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Preface

The Swedish Energy Agency's mission is to promote the development of the country's energy system so that it will become ecologically, socially and economically sustainable. The Swedish Energy Agency is also responsible for official energy statistics.

The annual report, Energy in Sweden, and its companion publication on the Swedish Energy Agency website, Energy in Sweden – Facts and Figures, aims to provide decision makers, journalists, the business sector, educators and the public with accessible, one-stop shop information on developments in the energy sector. Energy in Sweden provides an overview of the current energy and climate policy, policy instruments, the supply and use of energy, energy prices and energy markets, a secure energy supply, an international survey and the energy system's impact on the environment. The report is also published in Swedish with the name Energiläget.

This year's publication has been expanded to include two new sections. Markets for biobased motor fuels are described in Chapter 5 and the statistics used in the publication are described and explained in Chapter 9.

Current events and decisions reported in this publication relate primarily to the period from June 2010 to June 2011. In terms of the statistics on which this publication is based, the bulk of the data is based on official statistics up to and including 2010.

Project manager has been Zinaida Kadic and assistant project manager Charlotte Anners.

Eskilstuna, November 2011.

Andres Muld
Director General

Zofia Lublin
Head of Department

Zinaida Kadic
and Charlotte Anners
Project Manager/
Assistant Project Manager

Contents

Writers

Sweden's energy policy
Sara Björkroth

Energy in the EU
Lisa Lundmark

Energy taxation
Sara Björkroth

Electricity certificates
Mia Jöhnemark

EU Emissions Trading Scheme
Kristina Eklund

CDM and JI
Marie Karlberg

PFE
Johanna Moberg

Buildings
Anna Pettersson

Transport
Sara Björkroth

Technology procurement
Tomas Berggren

Research, development and demonstration
Maria Alm

Information activities
Elisabeth Linder

Total energy supply and use
Anders Dahlberg

The renewable share
Mikaela Sahlin

Residential and services
Lars Nilsson

Industry
Annika Persson

Transport
Nathalie Adilipour/Helen Lindblom

The electricity market
Sara Sundberg

District heating and cooling
Daniel Friberg

Energy gases
Mikaela Sahlin

The oil market
Helen Lindblom

The coal market
Carola Lindberg

Biofuels, peat and waste
Matti Parikka

The market for biobased motor fuels
Helen Lindblom

Energy prices
Lars Nilsson

Secure energy supply
Urban Bergström

An international perspective
Anders Dahlberg/Annika Persson

The environmental situation
Charlotte Billgren/Marie Karlberg

Energy facts
Charlotte Anners/Niklas Notstrand

1 Current energy and climate policy

Energy is becoming an increasingly important part of EU policy. This is mainly in order to enable the EU to achieve its targets and to help to tackle climate change. Energy also plays an important part in actions to support economic growth and create new jobs. EU energy policy has three main foundations: competitiveness, sustainability and security of supply, just like Swedish energy policy. Over the past year there have been a number of laws and legislative proposals in Sweden in areas such as the electricity and gas markets, the electricity certificate system and the transport sector.

1.1 A new strategy and roadmap for the EU's energy and climate policy

In June 2010, the European Council adopted a new strategy for the EU, aimed at promoting employment as well as smart and sustainable growth. Energy, efficient use of resources and innovation are key areas in the new strategy. The 20/20/20 targets previously established at the spring summit 2007 remain unchanged. These targets involve the reduction of greenhouse gas emissions by 20% compared with emissions in 1990. At least 20% of the EU final energy use must come from renewable sources, compared with 8.5% today. Energy efficiency should be improved and primary energy use reduced by 20% compared with projections. These targets are all to be achieved by the end of the year 2020. However, the energy efficiency target is not, as yet, legally binding.

In November 2010, the European Commission presented a draft energy strategy, Energy 2020 – A strategy for competitive, sustainable and secure energy. Energy supply is a key area in the process of converting to a sustainable society. The energy strategy proposes measures within five priority areas for the next ten years:

- improving energy efficiency
- an integrated market
- competitive prices and a secure energy supply
- technological leadership
- the external dimension of energy policy.

To promote the implementation of the energy strategy, a roadmap for the EU's long-term energy policy has been announced for the third quarter of 2011. It is called the Energy Roadmap 2050. The core area relates to what the EU initiatives and instruments must achieve by the year 2050 in order to establish low-emission energy systems while maintaining the Union's targets for security of supply and competitiveness.

FACTS EU DIRECTIVES

Listed below are the EU directives by their popular name, number and full name, as discussed in Energy in Sweden 2011. This publication will only refer to a directive's popular name.

The Fuel Quality Directive: Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC.

The Ecodesign Directive: Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (recast). The Ecodesign Directive is being reviewed in 2011 and 2012. Methods and effectiveness will be evaluated and further work will be planned.

The Energy Labelling Directive: Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products.

The Energy Taxation Directive: Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity. A proposal for a new energy tax directive was adopted by the European Commission on 13 April 2011. The new directive is proposed to enter into force in stages in 2013, 2015 and 2018.

