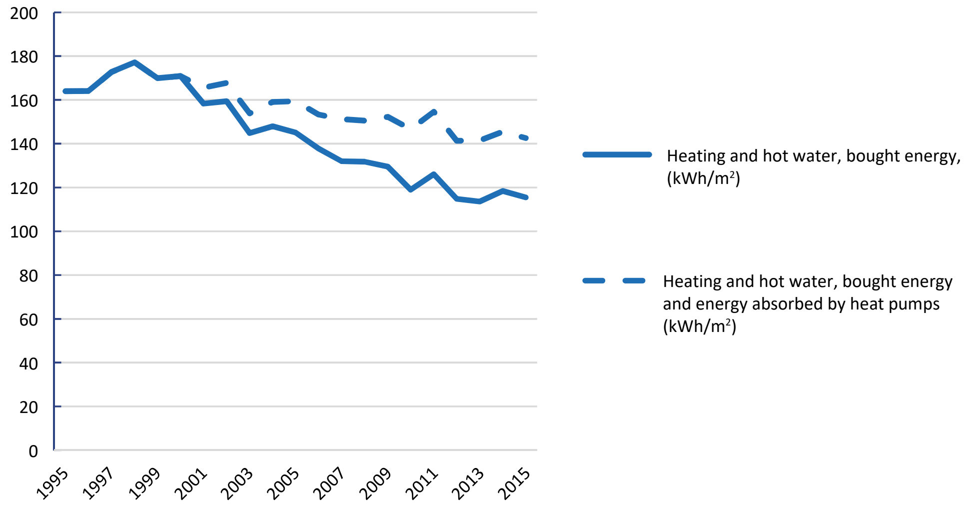

Figure 8 Temperature corrected energy use for heating and hot water in single family houses, kWh/m^2.

Source: Swedish Energy Agency and Statistics Sweden.

In multi-dwelling buildings district heating is the most common energy carrier for heating and added up to 21 TWh in 2015. Electric heating accounted for a little more than 1 TWh and the use of oil continued to decrease, ending up at 0,04 TWh.

In non-residential premises district heating is also the most common energy carrier for heating and hot water. 17 TWh came from district heating in 2015. The second most common energy carrier was electricity at 3 TWh. The use of oil for heating and hot water continues to decrease in non-residential premises, as well, and was 0,4 TWh in 2015.

Energy prices for household customers have increased

Prices for energy for household customers were relatively stable during the second half of the 1990s, and then had a strong increase during the whole of the 2000s. Increased fuel prices and taxes on energy are the main reasons for the increase.

Figure 9 shows that all energy prices have increased between 1996 and 2011. Since 2012 the price of electricity has decreased, both for customers with only household electricity and for those with electric heating.

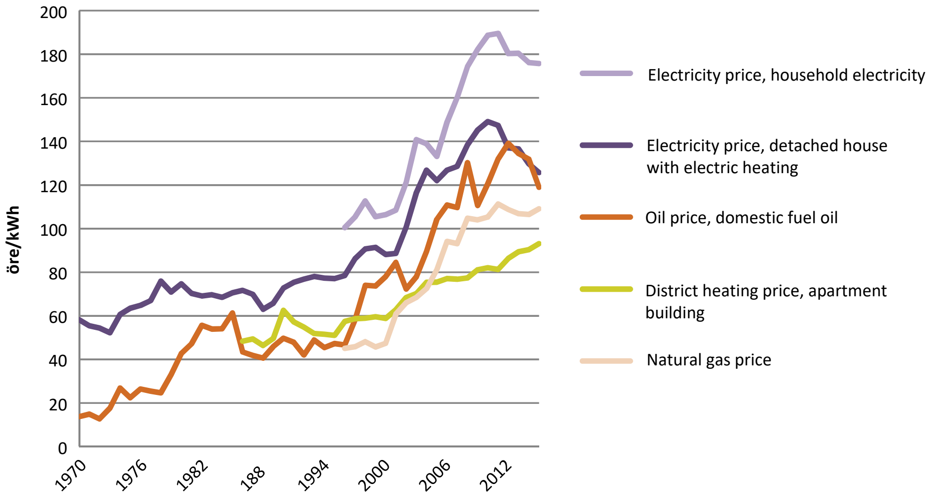

Figure 9 Energy prices for households and non-residential premises 1970–2015, real 2016 (öre/kWh).

Source: Swedish Energy Agency, SCB[4], SPBI[5].

The oil price in Sweden follows the development of the world market price of crude oil, which has risen during the 2000s until the peak 2012. After that the prices were a little lower and then decreased a great amount in 2015. This is reflected in the price that households must pay for domestic fuel oil. The switch to green taxes which means that taxes on electricity and fossil fuels gradually increase is also a reason to increased costs for oil. This is the main reason to why many households have converted from oil to other methods for heating. The natural gas price, which to a certain extent follows the oil price variation has stabilized a little during the last couple of years.

The district heating price for multi-dwelling buildings has increased during the whole 2000s. The differences between various municipalities are large because district heating in Sweden is made up by a great amount of local district heating systems. Therefore, it is difficult to draw any generic conclusions about the reasons for the price development for district heating. However, increased prices for fuels is one contributing reason to higher district heating prices.

Biomass such as firewood and pellets are also important energy carriers for household customers. In December 2016, the weighted average price in Sweden for bagged pellets for detached houses was 2673 SEK per ton, or 56 öre per kWh including VAT. The difference in pricing is mainly geographical, and lower prices most commonly occur in the central parts of Sweden.[6]

[4] Statistics Sweden.

[5] Swedish Petroleum and Biofuel Institute.

[6] Pellets Alliance, Statistics, http://pelletsforbundet.se/statistik/ (retrieved on 2017-03-30).

EU directives set standards on energy consumption for buildings and products

There are many EU directives that regulates the energy use in buildings.[7] Some directives also regulate products that utmost affects the use of electricity in the sector, such as lighting, ventilation, heating products, computers and domestic appliances. Both ecodesign and energy labelling requirements are developed in the form of product specific EU regulations which are immediately applicable in all member states of the EU. Energy labelling regulations specifies requirements on energy labelling and indicates clearly for the customer how energy efficient a product is. The purpose is to make it easy for the customer to consider the energy performance of a product when making a purchase.

New framework for nearly zero-energy buildings

The directive of energy performance of buildings states that all new buildings that are owned and used by public and government authorities should be nearly zero-energy buildings by 2018, and by 2020 for other actors.[8] In December 2016 the framework for nearly zero-energy buildings was decided. The new rules are described in the Planning and building ordinance, and are active from the 1st of April 2017.[9]

Investment support for dwellings in certain districts

In 2017 the Swedish Government has reserved 778 million SEK for investment support for refurbishment and energy efficiency measures of rental apartments in districts with socioeconomic challenges.[10]

Information center for sustainable building

The government suggested in the Budget Bill of 2017 to increase appropriations to the National Board of Housing, Building and Planning (Boverket) to create an information center for sustainable building, with focus on energy efficiency refurbishment and energy efficient building with use of sustainable materials.[11]

Investigation of the structure for energy saving measures loans

In July 2016, a committee of inquiry was appointed to investigate the conditions for a state loan for energy saving measures. The purpose of the loan is to increase energy efficiency in the built environment. A proposal on how such a loan could be outlined will be presented in September 2017.[12]

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[7] Directive of energy performance of buildings (2010/31/EU). Ecodesign directive (2009/125/EG). Energy labelling directive (2010/30/EU). Energy efficiency directive (2012/27/EU).

[8] Directive of energy performance of buildings (2010/31/EU).

[9] Planning and building ordinance (2011:338).

[10] Ordinance (2016:837) regarding support for refurbishment and energy efficiency in certain recidence districts.

[11] Government Bill 2016/17:1.

[12] Government Offices of Sweden, http://regeringen.se/pressmeddelanden (retrieved on 2017-04-03).

Investment support for installation of photovoltaics

Since 2009 there is a state support for installation of photovoltaics. The purpose is to contribute to a transformation of the energy system and to development of energy businesses. All actors are eligible for the support, such as companies, public organizations and private persons. All types of grid connected photovoltaic systems and solar heating hybrid systems can apply for the support. Today the support amounts to 20 per cent of the installation cost for private persons and 30 per cent of the installation cost for businesses. The support is limited to the extent that the support only can be given until the reserved money is out.[13]

In 2016 the last date for beginning the installation in order to apply for the support was extended to 31st of December 2019.[14] In 2015 the Government proposed to invest another 1.4 billion SEK on the support between 2016 and 2019.[15]

In the autumn Budget Bill, the government reserved another 1,4 billion SEK for the support in the period between 2016 and 2019. 770 million SEK of that amount is estimated to go to applications that are waiting for a decision.[16]

Tax reduction for excess electricity

Grid connected systems that feed excess electricity to the grid are from the 1st of January 2015 eligible for a tax reduction that amounts to 60 öre per kWh. The prerequisite is that connection point does not exceed 100 amperes.[17]

Reduced tax for consumption of self-produced electricity

Since the 1st of July 2016, owners of photovoltaics systems with an installed capacity below 255 kW were exempted from paying tax on use of self-produced electricity. This has received a lot of critics, since the new rules applied to each legal property, which meant that certain organizations and companies with many smaller plants that sums up to more than 255 kW were required to pay tax. In May 2017, the Government agreed on a broader tax relief for self-produced renewable electricity. On the first of July 2017, the energy tax level decreased from 29,5 öre/kWh to 0,5 öre/kWh for solar electricity prosumers, with a few smaller facilities that together add up to more than 255 kW. [18]

New support for batteries for storage of self-produced electricity

Since 2016 a new support for storage of self-produced electrical energy is available. The criteria is that the system is connected to the grid and connected to a plant for self-production of renewable electricity. The support amounts to 60 per cent of the costs of the storage system, limited to maximum 50 000 SEK. The support applies to measures that have been initiated between the 1st of January 2016 and the 31st of December 2019.[19]

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[13] Ordinance (2009:689).

[14] Ordinance (2016:900).

[15] Prop. 2015/16:1.

[16] Material for revision of the ordinance of support for photovoltaics (ER 2016:26).

[17] Swedish Tax Agency, http://skatteverket.se/privat/fastigheterochbostad Tax reduction for micro production of renewable electricity (retrieved on 2017-04-03).

[18] Tax committee report 2016/17:SkU30.

[19] Ordinance (2016:899).

The industrial sector

The energy use in the industrial sector was 140 TWh in 2015. This is one per cent lower than in 2014 and approximately 38 per cent of the total final energy use in Sweden in 2015. The largest share of energy use in the sector goes into industrial manufacturing processes. Despite an increasing production, energy consumption has remained relatively unchanged since the 70's. However, over the past years the use of energy has started to decrease. This is mainly due to structural changes within some industrial branches and more energy efficient manufacturing processes.

Biomass and electricity are the dominating energy carriers

Biomass and electricity are the primarily used energy carriers within Swedish industries. In 2015, 40 per cent of the sector's final energy use originated from biomass and 35 per cent was electricity use. Coal and coke accounted for ten per cent of the final energy use and petroleum products accounted for six per cent. District heating, natural and gasworks gases, and other fuels accounted for three per cent each. Fossil fuels, i.e. natural and gasworks gases, petroleum products and coal and coke, accounted for a little less than 19 per cent of the sector's final energy use. Figure 10 shows the final energy use for the industrial sector between 1970 and 2015.

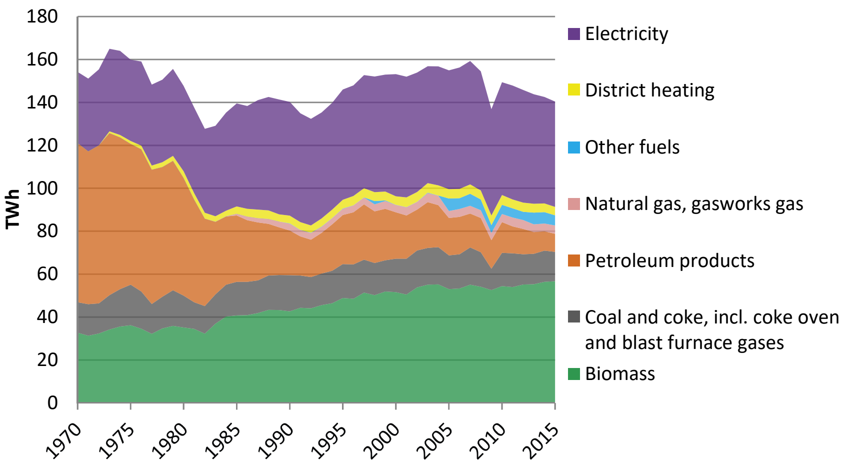

Figure 10 Final energy use in the industrial sector, by energy carrier, 1970–2015, TWh.
Source: Swedish Energy Agency.

Biomass is the energy carrier that has increased the most between 1970 and 2015. The use of biomass has increased from 33 TWh in 1970 to 57 TWh in 2015. The increase can partly be explained by the gradual transition away from oil products, particularly within the pulp and paper industry. The pulp and paper industry is responsible for almost 90 per cent of the total biomass use in the industrial sector.

Industrial use of electricity has increased from 33 TWh in 1970 to 49 TWh in 2015. The electricity use peaked in 2007 with approximately 57 TWh and has since then decreased gradually. The reduced consumption during the past years can partly be explained by a decrease in mechanical pulp production, which is an electricity-intensive process. The pulp and paper industry is the largest electricity consumer among Swedish industries. Therefore, changes in the sector's use of electricity have a significant impact on the total industrial electricity use. An overall transition to more energy-efficient manufacturing processes is another reason to the reduced electricity use.

The use of petroleum products has fallen from 74 TWh in 1970 to 8 TWh in 2015. The consumption decreased rapidly up until the early 90's. It is primarily the use of heavy fuel oils that has decreased. The use of liquefied petroleum gas (LPG) has increased over the same period.

The use of the remaining energy carriers has remained relatively stable since the 70's, except for during the recession of 2009 when the consumption of coal and coke fell. Coal and coke is mainly used within the iron and steel industry and the use decreased due to lower production levels.

Three sectors account for a large share of the energy use

The pulp and paper industry; the iron, steel and non-ferrous metals industries and the chemical industry together accounted for 76 per cent of the industrial sector's final energy use in 2015, see Figure 11. The mechanical engineering industry was responsible for six per cent and other industries were responsible for 18 per cent. Other industries include mining and quarrying, food industry, textiles industry, graphic industry and non-metallic minerals (e.g. manufacturing of glass, cement and lime) and those that normally go under the classification 'others'.

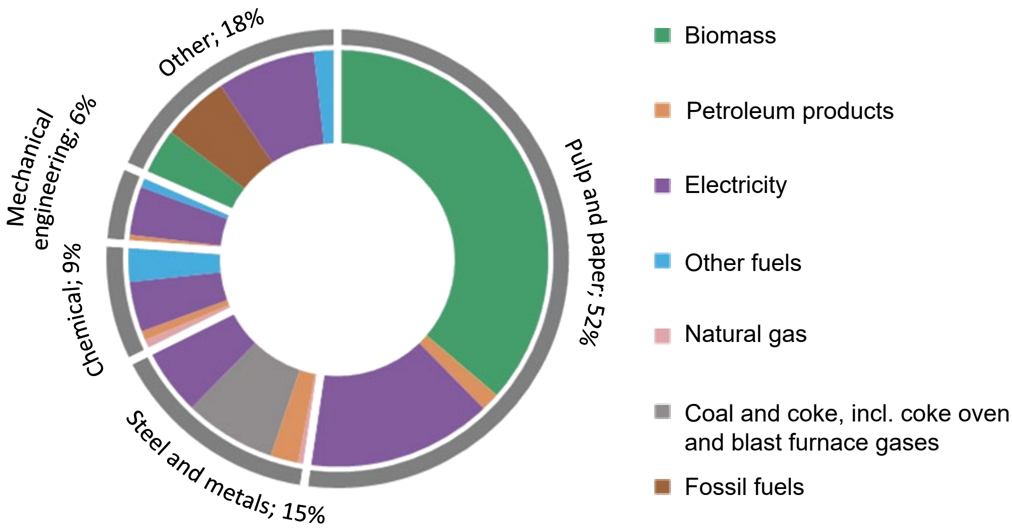

Figure 11 Final energy use in the industrial sector, by industry and energy carrier, 2015, per cent.

Source: Swedish Energy Agency.

Note: For other branches, the use of natural gas, coal and coke and petroleum products is presented as fossil fuels. Any energy use less than 1 TWh is not included in the graph.[20]

[20] Learn more about energy use per energy carrier and per industry in the Swedish Energy Agency's publication Energy in Sweden 2017 (facts and figures) and through the web tool Energy Balance on the Swedish Energy Agency's website: http://www.energimyndigheten.se/en/facts-and-figures/statistics/ .

The energy use in the pulp and paper industry amounted to 73 TWh in 2015, whereof 51 TWh was biomass and 20 TWh electricity. The most common types of biomass are black liquor and wood fuel. Black liquor is what remains of the pulp boil once the cellulose fibers have been removed following the boiling of paper pulp. The liquors are burned in the mills' recovery boilers and the recovered energy is used in the industrial processes.

Iron, steel and non-ferrous metals industries used 21 TWh in 2015. Coal, coke and electricity are the dominating energy carriers. Steel is produced either from iron ore or scrap. In iron ore-based steel production, oxygen is removed from iron oxide with the help of a reduction agent, usually coke. Coke is produced from coal. In scrap-based steel production, electricity-intensive arc furnaces are the main method used to melt the scrap steel. Copper, aluminum and zinc production use electricity for pyrolysis. In total, the use of electricity in iron, steel and non-ferrous metals industries amounted to 7 TWh and the use of fossil fuels amounted to 14 TWh (whereof 10 TWh was coal and coke).

Energy use in the chemical industry was 12 TWh in 2015. Half the energy use was electricity, which is mainly used for electrolysis. Other common energy carriers are various types of petroleum products, natural gas and LPG.

The mechanical engineering industry is not counted among the energy-intensive industries[21], yet the branch is the fourth largest consumer within the industrial sector. In 2015, the energy use amounted to 8 TWh, whereof 5 TWh was electricity use. Most of the electricity use goes into mechanical manufacturing processes. The comparatively high energy use is due to the large number of companies in Sweden.

Other industries used a little less than 26 TWh in 2015, whereof the use of electricity amounted to 11 TWh. Some industries included in this category are energy-intensive, e.g. manufacturing of cement, but their individual energy use is relatively low at the national level. Non-metallic minerals used the most fossil fuels in 2015, 3 TWh. Mining and quarrying used the most electricity, almost 4 TWh, and is; just as the iron- and steelworks, pulp and paper, and chemical industries; often classified as electricity-intensive. Among industries included in the category other industries, the wood products industry dominated in terms of biomass use, with a total use of almost 5 TWh.

Industry's energy prices are falling

The industry's natural gas price increased during 2015, whereas prices for fuel oils, electricity and wood chips fell, see Figure 12.

[21] There are several definitions of energy-intensive companies. The Energy Tax Act (1994:1776) and the Energy Taxation Directive (2003/96/EC) use the definition that a company is energy-intensive if its paid energy, carbon dioxide and sulphur taxes amount to at least 0.5 per cent of the company's value added. Value added is basically the value of a company's production minus the value of the input goods that have been used.

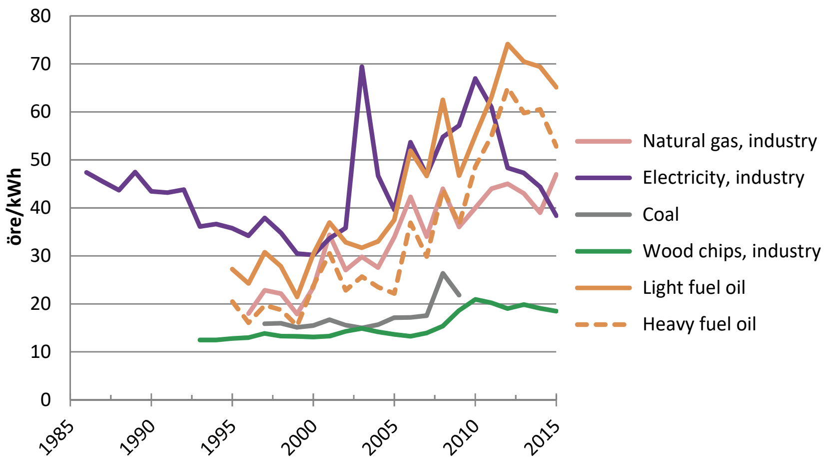

Figure 12 Energy prices for industrial customers 1986–2015, öre/kWh at current prices (2016).

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

Note 1: Prices for natural gas and fuel oils include product price and energy and carbon dioxide taxes. Sulphur tax is in addition included for heavy fuel oils[22]. Taxes are calculated with respect to the industry's general tax exemptions and are for plants not participating in the EU's Emissions Trading System (EU ETS)[23].

Note 2: Up until 1996, the electricity price is for an industrial customer with an annual electricity use of 50 000 MWh. Between 1997-2015, the electricity price is for an industrial customer with an annual electricity use in the range of 70 000 to 150 000 MWh.

Note 3: The coal price has not been presented since 2009 due to changed rules on confidentiality.

The reduced industrial use of petroleum products since the late 90's can partly be explained by increased prices for fuel oils, and by the establishment of a carbon dioxide tax in 1991, which since then has been raised successively. Between 1996 and 2012, prices for fuel oils increased threefold. The price drops over the past years is mainly due to the falling crude oil price. During 2015, the price for light fuel oil decreased by six per cent and the price for heavy fuel oils decreased by almost 13 per cent compared to 2014.

Industry's natural gas price developed similarly to the fuel oil prices until 2010. This is because the natural gas price historically has followed the trend of the crude oil price. Over the past years, the connection between the two prices has weakened. During 2015, industry's natural gas price increased by almost 21 per cent compared to the previous year. The raised carbon dioxide tax is the main reason. Price trends for crude oil and natural gas are further explained in the fossil fuel markets section.

[22] Learn more about the elements of energy prices in the Swedish Energy Agency's publication Energy Indicators 2017, ER 2017:9.

[23] Industrial plants included in the EU ETS do in general not have carbon dioxide tax, whereas most other industries have a tax imposed of 80 per cent of the general carbon dioxide tax level. Some industries are entitled to additional exemptions, which have not been accounted for in the price calculations. More information on current taxes and the EU ETS can be found in the section entitled Energy policy.

The electricity price for industrial customers is linked to the volume of electricity use. Electricity-intensive industries often pay a significantly lower price per kWh than small electricity users[24]. The price development over the past years shown in Figure 12 is for a typical electricity-intensive industry with an annual electricity use in the range of 70 000 to 150 000 MWh. The electricity price was almost 14 per cent lower in 2015 than in 2014. Learn more about electricity price trends in the electricity market section.

The price for wood chips increased between 2008 and 2010 but has since remained relatively stable. One reason behind the increase in price may be the increasing demand for biomass over the course of the 2000s. In 2015, the price for wood chips fell by three per cent compared to the previous year. Further details on biomass price trends can be found in the section entitled the biomass market.

New EU Directive regulates emissions from combustion plants

The EU Directive on the limitation of emissions of certain pollutants into the air from medium combustion plants (MCP Directive)[25] regulates pollutant emissions from the combustion of fuels in certain plants. The new regulated emission level values may require some plants to install additional purification systems. According to the Swedish Environmental Protection Agency (NV)[26], 70 per cent of the Swedish plants that may be affected by the Directive are district heating plants and seven per cent are plants operated within forest industries. Agricultural plants and plants used for the manufacturing of some metal goods and non-metallic products are also likely to be affected, according to NV. Regulations and statutes under the Directive should enter into force no later than December 19, 2017.

Energy taxes and emission allowances to reduce industry emissions

The energy tax on electricity and fuels includes energy and carbon dioxide taxes.[27] Together with the EU ETS, energy and carbon dioxide taxes are the most important policy measures for the industrial sector.

Most industries are entitled to an energy tax deduction for electricity and fuels used in manufacturing processes. After the industry's application for the tax deduction or refund has been approved, the tax level is 0,5 öre per kWh electricity. For fuels, industries have an energy tax imposed of 30 per cent of the general energy tax level. Both industries participating in the EU ETS and those not participating are obliged to pay energy tax.

[24] Learn more about how electricity price varies between typical industrial customers in the Swedish Energy Agency's publication Energy Indicators 2017, ER 2017:9.

[25] Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants.

[26] The Swedish Environmental Protection Agency (NV), Rapport 6765, Genomförande av MCP-direktivet: Förslag till svenskt genomförande av direktiv 2015/2193/EU om begränsning av utsläpp till luften av vissa föroreningar från medelstora förbränningsanläggningar. April 2017.

[27] The Energy Tax Act (1994:1776) and the Act (2009:1497) Concerning Changes to the Energy Tax Act (1994:1776).

The carbon dioxide tax for industries not participating in the EU ETS has increased successively since it was introduced in 1991. Between 2011 and 2014, industries paid 30 per cent of the general carbon dioxide tax, during 2015 the level was 60 per cent and as of 2016, they pay 80 per cent of the general carbon dioxide tax.[28]

The energy-intensive industries that are included in the EU ETS (e.g. oil refineries, iron and steel industry and manufacturing of cement) have been exempted from carbon dioxide tax. Instead they must buy emission allowances equivalent to the volume of greenhouse gases they emit. Industries competing on international markets are allocated a proportion of their allowances free of charge.[29]

The electricity certification system favours industries with their own electricity generation

The electricity certification system is a market-based policy measure which aims to increase the generation of renewable electricity. Producers of renewable electricity receive one certificate per generated MWh. The certificates are then traded between holders and quota obligated parties. Quota obligated parties are compelled to acquire a certain volume of certificates.[30] Within the industrial sector, this policy measure encompasses industries with their own electricity production, so-called back-pressure production. In addition, industrial facilities that are intensive users of electricity do not need to pay electricity certificates for the electricity used in manufacturing processes. Read more about electricity certificates in the electricity market section.

Policy measures for energy efficiency in industry

The Programme for Improving Energy Efficiency in Energy-Intensive Industries (PFE) is a voluntary programme that was introduced in 2005 to foster a more efficient use of electricity. The programme has not accepted new applicants since 2012.[31] Most of the companies included in the programme concluded their programme period in 2014 and the last batch of companies involved will be finished in 2017. Participants who manage to meet programme requirements are rewarded with a financial compensation equivalent to the energy tax they would otherwise have paid for electricity used in manufacturing processes. Requirements include performing an energy audit, implementing a certified energy management system, consistently choosing energy efficient options and implementing the identified energy efficiency measures.[32]

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[28] The Swedish Tax Agency. Lägre skatt för industriell verksamhet. https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/verksamhetermedlagreskatt/industriellverksamhet.4.18e1b10334ebe8bc80002009.html (retrieved on 2017-07-04).

[29] European Commission (EC). The EU Emissions Trading system (EU ETS). https://ec.europa.eu/clima/sites/clima/files/factsheet_ets_en.pdf (retrieved on 2017-07-04).

[30] The Electricity Certificates Act (2011:1200).

[31] PFE was introduced through The Programme for Improving Energy Efficiency Act (2004:1196). This Act was repealed in 2012 (SFS 2012:686).

[32] Swedish Energy Agency. Programme för energieffektivisering i energiintensiv industri (PFE). http://www.energimyndigheten.se/energieffektivisering/program-och-uppdrag/avslutade-program/pfe/ (retrieved on 2017-04-26).

The Act on Energy Audits in Large Enterprises (EKL)[33] was introduced as part of Sweden's implementation of the Energy Efficiency Directive (EED)[34]. The Act entails an obligation for all large companies to perform a quality-assured energy audit at least every four years. The aim is, among other things, to provide clarity on energy use and to provide input for how energy use can be reduced cost-effectively.[35]

Small and medium-sized enterprises are not subject to the EKL Act. They are offered a support which compensates half of the cost of the energy audit, though only up to a maximum of SEK 50 000. Support for energy audits is aimed at small and medium-sized enterprises with an energy consumption of more than 300 MWh/year.[36]

Furthermore, the industrial sector is also affected by other policy measures such as ecodesign, energy labelling[37] and the energy saving requirements in the Environmental Code.[38]

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33 The Act (2014:266) on Energy Audits in Large Enterprises (EKL).

34 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.

35 Companies are required to find out if they are covered by the Act. Guidance is offered in the Swedish Energy Agency's publication Vägledning för energikartläggning i stora företag; För privat och offentlig sektor, ET 2015:05 (in Swedish).

36 Swedish Energy Agency. Stöd för energikartläggning i små och medelstora företag. http://www.energimyndigheten.se/nrp/stod-for-energikartlaggning-i-sma-och-medelstora-foretag/ (retrieved on 2017-04-27).

37 Eco Labelling Act (2008:112).

38 The Environmental Code (1998:808) obliges companies to aim for renewable energy sources and to use energy sparingly.

The transport sector

In 2015, energy use in the transport sector amounted to 117 TWh. This consisted of 87 TWh in domestic transport, which corresponds to around a fourth of Sweden's total energy use. The remaining 30 TWh were used in foreign transport[39]. The transport sector is divided into road transport, rail transport, aviation and shipping. Road transport is the largest user and accounted for 94 per cent of domestic energy use for the transport sector in 2015. Figure 13 shows the final energy use of the transport sector divided into domestic- and foreign transport and subsectors.

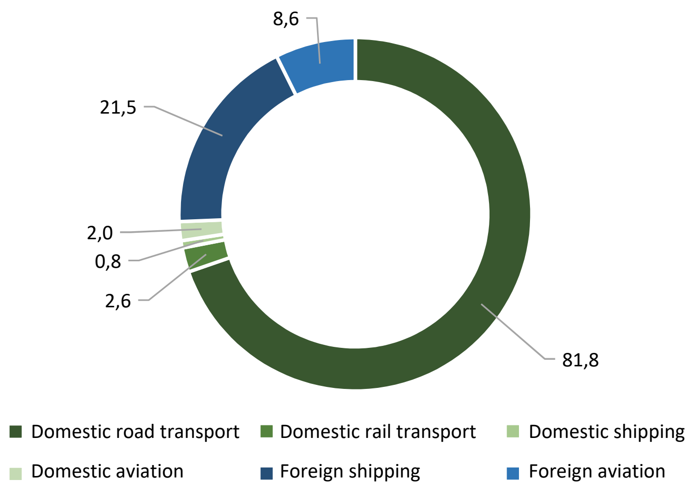

Figure 13 Final energy use in the transport sector 2015, TWh, divided into domestic- and foreign transport and subsectors.

Energy use in transport is declining

The general trend since the 1970s has been that energy use in domestic transport is increasing. In 2007, record highs in use were noted in the Official Statistics but has since declined. In 2015 the final energy use slightly increased but was still 5 TWh lower than in 2007, as shown in Figure 14. The increase was partly an effect of a record high in car sales in 2015[40].

[39] Foreign transports within shipping includes traffic between Swedish and foreign ports and traffic between two foreign ports. Within aviation foreign transports is defined by fuel bought in Sweden but used for flying between foreign destinations. The definition is taken from the project Ett fossilbränsleoberoende transportsystem år 2030 by Svensk Energi and Elforsk.

[40] BilSweden, http://www.bilsweden.se/statistik/nyregistreringar_per_manad_1/nyregistreringar-2015/nyregistreringar-december-2015-prel

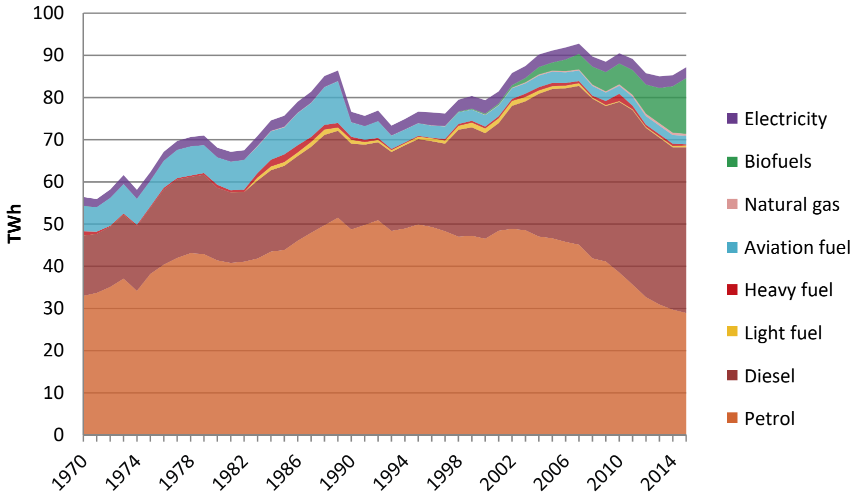

Figure 14 Final energy use in the transport sector, domestic, 1970–2015, TWh[41].
Source: Swedish Energy Agency, Statistics Sweden and the Swedish Transport Agency.

For road transport, there has been a trend for a long time towards reduced petrol usage and an increased use of diesel. Since 2010 diesel has been the most common fuel looking at final energy use. In 2012 diesel passenger cars accounted for 65 per cent of new cars sold, which is a record high. Since then the share has decreased slightly and accounted for 58 per cent in 2016. Gasoline cars accounted for about 36 per cent and the remaining 6 per cent were accounted for by EVs, hybrid EVs, gas- and ethanol cars.

New car sales of electric vehicles[42] increased in 2015, especially plug-in hybrids. According to Elbilsstatistik,[43] the number of electric vehicles in Sweden doubled between 2014 and 2015 to a total of about 15,000 electric passenger cars in 2015. This accounts for 2.5 per cent of the total new car sales in 2015 in Sweden. Behind Norway at 23 per cent and the Netherlands at 10 per cent Sweden has the third largest share of electric vehicles in the world.[44] Electric operation in road transportation only accounts for a marginal part of the energy use within the sector. A contributing factor to this is that passenger cars in electric operation use 3-4 times less energy than a fossil fuelled passenger car. As of now there is no official statistics over electrical operation for road vehicles. In 2015, new car sales of cars that can be driven using CNG and E85 continued to decline. New car sales of green cars[45] amounted to 17.5 per cent of all new car sales in 2015.

[41] Up until 1989, all aviation fuel was included in domestic flights, but from 1990 a division was made in aviation fuel between domestic and international energy use.

[42] Electric vehicles include battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs). A battery electric vehicle is driven only by an electric motor while a hybrid also has an internal combustion engine and can be driven on either electricity or liquid fuels.

[43] Elbilsstatistik, http://elbilsstatistik.se/ (retrieved 2017-03-13).

[44] International Energy Agency, Global EV Outlook 2016.

[45] A green car is defined by its fuel and its weight in relation to its greenhouse gas emissions.

Electricity consumption in rail transport[46] has varied very little from year to year during the 2000s; statistics point to a slight increase since 2010. The use of diesel in rail transport is marginal, and the long-term trend indicates a decline. Rail transport accounted for about three per cent of the total final domestic energy use within the transport sector.

Energy use from both domestic and foreign aviation is showing a trend towards levelling out since 2009. The number of passengers has increased steadily during the same period[47], this points to more efficient fuel consumption than before within the sector. Aviation accounts for about ten per cent of the total energy use within the transport sector.

Energy use in the maritime sector has decreased in recent years but in 2015 a slight growth was seen in foreign shipping. This growth can be a consequence of larger volumes of goods. Statistics show a shift from heavy fuel oils to light fuel oils and diesel, which is in line with the amendments to the Sulphur Directive that came into force on 1 January 2015.[48] The maritime sector accounted for nine per cent of the total energy use of the transport sector in 2015. Energy statistics for shipping are uncertain however as the sector is characterized by certain data collection problems. The Swedish Energy Agency is currently updating the model for data collection within the maritime sector.

The use of transport biofuels is increasing

The use of biofuels in the transport sector continues to increase, see Figure 15. Biofuels mainly consists of biodiesel, ethanol and biogas.

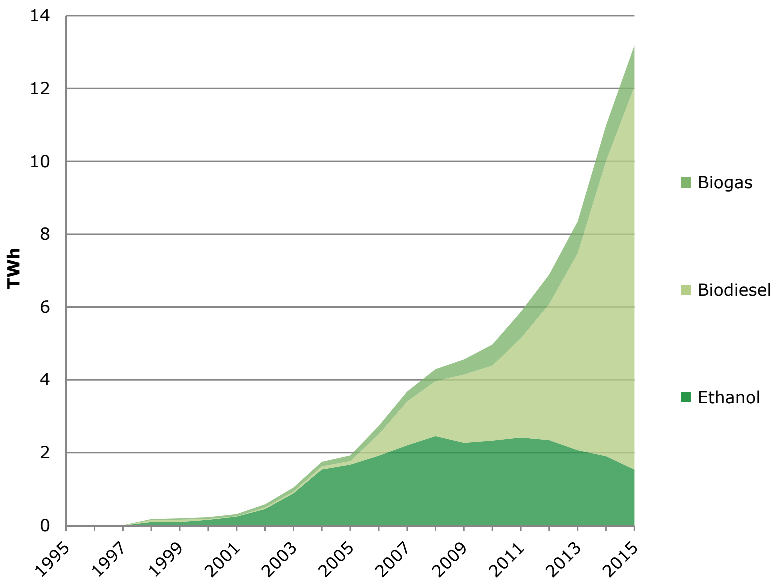

Figure 15 Biofuels in the transport sector, domestic, by fuel, 1995–2015, TWh.[49]
Source: Swedish Energy Agency and Statistics Sweden.

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[46] This encompasses railway, subway and tram services.

[47] Trafikanalys, Luftfart 2015.

[48] The Sulphur Directive (1999/32/EC), last amendment (2012/33/EC).

[49] Energy in Sweden publishes numbers for biofuels using statistics from 2015. In the report Energiindikatorer 2017, ER 2017:9, preliminary numbers for 2016 are presented.

In total, biofuels accounted for 15 per cent of domestic energy use in transport in 2015[50]. The biofuels available on the market today are ethanol, biogas and biodiesel. Between 2013 and 2014, the usage of biofuels increased by 24 per cent which accounted for the largest increase ever in absolute terms. The use of biodiesel has almost doubled in the last two years while biogas has increased marginally and ethanol use has decreased. In 2015, biodiesel accounted for 80 per cent of the total volume of biofuels in the transport sector.

The prices of transport fuels continue to rise

Figure 16 indicates that the price of diesel has historically been lower than the price of petrol. On average, the price of diesel has been 23 per cent cheaper than the price of petrol since 1980 seen as SEK per energy content. However, in recent years the diesel price has only been 9 per cent cheaper than the price of petrol per energy content. In 2015 E85 surpassed petrol as the most expensive fuel in SEK per energy content. This can be a consequence of a lowered tax reduction of E85 because of a lowered margin for overcompensation[51] and a low price of oil. In 2016 the tax reduction was twice revised for E85. The tax reduction was lowered on January 1st and increased on August 1st.