The Energy Services Directive: Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.

The Renewables Directive: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

The Emissions Trading Directive: Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community.

The CHP Directive: Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC.

The Third Internal Market Directive: Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

The Oil Storage Directive: Council Directive 2009/119/EC of 14 September 2009 imposing an obligation for Member States to maintain minimum stocks of crude oil and/or petroleum products.

EU decisions affect Sweden's energy and climate policy

During 2009, Parliament approved a new climate and energy policy on the basis of the Government Bills 2008/09:162 and 2008/09:163, under the common name of A joint climate and energy policy. The new climate and energy policy, which is based on the EU's 20/20/20 targets, sets a number of targets and strategies for Sweden.

By 2020, the share of renewable energy in the EU must correspond to 20% of its total energy use. On the basis of this, a national burden-sharing agreement has been decided for each member state, which for Sweden entails a renewable energy share of 49%. Sweden has further raised this goal so that its renewable energy share should be at least 50% of the total energy use.

The share of renewable energy at EU level must, by 2020, constitute at least 10% of the total motor fuel consumption in the transport sector. Sweden's target for renewable energy in the transport sector is the same as that of the EU. In addition to this, the long-term aim is for vehicles in Sweden to be independent of fossil fuels by 2030.

Within the EU the energy use is to be reduced by 20% between the years 2005 and 2020. This target, however, is neither legally binding nor part of any burden-sharing agreement. Swedish energy policy has set an overall target of a 20% reduction in energy intensity between the years 2008 and 2020.use

Within the EU, greenhouse gas emissions shall be reduced by at least 20% by the year 2020 compared with emissions in 1990. This target may be supplemented later by a decision on a 30% emissions reduction, provided that a broader, international agreement can be reached. Swedish greenhouse gas emissions are to be reduced by 40% by the year 2020 compared with 1990. This target encompasses activities not included in the EU Emissions Trading System. The vision for 2050 is that Sweden should have no net emissions of greenhouse gases into the atmosphere. This decision is a supplement to the environmental quality target for limited climate impact.

Ways of reaching these targets include government proposals to modify taxes and implement more stringent economic policy instruments. Green investments in developing countries as well as EU-wide decisions have also been highlighted as important means towards achieving these targets.

1.2 New EU initiatives lay the foundation for future policy

Over the past year, the European Commission has presented a number of overarching strategies for energy, climate and transport. More specific legislation has also been drafted.

New proposal for an energy efficiency directive presented

In March 2011, the European Commission presented an action plan for energy efficiency which points out measures that will enable the EU to reach its target of a 20% reduction of energy use by the year 2020. The Energy Efficiency Plan includes more than 20 proposals for measures and emphasizes the importance of improving energy efficiency throughout the energy system. The communication draws attention to the role of the public sector as a forerunner; low-energy buildings; improving energy efficiency for competitive industry and tailored financing. The Energy Ministers adopted conclusions on the Energy Efficiency Plan in June 2011.

In June 2011, the European Commission presented a draft for a new energy efficiency directive. The energy efficiency target of a 20% reduction in primary energy use in Europe remains. The directive proposal combines the old energy services directive and the cogeneration directive, see ’FACTS EU directives’. The target is a 368 Mtoe reduction in primary energy use in Europe in 2020 from the 1842 Mtoe projected for the target year. The target is to be achieved with the support of, for example, annual investments in improving energy efficiency in the public sector.

The member states will also introduce national energy efficiency obligation schemes which require energy suppliers to achieve end-user energy savings of 1.5% of the previous year’s sales. The directive also includes requirements for the individual metering of electricity, gas and district heating or cooling. The directive proposal also aims to promote the use of high-efficiency CHP in Europe.

In accordance with the directive proposal, the European Commission is, during 2014, to evaluate development towards reaching the EU’s 20% target for energy efficiency in 2020. The European Commission will then, if necessary, present further legislative proposals for establishing mandatory national targets for improving energy efficiency if the EU is not on track to reach the 20% target. Several of the key measures highlighted in the Energy Efficiency Plan would then become legally binding.

New ecodesign and labelling requirements

A number of new requirements relating to the directives on ecodesign and energy labelling have entered into force. Ecodesign takes into account a product's complete life cycle and sets efficiency requirements for products. Models that do not meet the requirements may not be sold in the EU's single market. Energy labelling draws attention to energy use, performance, noise, etc. and makes it easier for consumers to make comparisons when buying new products. New requirements which have taken effect this year are ecodesign requirements for domestic refrigerators and freezers since July 2010 and ecodesign requirements for electric motors since June 2011.

Most ecodesign requirements are introduced in stages, and more stringent requirements have been placed on the following products this year: domestic lighting, televisions, external power supplies and simple set-top boxes.

In addition, new decisions have been made regarding ecodesign requirements for fans and both ecodesign and energy labelling of air–air heat pumps and air conditioning. The requirements for these products have not yet taken effect.