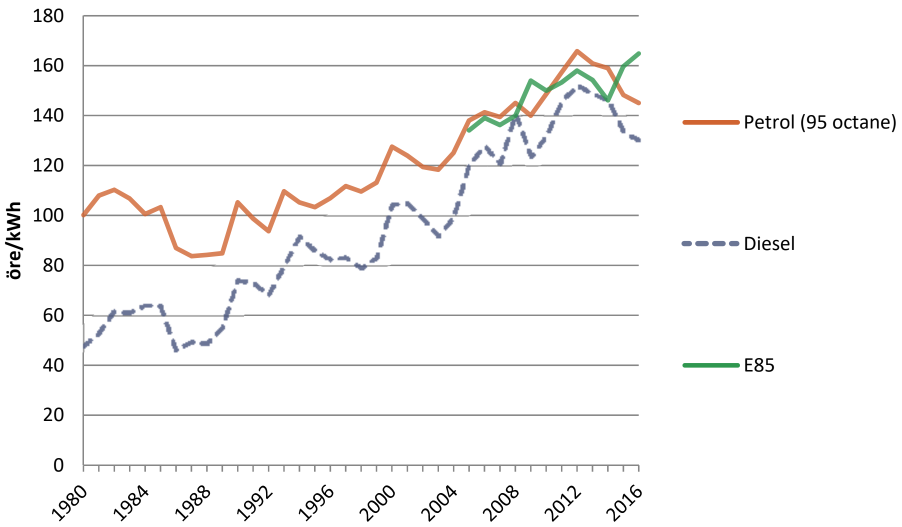

Figure 16 Road transport fuel prices 1980-2015, öre/kWh, real (2016)[52].
Source: Swedish Energy Agency and Statistics Sweden.

The transport fuel prices in the figure are presented as price per energy content. The litre price for E85 has generally been a few SEK lower than that of the price of petrol and diesel but compared with 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 share of the diesel price composed of taxes has increased more

[50] Biofuels plus electricity accounted for 18 per cent of total domestic energy use within the transport sector.

[51] Overcompensation occurs when a biofuel has a production cost that is lower than the market price of its fossil equivalent, seen to energy content.

[52] The figure shows yearly average respectively.

than its equivalent in the petrol price. The price of biofuel is often set based on its fossil equivalent and not based on production cost. This is to make the biofuel a competitive fuel. This does not ensure that the biofuel is chosen, however. Although E85 at the pump has essentially always been cheaper than petrol, there has been a substantial decrease in usage since 2011. Sales of new passenger cars that can run on E85 have also dropped in the last five years. In addition, the refueling rate of E85 in existing ethanol vehicles has decreased, which means that the cars that can run on E85 are increasingly using petrol. This may in part be due to the price of ethanol being higher than the price of petrol as SEK per energy content, and partly because a large percentage of the ethanol cars come from the second-hand market, where it is mainly the price and not the alternative fuel that is important for the buyer. For a definition of E85 and explanations of other biofuels, see Table 1 at the end of the section.

Electric vehicles for road transport accounts for a small portion of the vehicle fleet and the cost of an electric vehicle is currently around 200 000 SEK higher than the cost of regular vehicle. According to electric vehcile test by Vattenfall and Volvo the fuel cost is only a third of the fuel cost of a gasoline driven car.[53]

Also, read the section entitled the Biofuel Market for more information on price-influencing factors for liquefied biofuels.

New directives and regulations affecting the transport sector

Super green car premium gets extended

Further tax rules promoting the use of environmentally-friendly cars are the benefit tax on company cars[54] and the super green car regulation[55].[56] Since 2012 buyers of so-called super green cars have been entitled to a premium of at most 40,000 SEK per super green car. In 2016 489 million SEK were deposited for the super green car premium of which 348 million SEK were used. In 2017 there are 700 million SEK deposited for the premium[57]. The super green car premium can be received by cars acquired from 1 January 2012 but still have not utilized the premium. In December 2016, the Swedish government decided to prolong the super green car premium until the year-end of 2017.[58]

Bonus-malus system

In 2015 the Swedish Government assigned an inquiry to produce a proposition on a so-called Bonus-malus System for light vehicles. The Bonus-malus System would replace the super green car premium. Such a system means that car buyers choosing cars with low carbon dioxide emissions would receive some form of a bonus while

[53] Elbilsupphandling, http://www.elbilsupphandling.se/vanliga-fragor/ (retrieved 2017-03-10).

[54] Förmånsbil, Inkomstskattelagen (1999:1229).

[55] A super green car is a passenger car that fulfills the latest EU exhaust requirements, Euro 5 or Euro 6 as well as emitting less than 50 grams of carbon dioxide per kilometer during varied driving. The requirements of a super green car are higher than for a regular green car.

[56] Förordning (2011:1590) om supermiljöbilspremie.

[57] Regeringen, http://www.regeringen.se/artiklar/2015/07/stor-efterfragan-pa-supermiljobilspremien/ (hämtad 2015-08-24).

[58] Swedish Government, (retrieved 2017-03-06).

cars with high carbon dioxide emissions would be charged with a higher taxation. The inquiry suggested the system be implemented within the current system with the super green car and vehicle taxation. The inquiry suggested the bonus-malus system would be applied from 1 July 2018.[59, 60]

Reduction obligation

In 2016 the Swedish Energy Agency together with a few other government agencies received an assignment to coordinate the conversion to a fossil fuel free transport sector. The assignment is to be presented during 2017. It has amongst other things yielded a proposition for a reduction obligation. The reduction obligation requires all sold fuels to have carbon dioxide emissions at a certain percentage lower than their fossil equivalent. It is suggested that the reduction obligation be regulated per a target curve showing how much carbon dioxide reduction is needed every year. The proposition is currently out on referral and a decision is expected during 2017.[61]

Action program for the infrastructure of alternative fuels

Because of the European Parliament's *Directive on the Deployment of Alternative Fuels Infrastructure*, an action program for the infrastructure of alternative fuels has been prepared during 2016. The action program includes an assessment of the future development of the market for alternative fuels within the transport sector as well as national ambition and goals for the deployment of alternative fuel infrastructure. Per the directive of the European Union common standards for recharging and refueling of alternative fuels are to be developed. Implementation of these requirements is to be addressed in the law (2016:915) requirement of installation for alternative fuels and regulation (2016:917) requirement for alternative fuels both implemented in November 2016.[62]

A new Swedish aviation tax

In November 2016 a report regarding a new Swedish aviation tax was submitted to the Government. The aviation tax is to be applied on commercial flights lifting from a Swedish airport. The tax is to be designed as an excise duty and based on the number of passengers on the flight. The magnitude of the tax is decided based on the distance the flight is set to travel. The tax is to be paid by the aviation companies and is suggested to be implemented from 1 January 2018. A decision regarding the tax is expected during 2017.[63]

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[59] Swedish Government, (2016:33) Betänkande av Bonus-malus-utredningen.

[60] The Swedish Government, Memorandum, Reduktionsplikt för minskning av växthusgasutsläpp från bensin och dieselbränsle.

[61] Swedish Energy Agency, ER 2016:30, Förslag till styrmedel för ökad andel biodrivmedel i bensin och diesel.

[62] Swedish Government, Sveriges handlingsprogram för infrastrukturen för alternativa drivmedel i enlighet med direktiv 2014/94/EU.

[63] Official reports of the Swedish Government, (2016:83) En svensk flygskatt.

Electric bus premium

In June 2016 the Swedish Government decided on a regulation for an electric bus premium. The premium can be applied for by regional public transport agencies as well as municipalities that have received authority to purchase public transportation. The magnitude of the premium is decided by the emission class of the bus and its transportation capacity. The premium can be applied for by buses ordered from 1 January 2016.[64]

Klimatklivet

Since 2015 grants for climate change investments at a local level can be applied for in the Swedish Environmental Protection Agency's fund Klimatklivet. Grants within the transport sector can be support for deployment of infrastructure for electric vehicles or tank facilities for biofuels. To read more regarding Klimatklivet, see the Energy policy section of this report.[65]

News at the EU level

Upcoming changes in the renewable energy directive

The European Parliament's directive promoting the use of renewable energy, The Renewable Energy Directive, was adopted in 2009. The renewable energy directive specifies a specific calculation model for calculating the renewable share within the transport sector. In April 2015 changes in the directive were decided upon, changes that will be implemented in Sweden through Swedish law during 2017.

CORSIA – A new global instrument for international aviation

In October 2016 the United Nation's organization for civil aviation, ICAO, decided upon a new global instrument for climate-affecting emissions from international aviation called *CORSIA – Carbon Offsetting and Reduction Scheme for International Aviation*. The decision rules that carbon dioxide emission from international aviation is to be stabilized at the level of 2020. If 2020 emissions are exceeded the aviation company in question will be required to climate compensate through buying emission credits through the EU ETS-system. The system will begin with a voluntary phase from 2021 and from 2027 it will become mandatory.[66]

Regulation on carbon dioxide emission from shipping

In April 2015 a regulation regarding carbon dioxide emissions from shipping was decided upon. The proposition means that requirements on monitoring, reporting and verifying of carbon dioxide emissions from large ships (over 5,000 gross tonnage) operating in European Union ports are to be implemented. The regulation is suggested

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[64] Swedish Government, förordning (2016:836) om elbusspremie.

[65] Swedish Environmental Protection Agency, http://www.naturvardsverket.se/klimatklivet (retrieved 2017-03-09).

[66] ICAO decision A39-3.

to be implemented from 1 January 2018. The goal is to implement emission goals for the maritime sector and develop a market based instrument for emissions reduction in the future.[67]

Nitrogen Emission Control Area in Baltic Sea and Northern Sea

In August 2016 the Swedish Government assigned the Swedish Transport Agency to investigate a nitrogen emission control area[68] for the maritime sector. The reason was that the UN maritime organization, IMO, is currently investigating how a nitrogen emission control area can be implemented in the Baltic Sea and Northern Sea. The investigation and the eventual implementation could affect the energy use within the maritime sector.[69]

Connecting Europe Facility fund

Since 2014 cross-border projects promoting growth, infrastructure and sustainability can apply for grants from the European Union fund Connecting Europe Facility.[70] The fund is divided into three sectors: energy, telecom and transportation. In January 2017, the Swedish Government endorsed 13 Swedish projects regarding transportation to apply for the grants from the fund. [71]

For more detailed information regarding new regulations and directives affecting the transport sector see the Swedish Energy Agency's other publications such as *Marknaderna för biodrivmedel 2016.*[72]

[67] European Parliament, 2015/757, Regulation on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC.

[68] A nitrogen emission control area means tougher rules for emission of nitrogen from ships.

[69] Swedish Government, http://www.regeringen.se/pressmeddelanden/2016/08/konsekvenser-av-kvavekontrollomrade-for-sjofarten-ska-utredas/ (retrieved 2017-03-10).

[70] European Parliament, https://ec.europa.eu/inea/en/connecting-europe-facility (retrieved 2017-03-09).

[71] Swedish Government, http://www.regeringen.se/pressmeddelanden/2017/02/regeringsbeslut-om-tillstyrkande-av-ytterligare-en-ansokan-till-eus-fond-for-ett-sammanlankat-europa/ (retrieved 2017-03-09).

[72] Swedish Energy Agency, Marknaderna för biodrivmedel 2016, ER 2017:12.

The electricity market

Swedish electricity production is based largely on hydropower and nuclear power, which together account for 81 per cent of electricity production in 2015. The expansion of renewable electricity has however been extensive during the 2000s, with wind power accounting for the largest portion of the increase. Wind power set a new production record as electricity prices continued to be relatively low. Electricity consumption has declined over a 15-year period, but increased slightly compared to last year. In 2015, Sweden exported more electricity than ever before.

Electricity consumption is lower today than 15 years ago

The total amount of electricity used, including distribution losses, amounted to 137 TWh during 2015, see Figure 17. This is a small increase compared with 2014, when the total electricity consumption was 135 TWh. [73] Electricity consumption was at most 150 TWh in 2001 and has since declined.

Most of the electricity is used in the residential and service sector followed by the industrial sector. Read more about electricity use per sector in each chapter.

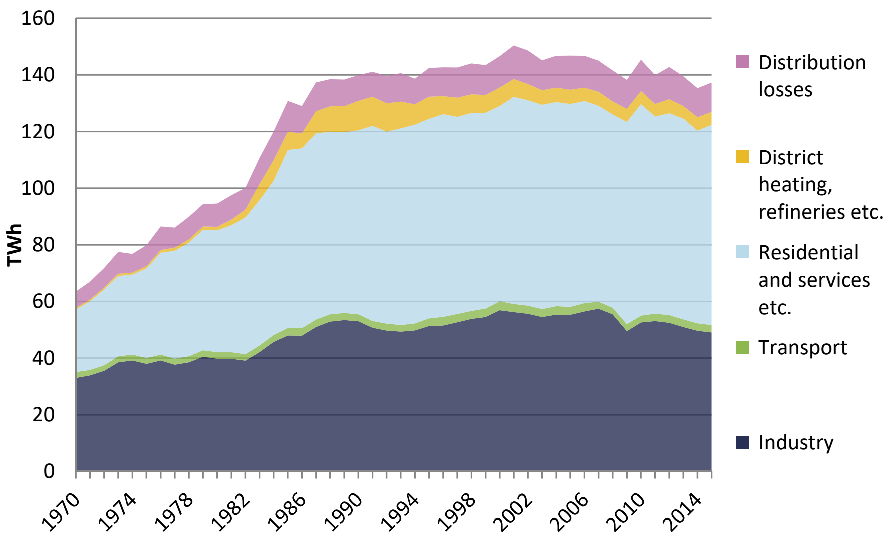

Figure 17 Electricity use, total and per sector 1970–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

Factors such as population changes and structural changes of industry have an impact on the use of electricity. Outdoor temperatures also have an impact due to electricity being a dominant source of heating in Sweden. Economic and technological development and the development of energy prices are other factors that impact the use of electricity.

[73] Total electricity consumption was 140 TWh in 2015 according to preliminary statistics.

Hydropower and nuclear power still dominate electricity production

The total electricity production amounted to 159 TWh in 2015, see Figure 18. This is an increase compared with 2014 when 150 TWh was produced. Production from hydropower was higher than normal during 2015 and total electricity generation was the second highest ever in Sweden. In 2015, electricity production was composed of 47 per cent hydropower, 34 per cent nuclear power and 10 per cent wind power. The remaining 9 per cent was combustion-based production, which mainly takes place in combined heat and power plants and within industry. [74]

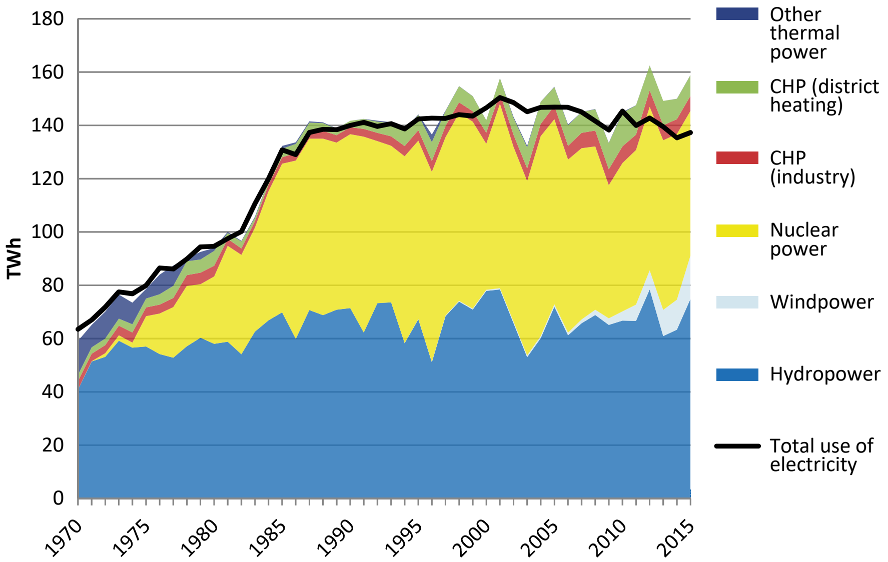

Figure 18 Net electricity production by source and total electricity use in Sweden 1970–2015, TWh.

Source: Swedish Energy Agency and Statistics Sweden.

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

Hydropower produced close to 75 TWh, which is significantly higher than in 2014 when a total of 63 TWh was produced. Production varies over the years due to water availability. In the past 20 years, the production has varied between 78 TWh at the highest and 51 TWh at lowest.

Swedish nuclear power plants produced 54 TWh in 2015, which is lower than normal production levels. Ten reactors would normally be producing around 65–67 TWh a year. One reason for the lower production in 2015 was that two out of the ten reactors were not operational during the year. One of these reactors, Oskarshamn 2, was not restarted after revision and has thus been taken out of service after a decision by the owners. Consequently, there are nine reactors still in operation in Sweden in the end of 2015. Another three reactors are to be taken out of service by 2020. Oskarshamn 1 will be taken out at the end of June 2017 and Ringhals 1 and 2 will be taken out in 2020 and 2019 respectively.

[74] Total electricity production was 152 TWh in 2016 according to preliminary statistics. Nuclear power stands for 61 TWh, hydro power 61 TWh, wind power 15 TWh, combined heat and power plants 8 TWh and 6 TWh produces within the industry. Only a very small production in condensing power plants.

Wind power production continued to increase sharply between 2014 and 2015 when it reached a level of 16 TWh. One reason for the high production was that the year was windy, but also since the number of wind power generators continued to grow during the year. 743 MW of wind power were installed in Sweden and 213 turbines were put into operation during 2015. By the end of 2015, the total number of wind turbines was 3,174, with a total of 5 840 MW of installed power.[75]

Combustion-based electricity production accounted for just over 13 TWh in 2015. This is mainly produced in combined heat and power plants, which produced 8 TWh, and within industry, so-called industrial cogeneration, which produced 6 TWh. Oil-fired condensing power plants and gas turbines primarily provide reserve capacity, amounting to 0.2 TWh.

The largest portion of fuel used for combustion-based electricity production is biomass, accounting for 72 per cent. Coal, including coke oven and blast furnace gases, accounted for 11 per cent of the fuel. The remaining fuels are natural gas, other fuels and a small amount of oil.

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 approximately 60 MW by the end of 2014 and 104 MW in the end of 2015. The photovoltaic market consists of both grid-connected and independent systems. Grid-connected systems account for over 90 per cent of the capacity.[76] The total capacity produces approximately 97 GWh per year, which represents about 0.06 per cent of Sweden's total electricity production.

Largest Net Exports Ever in 2015

In 2015, Swedish net exports amounted to 22.6 TWh, which is the largest ever. The second largest was 19.6 TWh in 2012. During 2016 net exports of electricity decreased to 12 TWh. The flows of trade between Sweden and neighboring countries vary both from year to year and throughout the year; see Figure 19. Trade in electricity between countries depends on price differences between different electricity areas. Price differences may be the result of the availability of water, the availability of nuclear power, the capacities for transmission and the use of the electricity. The majority of net imports came from Norway and the majority of net exports were sent to Finland both in 2015 and 2016.

[75] Swedish Energy Agency, ES 2016:01, Vindkraftsstatistik 2015 [Wind Power Statistics 2015].

[76] Swedish Energy Agency, Preliminary data collected from Annual Electricity, Gas and District Heating Supply 2015.

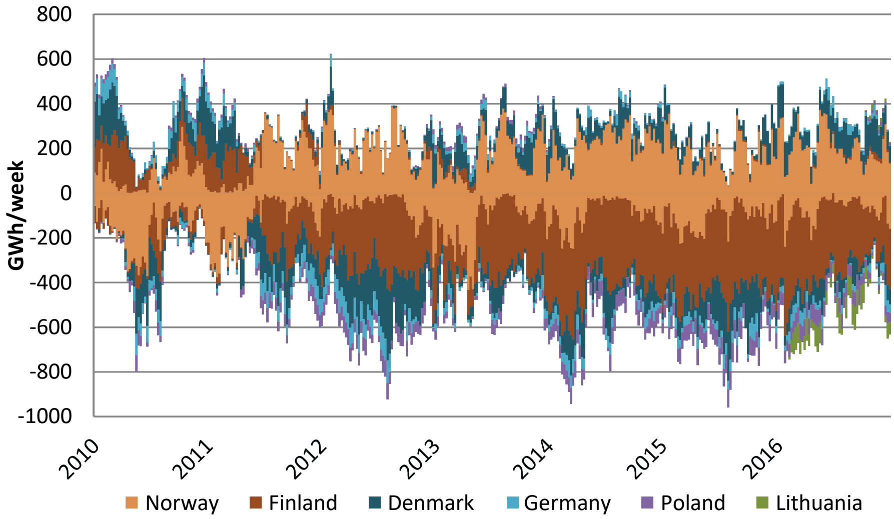

Figure 19 Electricity trade with other countries 2010–2016, GWh/week.
Source: Weekly Statistics Power Situation, Swedenergy.

Sweden currently has transmission connections with Norway, Finland, Denmark, Germany, Poland and, since the beginning of 2016, Lithuania. In 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 2025/2026. The Swedish Transmission System Operator, Svenska kraftnät, is developing the grid continuously, and there are many development projects in progress[77].

The installed power is decreasing in the electricity system in 2015

Following the deregulation of the Swedish electricity market in 1996, there was a marked decrease in installed electricity production capacity. It was primarily expensive thermal power, which was no longer profitable, that was phased out. After 2000, the capacity increased again and it 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.

In December 2015, the total installed electricity production capacity was 39 313 MW which is a small decrease from 2014. The decrease is mainly because reactor 2 in Oskarshamn was not restarted after an ongoing revision and was thus taken out of service. Hydropower accounted for 41 per cent; nuclear power accounted for 23 per cent, and wind power represented 15 per cent. Other thermal power accounted for 20 per cent.

In December 2016, the total installed electricity production capacity was a bit higher, 40 029 MW mainly since wind power capacity increased. The installed electricity production by type of power is presented in Figure 20.

[77] Read more about ongoing and planned developing projects on Svenska Kraftnäts website http://www.svk.se/en/grid-development/

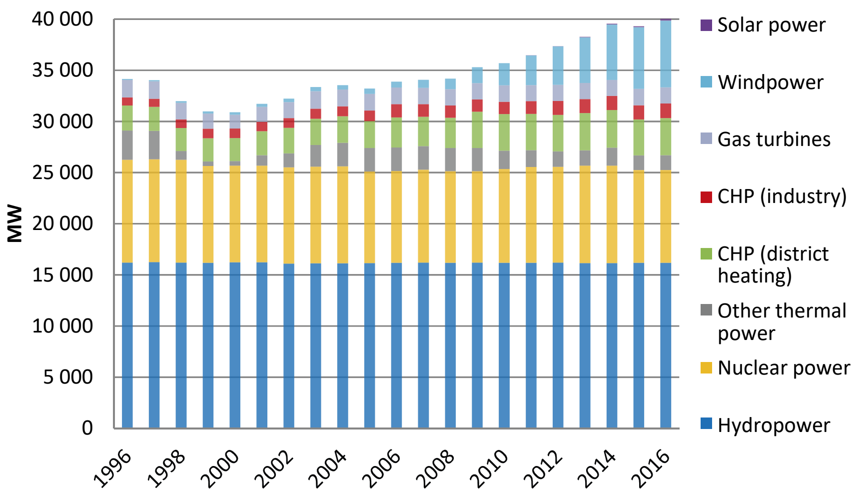

Figure 20 Electricity production capacity, 1996–2016, MW.

Source: Swedenergy.

Notes: Industrial back-pressure is synonymous with industrial cogeneration.

The highest power output during winter 2015/2016 happened on 15 January, between 8 and 9 am, and amounted to 26 883 MW. That is about 3 500 MW higher than under the previous winter. Even though the difference between the installed capacity and the maximum power output appears to be large, the power generation system may become strained.

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. All the hydropower capacity is therefore not available at the same time. Availability in nuclear power plants depends on the operational situation. 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.[78]

The electricity price on the exchange was low in 2015 and 2016

In 2016, the annual average value of the system price of electricity on Nord Pool was 25.5 öre/kWh. In 2015 the system price was even lower, 19.7 öre/kWh. The corresponding annual average value of the price for Sweden's electricity area, SE3, was 27.8 öre/kWh in 2016 and 20.6 öre/kWh in 2015. A bit higher than the system price which is seen in Figure 20.

[78] Svenska kraftnät, 2016/1129, Kraftbalansen på den svenska elmarknaden vintrarna 2015/2016 och 2016/2017 [The power balance in the Swedish electricity market in the winters of 2015/2016 and 2016/2017].

The year 2016 and especially 2015 was warmer than normal which resulted in lower electricity consumption than it had been at normal temperatures. A strong power balance resulted in both substantial net exports of electricity in both years and lower electricity prices.

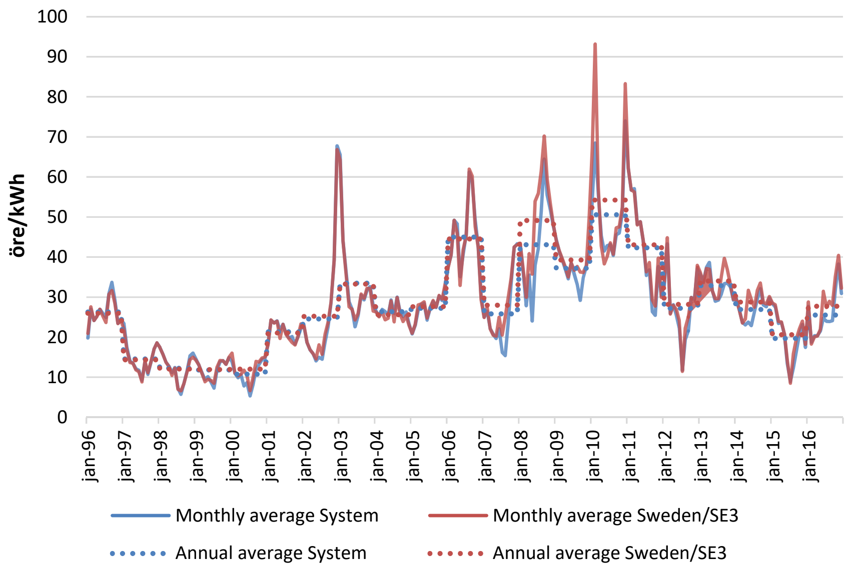

Figure 21 Average electricity price, yearly and monthly for the system Nordpool and for Sweden's electricity area 3 (SE3), 1996-2016, öre/kWh.

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.

Electricity is traded per hour. Price variations are greater between hours than between years. By 2016, the highest and lowest monthly system prices were 38 and 19 öre/kWh, and for the spot price in area SE3 the difference was between 40 and 18 öre/kWh.[79]

The electricity price can differ from one electricity area to the next depending on the restrictions between these areas. Since 1 November 2011, Sweden has been divided into four electricity areas because of the European Commission demanding that Sweden change its previous method of managing transmission limitations within the Swedish electricity network. The aim of the partitioning into electricity areas is to make it clear where in Sweden there is a need to reinforce and expand the national grid. It also provides a clear indication of where in the country there is a need to increase electricity production to better match the level of consumption in that specific area.

[79] For more detailed price information see Nord Pool Spots website, http://nordpoolspot.com/.

The differences in the annual average price between electricity areas in Sweden have been relatively small. In 2016, the price differential between SE1 (generally the lowest electricity prices together with SE2) and SE4 was 0.5 öre/kWh, which was a decrease from the year before when the difference was 1.6 öre/kWh.

The electricity prices described here are not the electricity prices that the consumer pays[80], 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.

In 2015, the companies trading on Nord Pool Spot turned over 489 TWh of electricity, of which 374 TWh in the Nordic and Baltic countries.[81] Electricity can also be traded directly between a seller and a buyer or internally within the electricity company.

An electricity market in change

There are major changes in the electricity markets in Europe and in the world, but things are changing at different rates. The electrical system has historically been built up of large-scale centralized power generation with a flow of electricity from electricity producer to consumer allowing electricity generation to be managed and planned. To reduce climate impact and to get an ecologically more sustainable electricity system, the proportion of renewable electricity in the system is increased. With the increased installation of both large and small wind and solar power, decentralized and variable production in the electricity system increases. This places new demands on flexibility and balance of the electricity grid, since there must always be a balance between production and use of electricity in the electricity system.

In Sweden, low electricity prices have contributed to the planned decommissioning of four reactors by 2020, making the challenges facing the electricity system even bigger and more pressing. Hydropower is excellent for regulating variations, thus maintaining the balance of the electricity grid, but not able to cope with all challenges. To maintain sufficient power in the system, plannable CHP is important.

Electricity networks also need to be developed as consumers can now also be producers and electricity flows in both directions. Within the Nordic countries, system administrators collaborate on a common view of the challenges in the new electrical system that will emerge and what can and must be done to also have sufficient stability in the electricity system in the future. [82]

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[80] End-customer prices also include costs for power grids, profit, taxes and VAT depending on customer category.

[81] Nord Pool Spot, Annual report 2015, Power without borders.

[82] A first report has been published in August 2016 by Svenska Kraftnät, Statnett, Fingrid och Energinet.dk under the name *Challenges and opportunities for the Nordic power system*. A second report is planned but it the date of publish is not set.

The electricity certificate system supports renewable electricity production

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 sales or electricity use. The size of the share is determined by a percentage (quota) for each year. The quotas are calculated based on the expected expansion of renewable electricity, the expected electricity sales and the electricity consumption with quota obligations.

The price of electricity certificates has varied since the system was introduced in Sweden in 2003, reaching its highest point, a little over SEK 350, in 2008. Since 2014 the average monthly price has not been over SEK 200 per certificate. In January 2016, the average price was SEK 161 per certificate and in December it had declined to SEK 122 per certificate. [83] One reason for the relatively low price in recent years is that the expansion of renewable electricity has been fast and 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 were determined.

Since 1 January 2012, Sweden and Norway have had a common[84] electricity certificate market to increase renewable electricity productions between 2012 and 2020. 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 changed in 2016 when it was raised by 2 TWh, from 26.4 TWh to the current target of 28.4 TWh. The target increase is only financed by Sweden, which will thus finance 15.2 TWh and Norway 13.2 TWh.

In 2016, electricity production from renewable energy sources and peat within the common electricity certificate system amounted to 26 TWh of which 21 TWh was produced in Sweden. Figure 22 shows how the production of renewable electricity in Sweden has increased from 2003 up to and including 2016 and how production is distributed between different sources of energy. Up and until 2012 the most electricity in the system was produced by bio fuels 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.

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[83] In the beginning of 2017 the price has continued to decline and in February the average price is SEK 61 per certificate.

[84] Read more about the common electricity certificate system in the annual report from the Swedish Energy Agency and Norwegian Water Resources and Energy Directorate (NVE), ET2016:12, The Norwegian-Swedish Electricity Certificate Market-Annual report 2015.

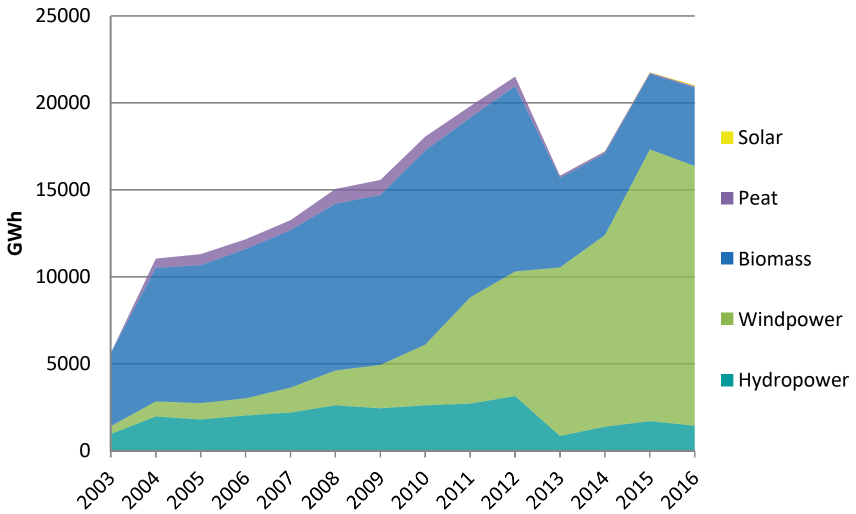

Figure 22 Electricity production in Sweden per type of power in the electricity certificate system 2003–2016, GWh.

Source: Swedish Energy Agency.

New policy measures and investigations in the electricity market

Proposals made by Energikommissionen[85] and related to electricity generation include a target of 100 per cent renewable electricity generation by 2040, 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.

Since 1 August 2015, the tax on the thermal output of nuclear power is 14 770 SEK/MW of the maximum thermal output per month.[86] The tax will be phased out in two steps. The tax was reduced to 1 500 SEK/MW on 1 July 2017 and will be removed 1 January 2018.

Since 1 January 2015, a party producing renewable electricity can receive a tax reduction of 60 öre/kWh. The tax reduction applies to micro-producers and may not exceed SEK 18 000 per year.

In autumn 2016, The Swedish Energy Agency presented a strategy[87] to increase the use of solar power. The strategy proposes measures that will make it easier to introduce both small and medium-sized plants in the electricity market.

85 Energikommissionen (The Energy Commission) was appointed in March 2015 to provide a basis for a broad political agreement on the direction of energy policy in Sweden, focusing on 2025 and beyond. Read more about the Energikommisionen and what agreements that were made in chapter Energy Policy.

86 Amendments to the Energy Tax Act (1994:1776).

87 http://www.energimyndigheten.se/fornybart/solenergi/solenisamhallet/forslag-till-solelstrategi/ (hämtad 2017-05-03)

In autumn 2016, the European Commission proposed a package of measures, *Clean Energy for all Europeans*[88]. The parts of the package relating to the electricity market contain regulations aiming at increasing the customer's power in the electricity market. This makes it easier to produce and sell the customer's own electricity, but also that the customer can offer market demand by responding to electricity prices or through aggregators. Furthermore, provisions are proposed to strengthen regional cooperation so that the risk of power shortages, network capacity calculations, operational analyzes, reservoir capacity dimensioning is to be assessed in the same way, etc.

From 1 May 2015, a regulation[89] applies where network companies can apply for network-reinforcement loans at Svenska kraftnät. The loan concludes that the first affiliated party only needs to pay its share of the network reinforcement needed and that the cost is then allocated to other players who join later. At any given time, Svenska kraftnät may have a maximum of SEK 700 million lent to network companies. In 2016, four grid reinforcement loans were granted totaling SEK 449 million. Current design is a temporary solution and the Energy Market Inspectorate has developed a proposal for a permanent solution but it has not yet been decided.

Measures to increase the security of the electricity supply

Electricity customers may experience mainly 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[90] is not expected to equal the total demand for electricity. If the electricity market can´t handle the shortage or if the functioning of the market leads to unacceptable societal consequences, measures that sideline the electricity market's function are used; for example, rationing that is only implemented following a political decision. The Swedish Energy Agency has prepared a proposal for a rationing model that encompasses all the country's industrial enterprises.[91]

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[88] European Commission. Commission proposes new rules for consumer centered clean energy transition. 2016. https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

[89] Regulation (2015: 213) on loans to network companies to facilitate the connection of renewable electricity generation.

[90] Electrical energy refers to the raw material used to produce electricity, such as water in reservoirs, oil, nuclear fuel or gas.

[91] Swedish Energy Agency, ER 2014:08, Förslag till hanteringsmodell för storskalig ransonering [Proposal for management model for large-scale rationing].

Electrical power shortages arise when the demand for electricity is greater than the availability. An extensive shortage of electrical power has never occurred in Sweden. However, the risk of an electrical power shortage was increased in conjunction with an elevated power output in the winter of 2009. As part of its system responsibility, Svenska kraftnät has the task of preventing and managing electrical power shortages. To avoid such shortages, Svenska kraftnät has a number of technical and commercial mechanisms available, such as a disturbance reserve and power reserve. If an electrical power shortage would arise, despite the disturbance and power reserves, electricity consumption must be reduced by disconnecting users. It is Svenska kraftnät that orders the electricity network companies to disconnect users. To ease the consequences for society, a method for planning the prioritization of socially vital electricity users has been developed called *Styrel*.[92]

[92] Swedish Energy Agency, ET 2013:28, Styrel – Handbok för styrels planeringsomgång 2014–2015 [Styrel – Manual for Styrel's planning round 2014 – 2015].

The district heating market

District heating has been available in Sweden since the 1950s and was previously produced mainly in thermal power plants. In 2015, district heating was responsible for 58 per cent of the total energy use in dwelling and non-residential premises. Half of the district heating was used in multi-dwelling buildings, while non-residential premises accounted for 37 per cent and one- and two-dwelling buildings accounted for 13 per cent. The proportion of district heating produced by cogeneration has increased steadily and currently represents around 40 per cent compared with 30 per cent in 2003.

Continued efficiency in district heating use

Thanks to improved technology, a more efficient use of the district heating networks and an increased proportion of ready heat[93], the distribution and conversion losses in the district heating systems have decreased over the years. During the period 1990–1999, the losses amounted to an average of 17 per cent, before decreasing to an average of 10 per cent between 2000 and 2009. In 2015, losses constituted 12 per cent of the total use of district heating. Figure 23 shows the use of district heating between 1971 and 2015. The significant increase in 2010 is mainly a result of a cold winter.

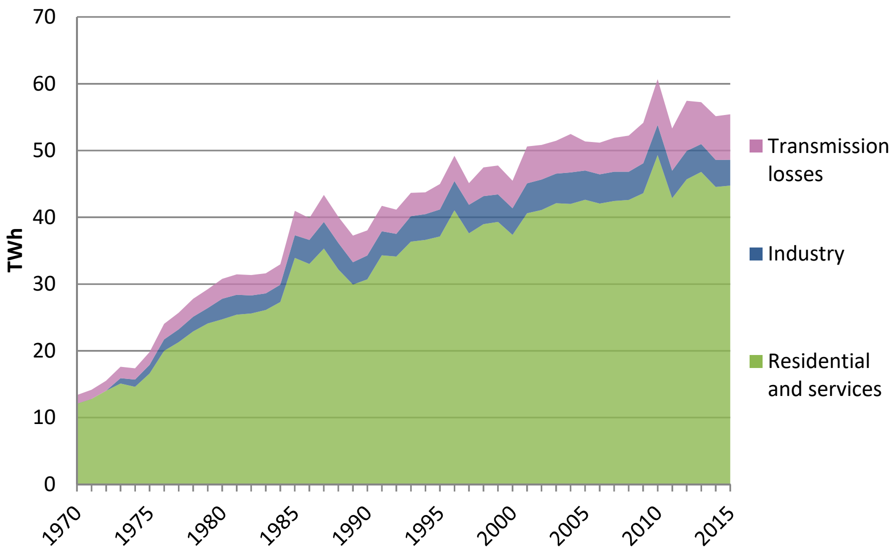

Figure 23 District heating consumption 1971–2015, TWh.

Source: Swedish Energy Agency and Statistics Sweden.

[93] Locally produced heat outside the district heating network.

District heating can utilize several different fuels

Several different fuels can be used for district heating production, and a major transition towards renewable fuels has taken place since the 1970s. Figure 24 shows the input energy used in district heating production in the period from 1970 to 2015.

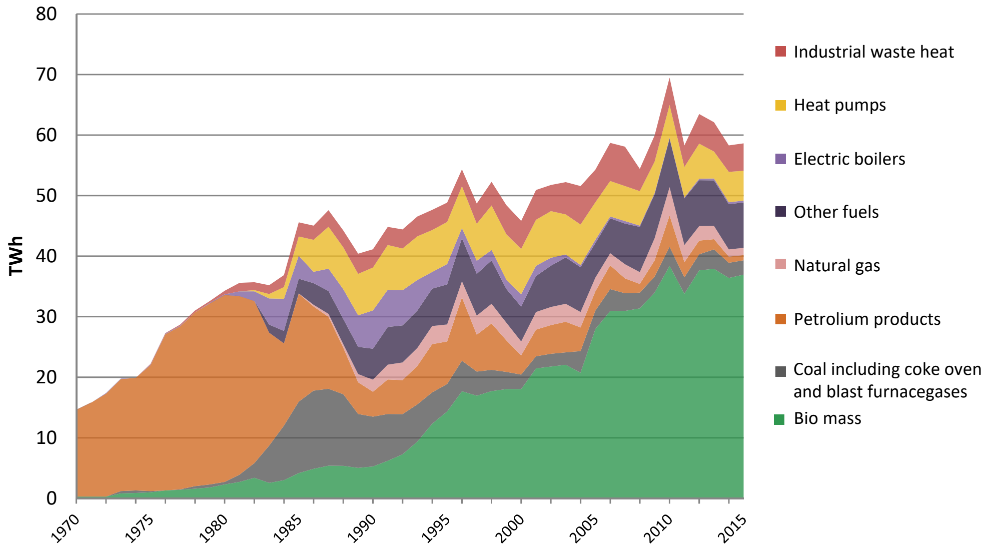

Figure 24 Input energy used in the production of district heating 1971–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

In 2015, biomass accounted for 63 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 and the use of electric boilers has almost completely disappeared since the early 2000s. The use of waste has increased in the past decade. The heat from incinerating waste is used as the basis for district heating in several Swedish cities. The increase is due to the ban on dumping combustible waste, in effect since 2002, and the ban against dumping organic waste, in effect since 2005. 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 99/m^2 for an apartment building (at 193 MWh), while Munkedal Municipality had Sweden's highest price at SEK 196/m^2.[94]

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. The customer's options in the heating market thus depend, to a large extent, on where they live.

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94 Fastigheten Nils Holgerssons underbara resa genom Sverige – *en avgiftsstudie för 2016.*

The overall turnover of the district heating sector was SEK 31 billion in 2014 and yielded an annual average of SEK 30,2 billion between 2009 and 2014. The average annual price increases from 2009 to 2014 have been 3 to 4 per cent.[95]

Secure supply of district heating with few disruptions

Today, district heating experiences few disruptions with limited consequences and is considered relatively secure for residences and other premises. However, with a large percentage of users of district heating, the individual user's flexibility decreases with regard to heat supply, which increases societal vulnerability. The increased use of biomass with limited opportunities for storage at the production facilities also has an impact on the level of risk.

In the autumn of 2015 the Swedish Energy Agency conducted a study on the security of supply on the district heating sector that concluded that some kind of regulation would be necessary to improve conditions. Today there is no regulation of any kind in place.

District cooling is decreasing somewhat

District cooling is used mainly in offices and business premises and for cooling industrial 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 customers.

The most common method of production is to utilise 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, what is 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 somewhat, from 1013 GWh in 2014 to 899 GWh in 2015, see Figure 25. In 2015, a total of 34 companies supplied district cooling. In 2015, the district cooling network was expanded to 544 km.

[95] Swedish Energy Markets Inspectorate, Ei R2015:04, Utvärdering av branschinitiativet prisdialogen [Evaluation of the industry initiative the Price Dialogue].

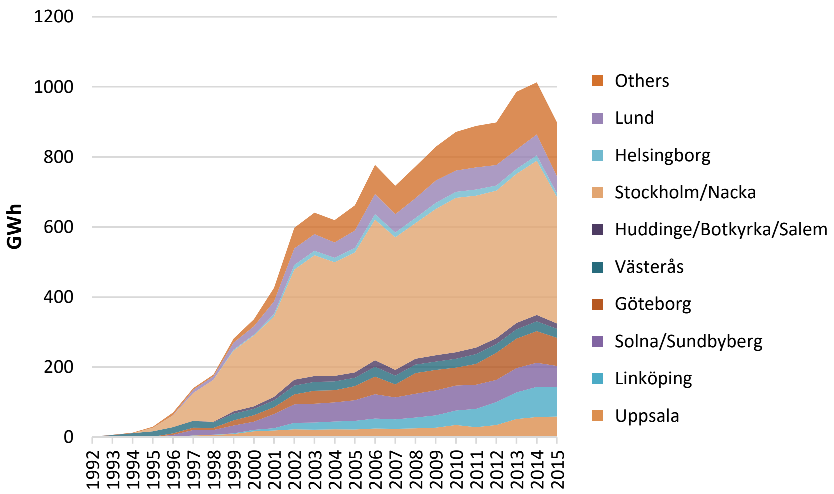

Figure 25 District cooling supply 1992–2015, GWh.
Source: Swedish District Heating Association, adapted by the Swedish Energy Agency.

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 is an agreement between the parties on the district heating market to improve the dialogue. In 2016, 60 per cent of the district heating market was included in the initiative. The Swedish Energy Markets Inspectorate's evaluation in 2016 concluded that the dialogue has led to increased confidence and a more coherent pricing system, but that it is still too early to say whether the initiative has a moderating effect on the district heating prices.[96]

[96] Swedish Energy Markets Inspectorate, Energimarknadsinspektionen, Ei R2016:05, Utvärdering av branschinitiativet Prisdialogen.

The biomass market

The use of biomass has grown steadily in recent decades for both electricity and heat production, as well as within the transport sector. 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 and biogas. The markets for bioethanol, biodiesel and biogas are described separately.

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 2015, the use of biomass has increased to 134 TWh, which is equivalent to 26 per cent of the total supply. In recent years, the use of biomass in the transport sector has increased rapidly and accounted for 13 TWh in 2015.

Figure 26 shows the use of biomass in the industrial sector, the residential and service sector, the transport sector and electricity and district heating production.

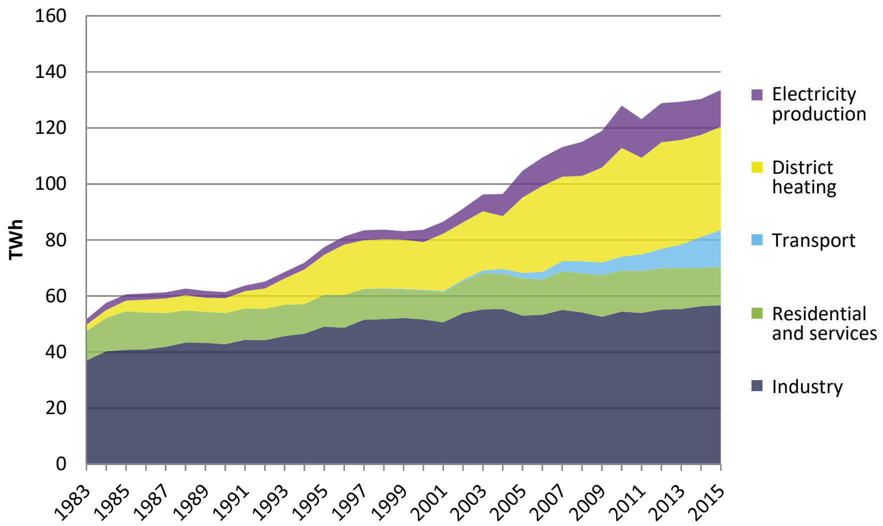

Figure 26 Use of biomass per sector 1983–2015, TWh.

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 previously 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.

Figure 27 shows the use of biomass by fuel type in 2015. The two largest segments consist of unprocessed wood fuel and black liquor[97], followed by municipal waste-bio and biodiesel. The term "other biofuels" encompasses other solid biofuels, bioethanol, vegetable and animal oils, other liquid biofuels and biogas.

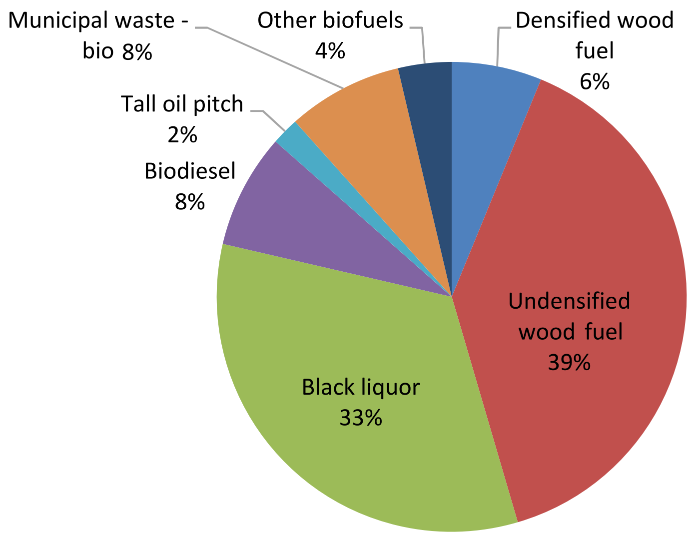

Figure 27 Use of biomass per fuel category 2015.
Source: Swedish Energy Agency and Statistics Sweden.

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 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.[98] 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 1.22 TWh in 2015.

Development for wood fuel prices

The increased use of biomass for electricity and heat production has led to an increased demand for wood fuels in particular. Throughout the 1980s and 90s, the prices of wood fuels for thermal power plants remained more or less unchanged. Good availability of cheap and easily accessible biomass is the result of a long period involving a surplus of waste production from the forestry industry.

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

[98] Bill (2003/04:40) Peat in the electricity certificate system.

The increased demand for wood fuels led to increased competition, which caused prices to rise during the 2000s. Greater extraction of fuel from forests is the main reason why the increased use has been possible.

Figure 28 shows the annual average values of current rates for wood fuels and peat, i.e. their nominal prices. The figure indicates that the decrease in prices that began following the coldest winter thus far, in 2009/2010, has continued for both wood chips and by-products. Prices for densified wood fuels and recycled wood has moved slightly upwards in 2015. During the last decade, the use of waste as fuel in electricity production and heat production has continuously increased. The increased use of waste is one of the factors that has affected prices for wood fuels negatively during recent years. Read more about the expected development for the biomass market in Kortsiktsprognos.[99]

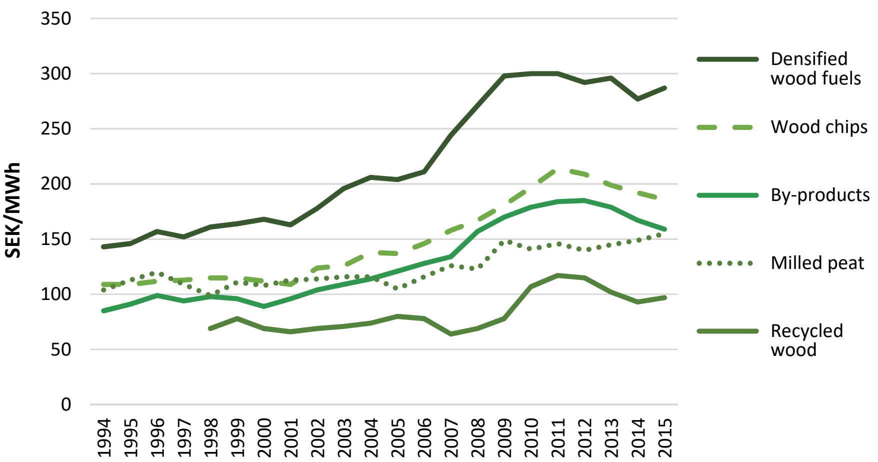

Figure 28 Wood fuel and peat prices for heating plants 1994 – 2015, current prices, SEK/MWh.

Source: Swedish Energy Agency and Statistics Sweden.

Most of the wood fuels used domestically is produced in Sweden. However, 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 forest and short rotation coppice fuel and had a net import of pellets of 0,5 TWh in 2015. In addition, there is also indirect imports, e.g. when forestry companies import round timber for industrial processes. The timber generates by-products and waste products such as bark and sawdust which can be used as fuel or as raw materials in the production of pellets, briquettes and dust. Because of this, indirect imports may also be included in the item "domestically produced fuel" in Sweden's energy balance.

[99] Swedish Energy Agency, Kortsiktsprognos [Short-term forecast] – Energianvändning och energitillförsel 2016-2018, autumn and spring 2017.

Biofuel used in the transport sector

The biofuels market is relatively young. In Sweden, the use of biofuels only began in 2005, but since then both production and use have increased sharply. In total, biofuels accounted for 15 per cent of final energy use in domestic transport 2015, as previously described in the section on transport. According to the Renewable Energy Directive[100] calculation method, the share of renewable same year amounted to 23.7 per cent. The difference in percentage is due to the fact that biofuels produced by certain biomass are double counted under the Renewable Energy Directive. Today, Sweden, together with Finland, are the European countries that use the most biofuels.

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. Low-admixture ethanol can also be designated E5, while high-admixture ethanol includes E85 and ED95. There are two different types of biodiesel in the Swedish market; HVO (hydrotreated vegetable oils) and FAME (fatty acid methyl esters). For further definitions of biofuel, see Table 1 in the section on the transport sector.

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, various types of offal. In Sweden, rapeseed oil is most commonly used in the production of FAME. In 2015, the feedstocks for HVO were mainly slaughterhouse waste, crude tall oil and palm oil.

FAME

The use of low-admixture FAME has increased since 2005, to be somewhat stabilized in recent years. This is partly because the use of fossil diesel has stabilized although still increasing slowly, and partly because low-admixture HVO has taken some of the market share. 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-admixture FAME, known as B100, has increased during the period 2005 to 2013, accounting for a growing part of the total FAME use. 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.[101]

HVO

HVO appeared on the Swedish market in 2011. Its use has since increased rapidly and was in 2013 the most widely used transport biofuel in Sweden. Low-admixture HVO blends accounted for 36 per cent of the total volume of renewable transport fuels in 2013. Unlike FAME, HVO is chemically identical to fossil diesel, allowing a considerably higher percentage to be mixed with the fossil diesel, and it can be used in standard diesel engines without any adjustments.

[100] Renewable Energy Directive (2009/28/EG).

[101] SPBI, Fact Database, http://spbi.se/blog/faktadatabas/artiklar/fame/ (retrieved on 06/04/2017).

In 2015 pure HVO was introduced for the passenger vehicle market and is now availble at a number of fuel companies. In September 2016, Peugeot and Citroën introdued an approval for the refueling of pure HVO in some of their passenger and transport vehicles.

Ethanol

Ethanol is produced through the fermentation of sugar and other carbohydrate-rich feedstocks such as sugar cane, maize, cereals and sugar beet. It is also possible to produce ethanol from cellulosic feedstocks such as straw and firewood, provided the cellulose is broken down into lighter fermentable constituents first. A low admixture of 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-level blend through the transport fuels E85 and ED95. In 2015, the feedstocks for ethanol consisted per cent of wheat, maize, rye and sugar cane.

The amount of ethanol used for low-blending in petrol depends on the total petrol usage, which has gradually decreased since 2005. The decrease is due to effective engines in new cars and the fact that diesel cars have increased their market share. In recent years, the use of high-purified ethanol has also begun to decline.

New car sales of ethanol cars have dropped sharply since the peak of 59,024 private cars in 2008. In 2016 856 ethanol cars were sold.[102] Statistics from 2015 indicate that this is a decrease with almost 40 per cent.

Price development for transport biofuels

The price of ethanol rose in the EU in 2015 due to a reduced supply in the market. Profitability and operational disturbances in production at major EU-based manufacturers contributed to a decrease in production. The price increase lasted until November 2016 and made ethanol more expensive in relation to petrol. That in turn led to European fuel companies choosing to mix less ethanol.

FAME and HVO are two different types of biodiesel but the European spot price for biodiesel includes both varieties. However, the majority of the volume sold is FAME biodiesel spot price since it is the most common form of biodiesel in Europe. HVO is traded on contract or through the spot price for biodiesel.

The price of biodiesel was generally higher at the second half of 2015, largely due to low water levels in the rivers Rhine and Danube. Low water levels limit the availability of imports to the major merchant ports. When the cargo ships could not enter the ports, the supply decreased in the European market and prices rose. When water levels returned to normal the prices fell again.

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.

[102] Transport Analysis, Vehicle Statistics http://trafa.se/vagtrafik/fordon/ (retrieved 2017-04-06).

Taxes for biofuels

All biofuels are covered by a sustainability decision and a plant decision [103], according to that the Act on Energy Tax [104] are totally exempted from carbon tax and allow different degrees of energy tax reduction. This is done by deduction in the excise tax declaration. It should be mentioned that parts of the professional fuel consumption have reduced energy and carbon tax also for fossil fuels. This applies primarily to use in ships, aircraft, trains and work machines. The tax rate has been adjusted several times in recent years. For current information, refer to the Swedish Tax Agency's website [105].

New directive for reporting renewable energy within the EU

April 28th, 2015 The European Parliament voted on the ILUC Directive (2015/1513/EU)[106]. The amendments mainly concern how the Member States should report the amount of renewables to the Commission. The Directive should be implemented in the national legislation of the Member States by September 10th, 2017. The Swedish Government has proposed that the amendments come into force as soon as possible, which is expected to be earliest January 1st, 2018.

The directive involves amendments to the Fuel Quality Directive and the Renewable Directive.

The government has written a memorandum called Implementation of amendments to Renewable Energy Directive and Fuel Quality Directive - ILUC. The memorandum, which is not yet decided, contains including new definitions of waste and residues and some changes around the requirement to reduce greenhouse gas emissions from biofuels.

Biogas

Increased use and production of biogas

The total production of biogas in 2015 amounted to 1 947 GWh, an increase of 9 per cent since 2014. Most of the biogas is produced in anaerobic digestion facilities and sewage treatment works, as shown in Figure 29. In 2015 production of biogas in gasification facilities came in to operation and constituted around 2 per cent of the total biogas production.

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[103] The directives have been transposed to Swedish legislation through Act (2010:598) concerning sustainability criteria for biofuels and bioliquids; and the Fuel Quality Act (2011:319).

[104] Energy tax act (1994:1776).

[105] Government Offices. http://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/energiskatterpabranslen/skattebefrielseforbiodrivmedel.4.2b543913a42158acf800021393.html

[106] European Parliament and Council, 2015a.

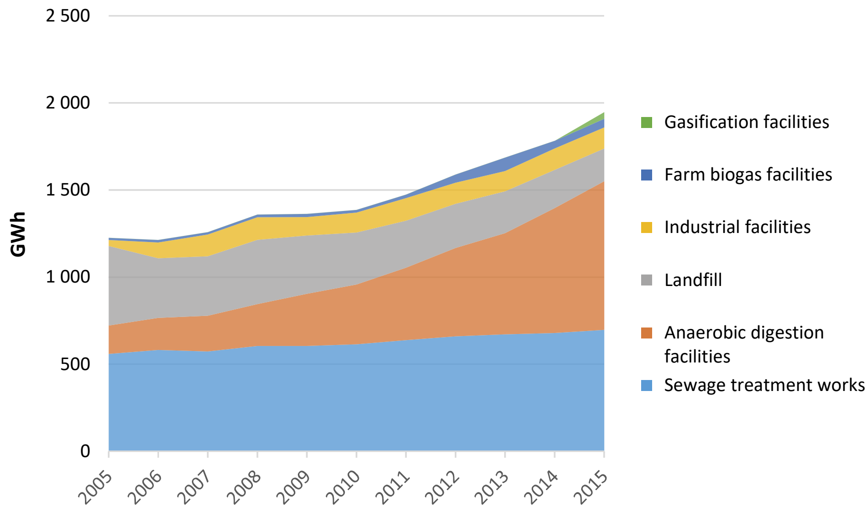

Figure 29 Production of biogas, by category of facility 2005–2015, GWh.
Source: Swedish Energy Agency.

The percentage of biogas that is upgraded has gradually increased, while the percentage that goes to heat production has decreased [107]. Nearly two thirds, 1 219 GWh, of the produced biogas was upgraded to vehicle fuel 2015. Upgrading means gas purified from corrosive substances, particles and water, and that the energy value is increased by carbon dioxide being removed. Approximately 20 percent of the biogas went on to heat production including heat losses, three percent went to electricity production and two percent were used in industry. The remaining quantities were trickled, that is, burned and released.

Biogas used as transport fuel is known as CNG. CNG sold in Sweden always contains at least 50 per cent biogas with the remainder being natural gas. This is a joint commitment from the vehicle gas industry, which refers to average annual sales of vehicle gas. Vehicle gas can consist of as much as 100 percent biogas. Biogas used as transport fuel is upgraded to increase the methane content to the corresponding methane content of natural gas. CNG was introduced to the Swedish market in the early 1990s and initially consisted mainly of natural gas. As biogas production was expanded in Sweden in the mid-1990s, the opportunity arose to upgrade and utilise it as fuel within the transport sector.

Since first making a mark in the transport fuel statistics in 1996, the proportion of biogas has gradually increased. In 2008 the proportion of biogas exceeded that of natural gas in terms of energy content and has since constituted the dominant share in CNG. Since 2015, the average mix has hovered around 74 per cent biogas and 26 per cent natural gas. At the end of 2015, there were 161 public filling stations around the country and 60 non-public, such as for example bus depots.[108]

[107] Swedish Energy Agency, Produktion och användning av biogas och rötrester år 2015 [Production and use of biogas and degistate in 2015], ES 2016:04.

[108] Swedish Gas Association, Gasbilen, Number of filling stations in Sweden in 2013, http://www.gasbilen.se/Att-tanka-pa-miljon/Fordonsgas-i-siffror/TankstallenUtveckling, (retrieved on 06/04/2017).

The price of biogas

As with certain liquid biofuels, CNG is priced based on fossil transport fuels; on average 10 to 20 per cent below the price of petrol. The price may vary between different fuel stations, depending on how close aproduction and upgrading plant is located and which distribution possibilities exists. The price of CNG may vary between different filling stations, depending on how close to a production and upgrading plant the filling station is located and the distribution possibilities available.[109] The gas price will also include a network fee which together constitutes the total gas price in Sweden.

For biogas produced in municipally-owned facilities, slightly different conditions prevail compared to another biogas produced. In part, it is the competitive landscape that differs, but also economic conditions. There is no clear picture of what the differences mean in pure costs. However, it is important to keep in mind, as a large portion of the biogas is produced in municipal property. Other reports on biogas production costs also point to the difficulties of specifying general costs, since many plants and actors have completely different conditions for their activities, and thus profitability is often achieved through a combination of several production facilities, distribution centres and end-users.[110]

Investment aid within the Rural Development Programme

Farmers and other rural entrepreneurs who want to invest in the production or processing of biogas can since autumn 2015 apply for aid in autumn 2015 within the Rural Development Programme.[111] The payment can amount to 40 per cent in investment aid, and in northern Sweden the aid may be as much as 40 per cent in certain cases. The investment aid is part of the Rural Development Programme 2014–2020. There are SEK 279.3 million allocated for biogas investments during the program period 2014–2020. So far, it has been granted SEK 3.9 million in support.[112]

Support for biogas production from manure

In 2014 the Swedish government decided to introduce special support for gas from manure,a methane reduction compensation. On February 1st, 2015, Regulation came into force (2014:1528) on state aid for biogas production. The aim was to compensate biogas production from manure due to its climate and environmental benefits, such as decreased methane emissions from manure and a reduced need for fossil fuels.

The support is designed as a project that runs from 2014 to 2023.

[109] Swedish Gas Association, Gasbilen, Gasbilen, Varför varierar fordonsgaspriset mer än andra drivmedel? [Why does the price of CNG vary more than other transport fuel?] http://www.gasbilen.se/Att-tanka-din-gasbil/FAQFordonsgas/FAQGaspriser, (retrieved on 23/06/2015).

[110] SGC, Rapport 2014:296, Kostnadsbild för produktion och distribution av fordonsgas [Cost structure for production and distribution of CNG].

[111] Swedish Board of Agriculture, What is the Rural Development Programme?, http://www.jordbruksverket.se/amnesomraden/landsbygdfiske/programochvisioner/landsbygdsprogrammet20142020.4.7c4ce2e813deda4d30780004608.html (hämtad 2017-09-04).

[112] Swedish Board of Agriculture, personal message, Pasi Kemi, (01-11-2016).

Table 1. Glossary for biofuels.

Transport biofuels	
Ethanol	Included as ad-mixture in petrol up to 5 volumes per cent. Also, ad-mixtured into E85 and ED95.
Biodiesel	Collective name for biodiesel that can replace diesel. Today made up of FAME and HVO. Biodiesel can be used in pure form in buses and trucks, or ad-mixtured into regular diesel.
CNG	Collective name for methane gases: biogas, natural gas and mixtures thereof.
Liquid biofuels	Biological oils: Rapeseed oil, palm oil, tall oil, waste oils, MFA, LBG
Other gaseous transport biofuels	DME
Fuel explanation	
B100	Pure biodiesel containing of FAME
HVO100	Pure biodiesel containing of HVO
DME	Dimethyl ether, made from synthetic gas
FAME	Fatty acid methyl esters, in Sweden basically all FAME consists of RME
RME	Rapeseed methyl ester, a type of FAME produced from rapeseed oil
HVO	Hydrotreated vegetable oils, produced from different types of oil crops such as tall oil or tallow.
E85	85 per cent ethanol and 15 per cent petrol (summertime) or 75 per cent ethanol and 25 per cent petrol (wintertime)
ED95	95 per cent ethanol plus ignition improver and an anti-corrosion agent
ETBE	Ethyl tertiary butyl ether
MFA	Mixed fatty acids
LBG	Liquefied Biogas

Fossil fuel markets

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 accounts for over 30 per cent of the world's total energy supply. Crude oil is the world's most traded commodity. 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. Despite many uncertainties, the market and the price have remained relatively stable, until the summer of 2014 when a sharp decline in price began.

The use of oil products in Sweden has halved

Vehicle fuel currently represents the clear primary final use of oil products in Sweden. Since the 70s, 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 30. It is primarily the use of fuel oils that has decreased, particularly in the detached house market[113].

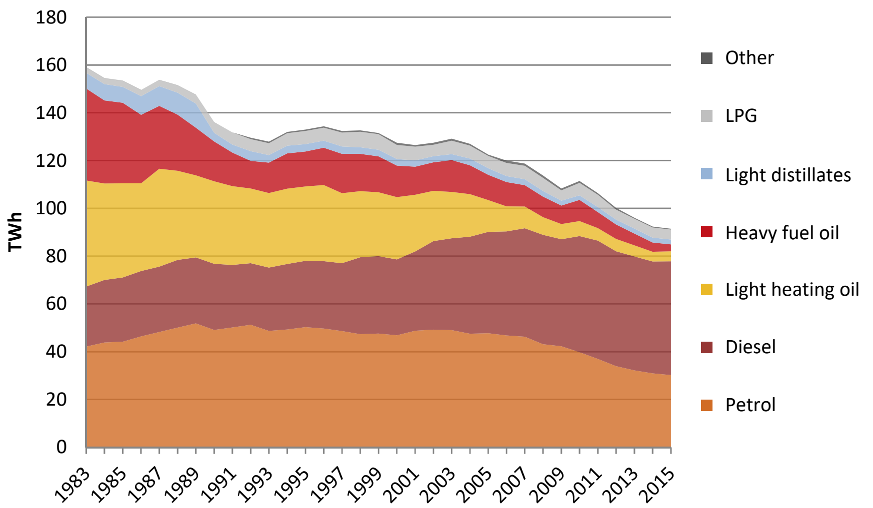

Figure 30 Final use of petroleum products, by product 1983–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

[113] 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 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 on the Swedish east coast. It may therefore be profitable to import refined products from other countries, primarily from the Baltic region.

Since Sweden does not produce any crude oil of its own, it depends on imports. Sweden imported 20 million tonnes of crude oil in 2015. Figure 31shows imports of crude oil broken down by source country of origin.

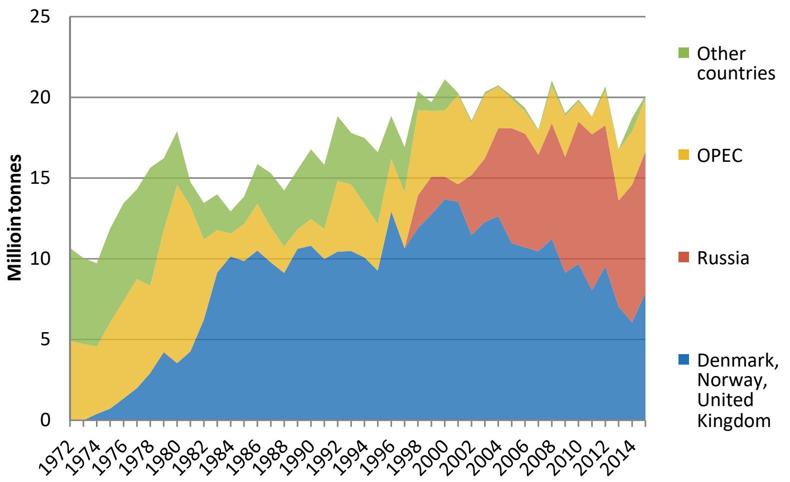

Figure 31 Swedish import of crude oil, by country of origin 1972–2015, million tonnes.

Source: Swedish Energy Agency and Statistics Sweden.

The crude oil that Sweden imports mainly comes from the North Sea and Russia, which is a natural consequence of the geographical position between these two-major oil-producing regions. Russia's crude oil exports across the Baltic Sea have increased over the past decade, while crude oil production from the North Sea has declined.

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. The technique involves creating fractures in rock by injecting large quantities of water mixed with chemicals. The purpose is to release the oil, and also gas, that is located deep underground. The fastest development of shale oil extraction has taken place in the USA, which has led to an increased supply on the global market. Production of shale oil increased from 2.5 per cent of total crude oil production in the USA in 2003 to around 52 per cent in 2015.[114] The increased

[114] IEA, Annual Energy Outlook 2017.

production in the USA has led to the country reducing its imports of crude oil from 10 million barrels per day in 2005 to 7 million barrels per day in 2015.[115] The increased supply on the global oil market affects the pricing globally for importing countries, such as Sweden.

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 32 for prices of crude oil. The prices are presented here in annual average values.

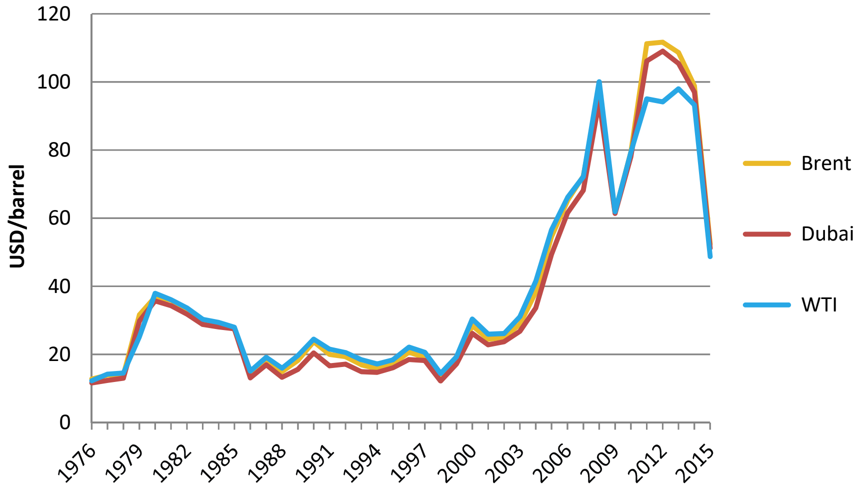

Figure 32 Crude oil prices 1976–2015, USD/barrel.
Source: BP, Statistical Review of World Energy 2016.

Historically, the three reference prices have followed one other, but the price of WTI has decreased in recent years. This is due to limitations of the infrastructure in the USA, where the large trading point in Cushing, Oklahoma, has constituted a bottleneck.

The falling oil prices in 2014 still affects the market

After a longer period with high and stable crude oil prices, a substantial fall in price began in June 2014 and continued throughout the autumn and winter. There are several explanations for why the price of oil fell. One of the influential factors was the downward revisions of expectations for the global demand for oil. Before the price drop occurred, the oil market was characterized by a period of both economic uncertainty and geopolitical risks, especially in the Middle East and North Africa. At the same time, the production growth of shale oil in North America was unexpectedly high.

[115] BP, Statistical Review of World Energy 2016.

When the market's focus shifted from geopolitical risk factors to the actual oversupply in the global crude oil market, the price stability that had long prevailed crumbled in June 2014. The global oil market since then has been characterized by oversupply and substantially lower prices than in the years before the price drop.

During 2015 and 2016 oil production data have declared that the oversupply has remained high and that the shale oil production in the U.S has not decreased as the marked had expected. As a result of the oversupply that characterized the market, the oil producer group, OPEC, decided, at its ministerial meeting at the end of November 2016, to reduce its joint production by 1.2 million barrels per day. Some oil-producing countries that are not members of OPEC, such as Russia, also chose to reduce their production with OPEC to balance the market and reduce the global oversupply. The U.S. however is not a part of the agreement. The market reacted to OPEC's decision and the reference price for the North Sea Brent increased to about 55 dollars per barrel at the end of 2016, from price levels at 40–50 dollars per barrel earlier during the year.

In the spring of 2017 the market appears to be at a crossroad. Fundamentally, a strong, slightly sluggish demand growth, as well as OPEC's and Russia's production reductions, seem to have led to a rebalance between supply and demand. However, the slightly higher prices have begun to stimulate renewed growth for US shale oil production, which adds another layer of uncertainty in the oil supply balance. The oil producing countries, including Saudi Arabia, are still reluctant to compromise and accept any restrictions on their market shares
in addition to the agreed production cut. This may very well constitute an instability factor for OPEC relations. If the shale oil producers in the US return to the rapid growth rate achieved in 2009–2014 it will be additionally difficult for OPEC and its partner countries to cut back on the output restriction
after the first quarter of 2018, without the price again falling significantly.

Secure oil and fuel supply

In three years, the low prices have almost halved the global investment in new conventional production capacity. Given the long lead times in the industry, this trend can within only a few years lead to a production drop that may affect global supply. Even in IEA's two degrees scenario[116], major new investments will be needed to meet the world's demand for crude oil until 2050.

The uncertainty surrounding oil and fuel markets increases the oil industry's needs for structural adjustment and reorganization, as well as innovative and internationalized solutions for financing. This in turn leads to an increased need for analysis and regulatory capacity as well as a development of legislation and regulations in Sweden.

Coal

After oil, coal is the most common source of energy worldwide and accounts for nearly 30 per cent of the world's energy supply. It is also the energy source whose use has increased the most during the 2000s, where China has accounted for the vast majority

[116] The world leaders agreed on a goal to limit the temperature rise to two degrees at the UN talks on climate change in Cancun 2010.

of the increase. In 2004, coal took over the lead as the largest source of carbon dioxide emissions caused by mankind.[117] Globally, coal is used primarily as fuel for electricity production. Coal is also used in industry, especially for the manufacture of iron and steel, where coal can be used both as a source of energy and as raw material for the manufacturing process.

Coal is a term for several types of solid fossil fuels that contain high levels of the element carbon, and which has been formed by the mouldering of organic material and its subsequent transformation in the earth crust over a long period under high pressure. Depending on how long the transformation process has been in effect, the energy content varies. Lignite is a young form of coal that contains more liquid and therefore has relatively low energy content, while pit coal has been stored in the earth crust for a long time and has higher energy content and contains 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 4 per cent of the total energy supply. 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, inter alia, in heat and electricity production in the iron and steel works, as well as within the district heating and electricity sector. During iron production in blast furnaces, blast furnace gas is produced, which is also used for heat and electricity production, among other things. Figure 33 shows the use of coal by sector.

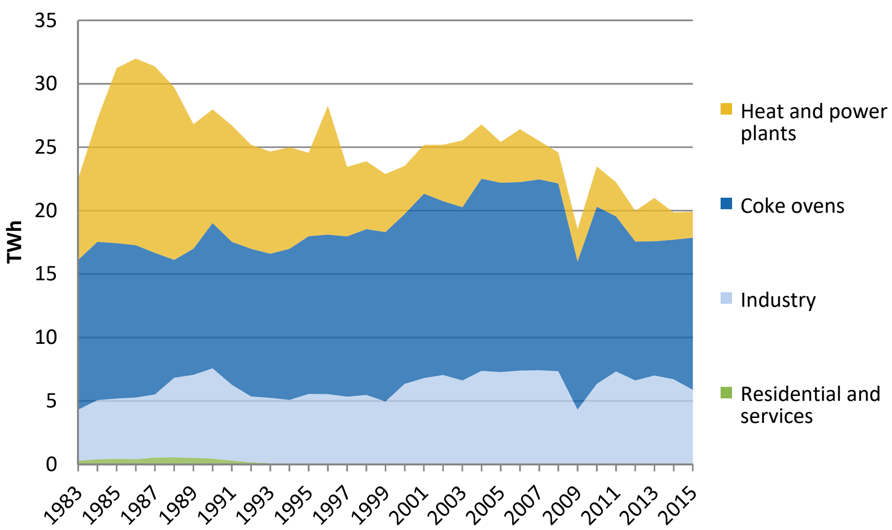

Figure 33 Use of coal by sector, 1983–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

Within 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

[117] IEA, CO2 Emissions from Fuel Combustion 2016.

for this is that the tax regulations for combined heat and power production are more beneficial than for the production of 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.

Global coal consumption has stalled recent year

After an increase in coal consumption every year during the 2000s the consumption instead decreased in 2015 and the data for 2016 is expected to show further decrease.[118] This is mainly due to the fact that coal consumption in China and the U.S. decreased, although it increased simultaneously in some countries, mainly in Southeast Asia. In China, coal consumption has been affected by the fact that the growth in electricity demand has almost stopped, while there at the same time is a policy to diversify electricity generation. In the U.S., it is also largely in electricity generation that coal consumption has fallen, both due to competition from cheap shale gas and emission requirements for power plants.

Most coal is mined in the vicinity of where it is used. However, there is also a global international trade in coal where the long-distance transport mainly occurs via shipping. In 2015, the international coal decreased for the first time in over 20 years. The total amount of thermal coal that was traded internationally in 2015 amounted to 1.003 billion tonnes, equivalent to 17 per cent of the total demand.[119] It is almost exclusively hard coal that is traded internationally because lignite's lower energy content makes it less profitable to transport. Europe's import of thermal coal mainly comes from Russia, Colombia, the USA, South Africa and Australia.

In recent years, the supply in the global coal market has been greater than the demand, and the global prices of coal have therefore decreased sharply, see Figure 34.

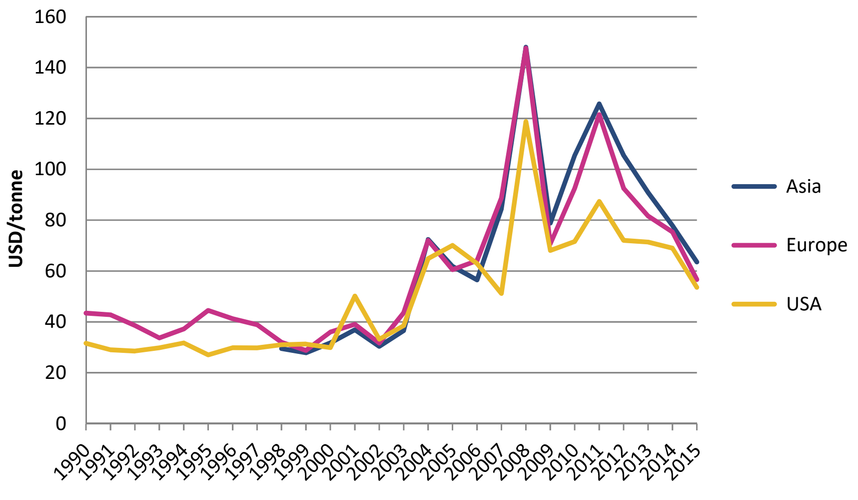

Figure 34 Coal prices in Europe, the USA and Asia 1990–2015, USD/tonne.
Source: BP, Statistical Review of World Energy 2016.

[118] IEA, Medium-Term Coal Market Report 2016.

[119] ibid.

The oversupply situation is mainly due to that a lot of new production capacity was built when energy prices were high. When the demand for coal did not increase in the same pace as the production this resulted in lower prices and when the demand growth for coal instead turned negative in 2015 prices fell substantially. However, during 2016 coal prices have risen a great deal, mainly since China's coal import has increased relatively much, since the Chinese authorities have restricted the coal production to handle the oversupply.

Natural gas

In third place after coal and oil comes natural gas, which accounts for just over 20 per cent of the primary global energy consumption. Natural gas has gained a greater role in the global energy mix in recent years, to a great extent due to the rapid development of shale gas production in the USA. Shale gas can be extracted with the same technology as for shale oil, as described in the previous section on oil.

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 2 per cent in 2015. 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 at the same time as it was a cold winter. At present, natural gas is primarily used in Sweden as a fuel for electricity and heat production as well as in industry. 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. Natural gas is further used as a raw material in industry. For natural gas use by sector, see Figure 35.

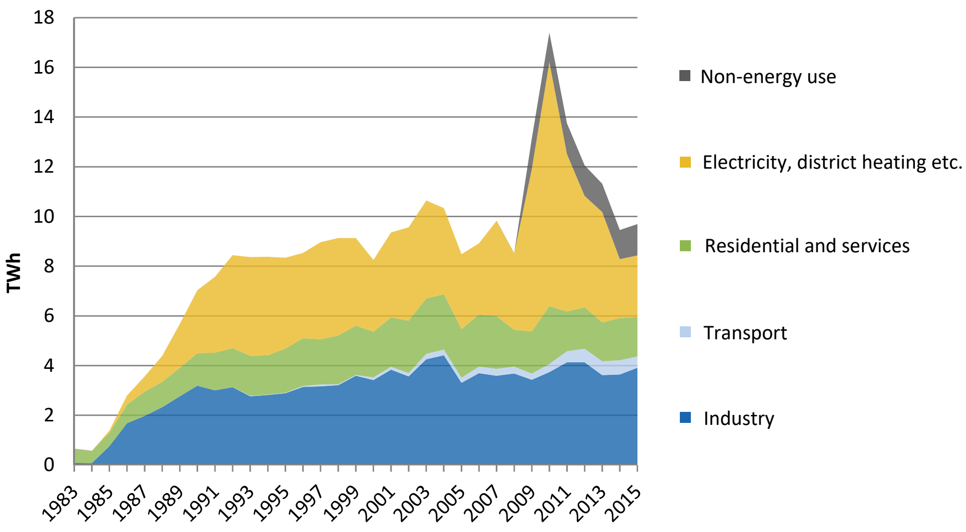

Figure 35 Use of natural gas and gasworks gas, by sector, 1983–2015, TWh.
Source: Swedish Energy Agency and Statistics Sweden.

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 25 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. Smaller quantities of liquefied natural gas, LNG, are also imported, mainly from Norway.

Regional markets for natural gas

The global trade in gas is less integrated and more regional than the trade of 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 is supplied to Europe comes through pipelines from Russia in particular. In Asia, the majority of natural gas is supplied as LNG using cargo ships. Another large difference between the different markets is the price of gas. The gas prices in Asia is substansially higher than in both the USA and in Europe, see Figure 36.

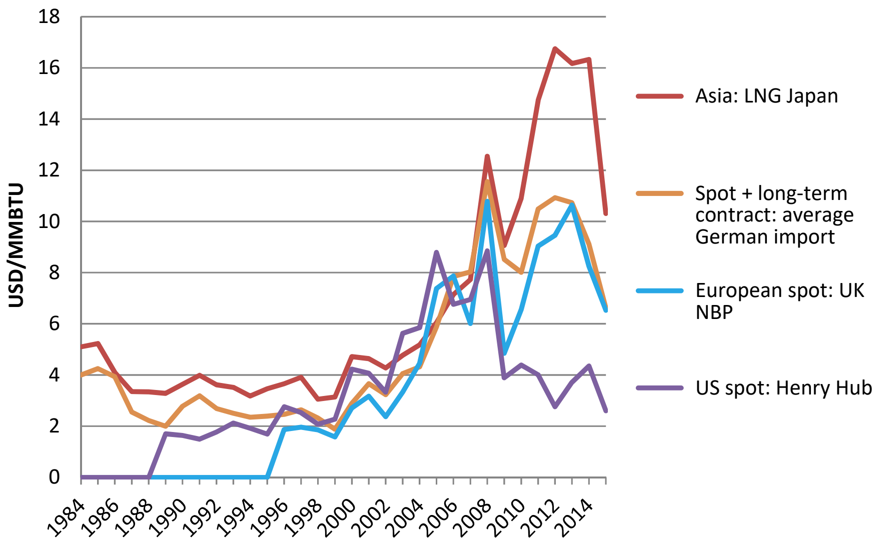

Figure 36 Average natural gas prices in Europe, the USA and Asia 1984–2015, current prices, USD/MMBTU*.

Source: BP, Statistical Review of World Energy 2016.

* Million British Thermal Units.

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. Until recently, there has not been a liquid spot market for natural gas in either Europe or Asia. After the oil price rose sharply in 2008, however, spot markets for natural gas have emerged, particularly in Europe but also in Asia.

2016 was a year with volatile prices

The year 2016 tuned out to be an interesting year for the European gas market. The market has been characterized by a variety of factors driving the market in different directions, which explains the strong price volatility. On the demand side, prices have, on the one hand, been high and hence dampened the possibilities for demand growth, while 2016 was a year in which the fuel switching to gas has been very high as a result of higher prices of crude oil, coal and carbon emission allowances. On the supply side, there have been many uncertainties and unexpected delivery disruptions, mainly from Norway, and significantly less LNG deliveries than expected by the market, while the Russian state-owned gas company Gazprom has delivered more gas than ever before and expanded its trading in the European market.

The global LNG market has grown stronger in 2016 with increased exports mainly from North America and Australia. Demand growth in Asia has been strong and the largest export has gone to the Asian market. The price of LNG has been largely influenced by price developments in the global crude oil market, but also by the increased supply of global LNG trade. An expanded global trade of LNG can make the regional natural gas markets more integrated.

Secure natural gas supply

Increased vulnerability with shutdown of the Tyra platform

In general, all supplies of natural gas to Sweden are from Denmark, which means that the Swedish natural gas system is entirely dependent on the Danish natural gas system works[120]. 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 Denmark mainland is the Tyra platform. This platform is starting to reach the end of its operational lifespan and requires extensive investments for continued operations. Production is now planned to be stopped December 1, 2019 and resumed March 1, 2022. 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. The transmission system operator Energinet.dk has, however, downgraded the available storage capacity in the Danish stocks by seven per cent[121]. Since less gas can be stored, the potential possibility for the gas storages to contribute to security of supply for both Swedish and Danish gas market. This increases the risk that the situation may be strained during certain periods while production at the Tyra platform is stopped.

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

The European Parliament, the Council of Ministers and the European Commission have negotiated on a new Security of Gas Supply Regulation, that when approved by the Council and the Parliament will replace the current one. The purpose of the new regulation is to increase security of supply within the EU by, inter alia, sets greater demands for cooperation between Member States, clearer demands on solidarity and increased requirements for transparency in contracts for gas imports. A political agreement on the new regulation was reached between the Council of Ministers and the European Parliament in April 2017.

[120] The Danish network is linked to the European gas network.

[121] The decision was based on a recent performance test of the Danish gas storage Stenlille.

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 the countries' energy needs can be met because it affects both global economic growth and national development. Imbalances in the relationship between supply and demand that occur anywhere in the world, impact the rest of the world's energy markets to a greater or lesser extent. Energy raw materials' price volatility also leads to the energy market being affected by speculations within the financial system.

Energy use continues to rise in the world

In 2014 the total energy use in the world was almost 100,000 TWh. Energy use has continued to increase but comparing the period between 2010 and 2014 with the decade before the average yearly increase has slowed down. Between 2000 and 2010 the average yearly increase was 2.1 per cent while the average yearly increase was 1.6 per cent per year between 2010 and 2014.

Total energy use has increased by almost 50 per cent from 1990 to 2014. However, the distribution between different user sectors has remained relatively unchanged during the same time span. The transport sector, often described as the fastest growing sector, has been at a rather constant level during the 2000s at around 30 per cent of the total energy use. Energy use in the residential and service sector has seen a slightly decreasing trend in recent years but remains the biggest user sector and in 2014 accounted for 37 per cent of total energy use. The industrial sector has also been relatively constant at 32 per cent of total energy use in recent years.

The economic disparities between regions of the world is clearly reflected in energy use per capita, see Figure 37.

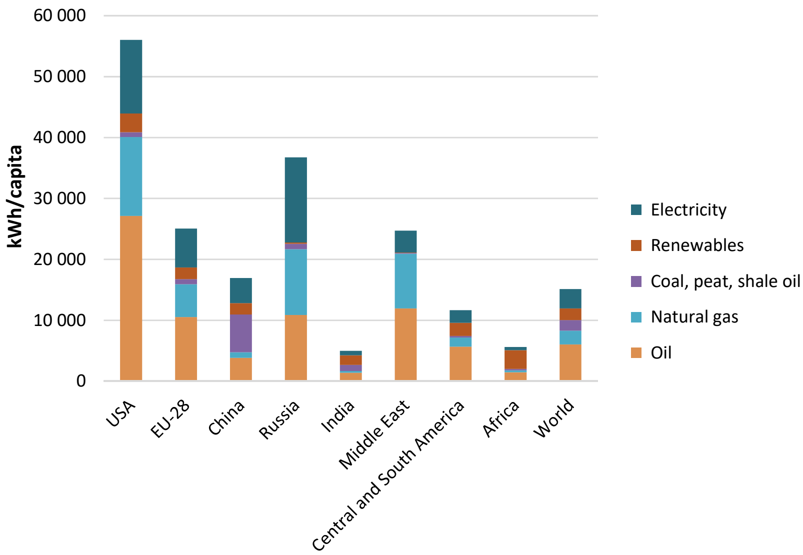

Figure 37 World energy consumption per capita in 2014, kWh/capita.

Source: IEA.

In the USA, the average inhabitant uses by far the most energy, followed by the inhabitants of Russia and the EU. However, these three regions have reduced their energy use per capita in 2014 compared to 1990, while other regions have increased their average energy use. The biggest increase has occurred in China where the energy consumption per capita has more than doubled since 1990. As an increasing number of regions are moving towards a higher standard of living, it will require a greater energy output, not least in the form of fossil fuels that still dominate the world's energy use.

The World depends on fossil fuels

The global energy supply in 2014 amounted to 159,000 TWh, as shown in Figure 38.

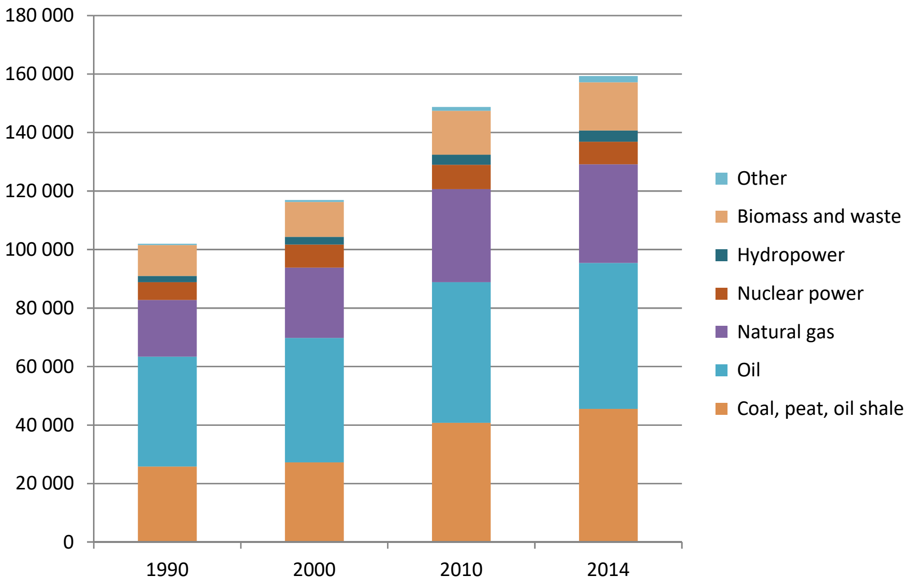

Figure 38 World total primary energy supply, by fuel, 1990–2014, TWh.
Source: IEA.

Fossil fuels represent over 81 per cent of the supply, where oil dominates with 31 per cent, followed by coal with 29 per cent and natural gas with 21 per cent. Renewable energy, including hydropower, has amounted to a share of 14 per cent. In 2014, nuclear power accounted for 5 per cent of the energy supply, which is a decrease resulting primarily from the nuclear accident in Fukushima 2011.

In 2014, a continued recession in the growth of the global energy supply was seen, partly because of lower economic growth, but also due to individuals and companies having reacted to higher prices by becoming more efficient in their energy use. Growth in 2014 was 1.2 per cent compared to 1.6 per cent in 2013. In OECD countries, the energy supply only increased by 0.5 per cent while the energy supplied increased by 1.5 per cent in non-OECD countries.

The global supply of renewable energy is increasing

In 2014, renewable energy accounted for 33,000 TWh or 14 per cent of the world's energy supply, see Figure 39.

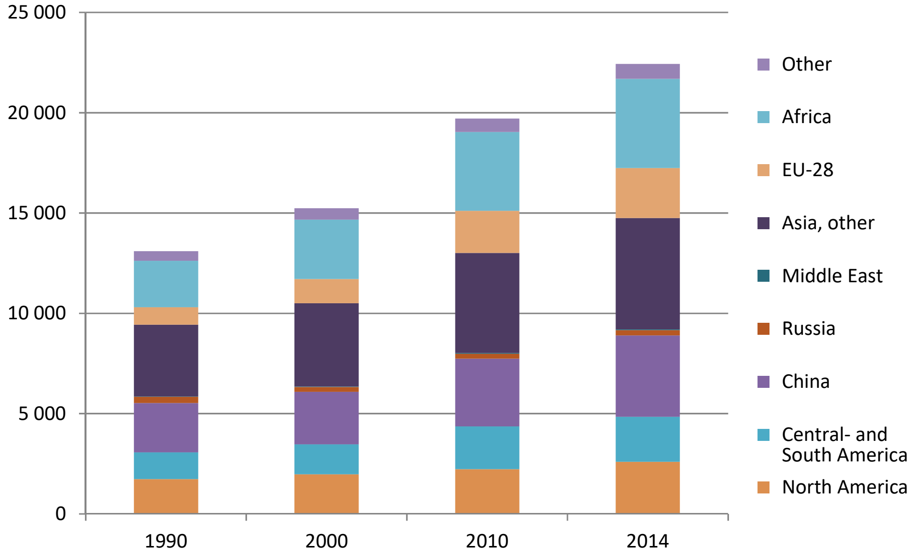

Figure 39 World supply of renewable energy, by region, 1990–2014, TWh.
Source: IEA.

The global supply of renewables continued to increase, but not to the extent that it significantly affected renewable energy's overall share of the energy supply. Solar and wind power admittedly only accounted for about one per cent of global energy supply but the installed effect increased by 30 per cent between 2013 and 2014.[122]

Renewables increased in all regions but Russia and the Middle East where a reduction was seen from 2013 to 2014. The biggest growth was seen in North America and China where the increase accounted for 6.4 per cent and 5.4 per cent respectively compared to 2013. In addition to economic factors, political decisions impact the development, where goals for greenhouse gas reductions and reduced reliance on fossil fuels are the main driving forces.

Fossil fuels dominate the global electricity production

The world's production of electricity amounted to over 24,000 TWh in 2014, see Figure 40.

Combustion of fossil fuels was still the most common way to produce electricity. Coal, peat and oil shale have increased their share of the global electricity mix and accounted for 40 per cent of the mix. The same applies to natural gas, while the importance of oil in the electricity mix has decreased slightly. After fossil fuels, hydropower and nuclear power were the most common energy sources for electricity generation. Electricity produced with biomass, waste, solar and wind power increased, but still accounted for only 6 per cent of the electricity mix.

[122] IRENA, International Renewable Energy Agency.

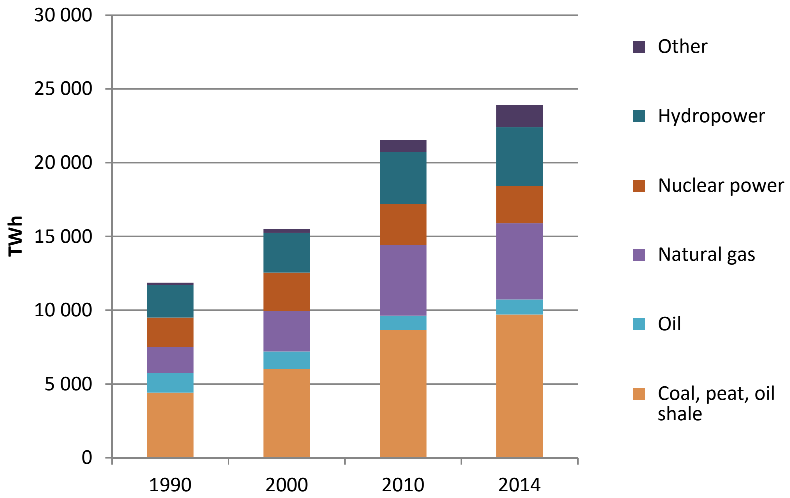

Figure 40 World electricity generation, by energy source 1990–2014, TWh.
Source: IEA.

Energy policy

In recent years, the EU's adopted objectives for 2020 and the EU's energy strategy for the period until 2030 have formed the basis for energy policy in Europe. In October 2014, the European Council endorsed objectives for the for climate and energy policy for 2030. The objectives of the EU constitute the basis for the adopted energy and climate goals in Sweden. Through its work in the energy sector, the EU hopes to put Europe on the right track – towards a sustainable future in a low-carbon and energy-efficient economy.

Energy and climate goals within the EU

The goals set by the EU, with 2020 as the target year, entail the Union committing to reducing greenhouse gas emissions by 20 per cent, reducing energy consumption by 20 per cent through improved energy efficiency, acquiring 20 per cent of the total energy consumption from renewable sources and acquiring at least 10 per cent of total fuel use within the transport sector from renewable energy sources.

The EU also undertakes to reduce greenhouse gas emissions by 40 per cent compared to emissions in 1990, to reduce energy consumption by 27 per cent through improved energy efficiency, and to ensure that 27 per cent of energy comes from renewable sources. These proposed target levels are currently negotiated with the European Parliament in the framework of various directives and regulations (see section on the Energy Union below) and are to be met by the year 2030. For the electricity sector, the European Commission has a specific ambition for a minimum level of interconnection of power grids set at 10 and 15 per cent of a Member State's installed electricity generation capacity by 2020 and 2030 respectively.[123]

Legislation is a means for the EU to reach the objectives established in the energy and climate field. EU targets for 2020 have been transformed into directives and regulations, which have been incorporated into Swedish law. These include The Renewable Energy Directive, The Energy Efficiency Directive, The Energy Performance of Buildings Directive, The Ecodesign Directive and The Energy Labelling Directive.

Energy Union with a forward-looking climate change policy

When the present European Commission took office in autumn 2014, the idea of an Energy Union was raised as one of ten priority areas.[124] The Energy Union shall aim to accelerate the implementation of and to provide comprehensive support to the EU climate and energy policy, including the fulfilment of the objectives by 2020 and 2030.

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[123] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/sv/ec/145418.pdf

[124] http://www.consilium.europa.eu/sv/policies/energy-union/ (24-04-2017).

In February 2015, the European Commission presented *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*,[125] where the Energy Union is proposed to include five areas:

- security of supply,
- internal energy market,
- energy efficiency,
- reduced greenhouse gas emissions,
- research, innovation and competition.

Concrete measures and proposals for new initiatives and legislative proposals covering all five areas have been presented.

The EU and climate negotiations in Paris

As part of the Energy Union, and to prepare the EU in the negotiations prior to the Paris conference in December 2015, the European Commission presented *The Paris Protocol – A blueprint for tackling global climate change beyond 2020.*[126]

The climate negotiations in Paris are taking place within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and aim to establish consensus on a new legally binding agreement involving all parties. The idea is for the world's countries to agree on the basis for the new agreement in Paris in December 2015, and for the agreement to enter into force in 2020. More specific rules concerning the implementation will be determined in the years running up to 2020.

The European Commission's ambition is for the agreement to be legally binding and enter into force once it has been signed by the countries that together account for emissions totalling 40 gigatons of carbon dioxide equivalents (corresponding to around 80 per cent of global emissions in 2010).[127] Countries shall be encouraged to participate in climate finance, technology development and transfer, and capacity building. The European Commission also emphasizes that the protocol must include requirements on the reduction of greenhouse gas emissions from all sectors, including aviation and shipping, and fluorinated gases.

The EU's contribution to the negotiations in Paris entails the Union's commitment to reduce the emissions of greenhouse gases by 40 per cent by 2030 compared with emissions in 1990. To achieve this overall objective, sectors covered by the EU emissions trading system must reduce their emissions by 43 per cent by 2030 compared to 2005, and sectors outside the EU ETS must reduce their emissions by 30 per cent.

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125 European Commission, COM (2015) 80 final Energy Union Package. A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy.

126 European Commission, COM(2015) 81 final Energy Union Package Communication The Paris Protocol – A blueprint for tackling global climate change beyond 2020.

127 European Commission - Fact Sheet Questions and Answers on the European Commission Communication: The Paris Protocol – A blueprint for tackling global climate change beyond 2020, Brussels, 25 February 2015 http://europa.eu/rapid/press-release_MEMO-15-4487_sv.htm (retrieved on 24/09/2015).

The Swedish energy and climate goals

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

Swedish energy policy is based on the legislation adopted within the EU. The climate and energy goals adopted by the Swedish Parliament specify that:

- the proportion of energy use from renewable sources in 2020 shall be at least 50 per cent of the total energy use,
- the proportion of energy use from renewable sources in the transport sector shall be at least 10 per cent in 2020,
- energy consumption shall be 20 per cent more efficient in 2020 compared to 2008 (a cross-sectoral goal of reduced energy intensity),
- the emissions of greenhouse gases in 2020 shall be 40 per cent lower than in 1990 (relates to activities not covered by the EU's system for emissions trading).

Learn more about monitoring the energy policy objectives in the Swedish Energy Agency's annual publication *Energy Indicators*.[128]

A secure energy supply is an important part of the energy policy

The functioning of our society is conditional on access to energy. This means that there are great demands placed on the reliability of the energy systems. The Swedish energy policy therefore aims to combine ecological sustainability with competitiveness and security of supply. In addition to the energy policy objectives, there are policy goals within other areas with clear links to the security of supply. For example, the objectives for emergency preparedness and security policy, various environmental objectives and goals linked to health and social security.

A prerequisite for a secure energy supply is well-functioning energy markets. Global events create the need for market mechanisms and other measures that can prevent and mitigate the effects of disruptions in the energy markets. For these mechanisms to work, there is cooperation at the international, national, regional and local levels. These mechanisms, which interact with the scope of different energy markets, are part of society's emergency management system.

Long-term rules for Swedish energy supply

In March 2015, the Government appointed a parliamentary commission with the task to develop a basis for a broad political agreement on the direction of the energy policy with a focus on 2025 and forward.[129] The Energy Commission was headed by

[128] Swedish Energy Agency, ER 2015:15, Energiindikatorer – Uppföljning av Sveriges energipolitiska mål [Energy Indicators 2015 – Monitoring Sweden's energy policy objectives].

[129] Swedish Government Official Reports, Energy Commission, 2015, www.energikommisionen.se, (retrieved on 27/08/015).

Energy Minister Ibrahim Baylan and consisted of eleven representatives from the parliamentary parties as well as the Directors General of the Swedish Energy Markets Inspectorate, the Swedish TSO, Svenska kraftnät and the Swedish Energy Agency. The Energy Commission submitted its report – Energy Council for Energy of the Future, SOU 2017: 2 to the Government on January 9, 2017.

The mission was to provide the basis for a broad agreement on energy policy, with a particular focus on electricity supply after 2025–2030.

The work resulted in the following targets and objectives:

- A target of 100 per cent renewable electricity production by 2040. This is a target; it is neither a deadline for banning nuclear power nor a political decision to close nuclear power plants.
- An energy-efficiency target of 50 % more efficient energy use in 2030 compared to 2005 (a cross-sectorial goal of reduced energy intensity).
- By 2045, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions.

The enquiry also gives a number of other proposals, inter alia that the electricity certificate system will be extended and expanded by 18 TWh of new electricity certificates until 2030[130] while the level of ambition will not be raised any further before 2020. The Parliament adopted legislation of an extended electricity certificate scheme[131] to 2045 in July 2017. Furthermore, the government has assigned a commission of enquiry to investigate obstacles for energy efficiency, small-scale electricity production and electricity storage. If the enquiry finds it economically motivated, new policy measures shall be proposed in the second phase of the enquiry. The enquiry shall submit its report by 15 October 2018.[132]

As a result of the Energy Commission the Swedish Energy Agency has also recieved the task from the Government to form sectorial strategies for energy efficiency. The purpose is to create dialogue between relevant governmental agencies and actors concerning suitable objectives and measures within each sector in order to contribute to the national energy and climate targets in a cost-effective manner. The agency shall submit its first report to the Government Offices 31 January 2018.[133]

As a result of the energy agreement, the Parliament has decided to phase out the tax on thermal output in nuclear power plants gradually until 2018 and to reduce the property tax on hydropower plants to the same level as for most other electrical production plants, i.e. 0.5 per cent. The tax reductions are financed through an increase of the electricity consumption tax in the household and services sectors. The first changes entered into force 1 July 2017.[134]

[130] Report 2016/17:NU20. Nytt mål för förnybar el och kontrollstation för elcertifikatssystemet 2017.

[131] See the section about the Electricy Market to learn more about the electricity certificate system.

[132] Committee terms of reference 2017:77. Utredning om energieffektivisering och småskalig elproduktion och lagring för mindre aktörer.

[133] Ministry of the Environment and Energy. Government decision M2017/01811/Ee. Uppdrag till Statens Energimyndighet att formulera sektorsstrategier för energieffektivisering.

[134] Committee Report 2016/17:SkU31. Skatteförslag med anledning av energiöverenskommelsen.

Cross-sectoral instruments and inquiries

Policy instruments and inquiries of a cross-sectoral character are presented below. Instruments and inquiries relating to a specific sector or market are found in the respective section.

Cross-party Committee on Environmental Objectives

On 18 December 2014, the Government tasked the Cross-Party Committee on Environmental Objectives with proposing a climate policy framework and a climate strategy for Sweden. The Committee presented an agreement between the Social Democratic Party, the Green Party, the Moderate Party, the Centre Party, the Liberal Party and the Christian Democrats (and in some parts the Left Party) containing a large number of proposals to tighten up climate policy in Sweden (SOU 2016:21 and SOU 2016:47). On 14 March 2017, the Government presented a bill on a climate policy framework based on the proposals of the Cross-Party Committee on Environmental Objectives. The Parliament adopted the Climate Act and the new climate goals on 15 June 2017.

The climate policy framework consists of three pillars: a Climate Act, climate goals and a climate policy council.

The Climate Act establishes that the Government's climate policy must be based on the climate goals and specifies how work is to be carried out. The Government is required to present a climate report every year in its Budget Bill. Every fourth year, the Government is required to draw up a climate policy action plan for how the climate goals are to be achieved. The new Climate Act will enter into force on 1 January 2018.

By 2045, Sweden will have net zero emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. Negative emissions mean that greenhouse gas emissions from activities in Sweden are less than, for example, the amount of carbon dioxide absorbed by nature as part of the ecosystem, or less than the emissions Sweden helps to reduce abroad by investing in various climate projects. The remaining emissions from activities on Swedish territory will be at least 85 per cent lower than in 1990.

Emissions in Sweden in the sectors that will be covered by the EU regulation on the division of responsibilities should, by 2030, be at least 63 per cent lower than emissions in 1990, and at least 75 per cent lower by 2040. In a similar way as for the long-term goal, parts of the goals may be achieved by 2030 and 2040 through supplementary measures, such as increased uptake of carbon dioxide by forests or by investing in various climate projects abroad. Such measures may be used to achieve a maximum of 8 and 2 percentage points respectively of the emission reduction goals by 2030 and 2040.

Emissions from domestic transport, excluding domestic aviation, will be reduced by at least 70 per cent by 2030 compared with 2010. The reason domestic aviation is not included in the goal is that domestic aviation is not included in the European Union Emissions Trading System.

The third pillar of the framework is a climate policy council tasked with assisting the Government by providing an independent assessment of how the overall policy presented by the Government is compatible with the climate goals. The council will evaluate whether the direction of various relevant policy areas will increase or reduce the likelihood of achieving the climate goals.

The report from the Committee also contained proposals for a cohesive strategy for a Swedish clean air policy:

- Limited emissions from road traffic in urban areas: The proportion of journeys undertaken by cyclists, pedestrians or passengers on public transport is to be at least 25 per cent by 2025.
- Limited emissions from small-scale wood burning: Emissions are to fall continuously until 2020. By 2019, at the latest, it shall be clear what level of reduction in emissions is required to attain the environmental clean air quality objective.
- Limited in-bound transport of air pollutants: Sweden is to have carried out initiatives targeted at countries east of the EU which are responsible for sizeable emissions by 2020. Emissions of nitrogen oxides from shipping in the Baltic Sea and North Sea are to be halved by 2025 compared with 2010.
- Meet the emission undertakings of the National Emission Ceilings Directive: Emissions of nitrogen oxides, sulphur dioxide, volatile organic compounds, ammonia and particles, PM2.5 are to correspond to the indicative targets for 2025 as shown in the revised National Emission Ceilings Directive.

The Research Bill increases the budget for energy research

The Government Bill on Research and Innovation within the energy field was presented in December 2016. The budget for energy research is increased by 20 per cent until 2020, from 1,3 billion SEK per year in 2016 to 1,6 billion SEK from 2020. Parts of the increase are to be used for cross-sectorial research, more international cooperation and gender equality. The funds are increased to stimulate innovation, economic growth, exports and gender equal research.

Current energy taxes in 2017

Energy taxation is a collective term for excise duties on fuels and electricity. Energy, carbon dioxide and sulphur taxes are regulated in the Energy Tax Act (1994:1776). Energy tax is paid on the majority of fuels and is based on the energy content, among other things. Carbon dioxide tax is paid per emission of one kilo of carbon dioxide on all fuels except biomass and peat. Sulphur tax amounts to SEK 30 per kilo of sulphur emission on coal and peat, and SEK 27 per cubic metre for each tenth of one per cent by weight of sulphur content in oil. Oil with a maximum of 0.05 per cent by weight of sulphur content is exempt from sulphur tax.

The established carbon dioxide and energy tax rates on fuels for 2017 are marginally higher than 2016's tax rates. The increase in rates is due to the inflation that was forecast for the conversion to the 2015 tax rates having been higher than the actual inflation for the same period. The exceptions are low-grade ethanol, ethanol in E85, and high and low-blended FAME, which received a larger tax deduction in August 2016, and is therefore lower than the year before. A VAT effect will come about if the price of fuel is changed correspondingly and if the purchaser is a private individual.

Table 2 General energy and carbon dioxide taxes from 1 January 2015, excluding VAT.

	Energy tax	CO_2 tax	Sulphur tax	Total tax	Tax öre/kWh
Fuels					
Fuel oil 1, SEK/m^3 (<0.05 % sulphur)	850	3,218	–	4,068	40.9
Fuel oil 5, SEK/m^3 (<0.4 % sulphur)	850	3,218	108	4,176	39.5
Coal, SEK/tonne (0.5 % sulphur)	646	2,800	150	3,596	46.7
LPG, SEK/tonne	1,048	3,385	–	4,477	35.0
Natural gas, SEK/1,000 m^3	939	2,409	–	3,348	30.3
Raw tall oil, SEK/m^3	4,068	–	–	4,068	41.5
Peat, SEK/tonne, 45 % moisture content (0.3 % sulphur)	–	–	50	50	1.8
Transport fuels					
Petrol, unleaded, environmental class 1, SEK/litre	3.25	2.60	–	5.85	64.3
Low-admixture ethanol, SEK/litre	0.36	–	–	0.36	6.1
Diesel, environmental class 1, SEK/litre	1.83	3.22	–	5.05	51.5
Low-admixture FAME, SEK/litre	1.69	–	–	1.69	18.4
High-admixture FAME, SEK/litre	1.03			1.03	11.2
Natural gas/methane, SEK/m^3	–	2.41	–	2.41	21.8
LPG, SEK/kg		3		3	27
Electricity use					
Electricity, northern Sweden, öre/kWh	19.4	–	–	19.4	19.4
Electricity, rest of Sweden, öre/kWh	29.4	–	–	29.4	29.4
Electricity use, industrial processes, öre/kWh	0.5	–	–	0.5	0.5


öre/kWh
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Energy measurements and recalculation factors

The international standard unit for energy is the joule (J). However, Sweden often uses watt hours (Wh). The units of measurement tonne of oil equivalent (toe), calorie (cal) and British Thermal Unit (BTU) are common in international comparisons. Relationships between several different units of measurement are reported in Table 3.

Table 3 Conversion factors between energy units.

	GJ	MWh	toe	Mcal	BTU
GJ	1	0.28	0.02	239	0.95
MWh	3.6	1	0.086	860	3.412
toe	41.9	11.63	1	10,000	39.72
Mcal	0.0419	0.00116	0.0001	1	0.0398
MMBTU	1.055	0.2954	0.0211	252.145	1

At the national and international level, the quantities of energy are so large that it is more practical to use prefixes, see Table 4.

Table 4 Prefixes for energy units.

Prefix	Factor	Magnitude	Numerical value
k	kilo	10^3	Thousand
M	Mega	10^6	Million
G	Giga	10^9	Billion
T	Tera	10^{12}	Trillion
P	Peta	10^{15}	Quadrillion

Recalculation factors are presented in Table 5 and constitute an average effective thermal value, except for wood fuels, which display an interval. Variations in thermal values are found mainly in wood fuels and coal. For natural gas, the net calorific value is listed.

Table 5 Recalculation factors for effective thermal values

Fuel	Physical quantity	MWh	GJ
Wood chips, bark, sawdust	1 tonne	2.00–4.00	7.20–14.4
Peat	1 tonne	2.50–3.00	9.00–11.0
Pellets, briquettes	1 tonne	4.50–5.00	16.0–18.0
Coal	1 tonne	7.56	27.2
Coke	1 tonne	7.79	28.1
Nuclear fuel	1 toe	11.6	41.9
Crude oil	1 m^3	10.07	36.3
Topped crude oil	1 m^3	11.1	40.1
Petroleum coke	1 tonne	9.67	34.8
Asphalt (bitumen)	1 tonne	11.4	41.0
Lubricating oils	1 tonne	11.5	41.4
Motor gasoline	1 m^3	9.10	32.6
Aviation gasoline	1 m^3	8.67	32.8
Light virgin naphtha	1 tonne	7.91	28.5
White spirit	1 m^3	9.34	33.6
Aviation kerosene and other intermediate oils	1 tonne	9.60	34.6
Other kerosene	1 m^3	9.54	34.3
Diesel and fuel oil 1	1 m^3	9.95	35.8
Heavy fuel oils	1 m^3	10.58	38.1
Propane and butane	1 tonne	12.8	46.1
Gasworks gas	1,000 m^3	5.8	20.9
Coke-oven gas	1,000 m^3	4.65	16.7
Natural gas	1,000 m^3	11.1	39.8
Blast furnace gas	1,000 m^3	0.93	3.35
Ethanol	1 m^3	5.90	21.2
Biogas	1,000 m^3	9.70	34.9
FAME	1 m^3	9.17	33.0
E85	1 m^3	6.59	23.7
HVO	1 m^3	9.44	34.0
CNG	1,000 m^3	10.16	36.6

A sustainable energy system benefits society

The Swedish Energy Agency has an overall picture of the supply and use of energy in society. We work for a sustainable energy system, combining ecological sustainability, competitiveness and security of supply. The Agency:

- Develops and disseminates knowledge about a more efficient energy use to households, industry, and the public sector.
- Finances research for new and renewable energy technologies, smart grids, and vehicles and transport fuels of the future.
- Supports commercialisation and growth of energy related cleantech.
- Participates in international collaboration with the aim of attaining Swedish energy and climate objectives.
- Manages instruments such as the Electricity Certificate System and the EU Emission Trading System.
- Provides energy system.

Swedish Energy Agency

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