The Ecodesign Directive will be reviewed in 2011 and 2012. Methods and effectiveness will be evaluated and further work will be planned. A number of new implementing measures for ecodesign and labelling is currently being decided. This includes tumble dryers, water pumps, water heaters and storage tanks, as well as oil, gas and electric boilers.

Future energy infrastructure in the spotlight

In November 2010, the European Commission presented a communication on the energy infrastructure of the future[1] which will be followed up with a legislative proposal in autumn 2011.

In December 2010, the European Commission presented a communication describing new tasks for the regional initiatives[2]. Examples of initiatives are development of cross-border infrastructure and implementation of the third Internal Energy Market Package. A new governance structure for the existing regional initiatives and adjustments to make them more effective are other further initiatives.

In April 2011, the European Commission presented a communication on smart grids[3] consisting of policy development to accelerate development and the expansion of the future European electricity network. The communication presents proposals for measures in five areas:

- the development of technical standards
- data protection for consumers
- a set of regulations which creates incentives to develop smart grids
- guarantee transparency and competitiveness of the retail market
- ongoing support for the innovation of technology and systems.

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1 COM(2010) 677 final
2 COM(2010) 721 final
3 COM(2011) 202 final

The SET plan is expanded to bioenergy and smart cities

The purpose of the SET Plan is to increase the involvement of the industrial sector in energy research and thus create conditions for achieving the energy and climate targets adopted in the EU. The SET plan runs until 2020.

In January 2011, the European Commission launched an industrial initiative for bioenergy within the framework of the SET plan[4]. The document proposes a plan to implement the initiative in 2011 and 2012. The focus will be on partnerships between the public and private sectors which will share both the risks and the financial burden.

In June 2011, the European Commission presented an industrial initiative for smart cities. An innovative and carefully planned integration of various technologies will make cities and societies ”smart”. This will require commitment and cooperation between authorities, citizens, financial institutions as well as universities and colleges.

Proposals for new targets for reduced emissions presented

In March 2011, the European Commission presented a communication to achieve the reduction of greenhouse gas emissions[5]. As a result of this communication, the European Commission will present more detailed initiatives for individual sectors. These initiatives will be in line with the EU’s growth strategy, Europe 2020, in particular the initiative for a resource-efficient Europe. The EU shall reduce its greenhouse gas emissions by 80% by the year 2050 compared with emissions in 1990. To succeed, a number of intermediate targets have been set: 25% reduction by 2020, 40% by 2030 and 60% by 2040. In working to achieve these targets, energy efficiency and electricity production with almost zero emissions play a major role. The Environment ministers (in 26 of 27 member states) adopted conclusions on the communication in June 2011.

In March 2011, the European Commission presented a white paper which will constitute an overarching strategy for a competitive transport system. The European Commission’s white papers are documents containing proposals for Community measures within a particular field. The Transport ministers discussed the white paper at their Transport Council meeting in June 2011. The strategy will help increase mobility, remove major barriers in key areas and fuel growth and employmen[6]. The most important targets contributing to a reduction in transport emissions by 60% by 2050 are:

- No more conventionally-fuelled cars in cities.
- 40% of the aviation fuel requirements are to be covered by sustainable motor fuels with minimal carbon dioxide emissions.
- Shipping emissions are to be reduced by at least 40%.
- A 50% shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport.

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4 COM(2007) 723 final
5 COM(2011) 112 final
6 COM(2011) 144 final

Several components considered for new energy taxation

In April 2011, the European Commission presented a proposal for a recast of the Energy Taxation Directive[7]. The new rules are intended to reorganize the taxation of energy products, to eliminate current imbalances and take into account both carbon dioxide emissions and energy content. The current energy taxation would be divided into two components which together will determine the total tax rate for a product. The European Commission wishes to promote greater energy efficiency and use of more environmentally friendly products. At the same time, distortion of competition within the internal market needs to be avoided. The proposal is intended to help member states reorganize their overall tax structures to promote growth and employment. This would be achieved through shifting taxation from labour to use. The recast directive is planned to enter into force in 2013.

A legislative proposal on sustainability criteria for solid biofuels expected this autumn

A report and possibly a legislative proposal on sustainability criteria for solid biofuels are expected towards the end of 2011. The Renewables Directive requires the European Commission to report back on the need to introduce sustainability criteria for solid and gaseous biofuels. At present, there are sustainability criteria for liquid biofuels. The European Commission will analyze whether existing national systems are sufficient to guarantee the sustainability of these fuels. If the European Commission finds that this is not the case, it may be necessary to present legislative proposals at a EU level.

Proposals presented on the financing of future EU energy policy

The European Commission presented its proposal for a multi-annual framework for the EU budget for 2014-2020. The budget, presented in June 2011, includes investments in infrastructure, research and development as well as innovation.

The proposal includes a new financial instrument for investments in energy infrastructure, Connecting Europe Facility. It is proposed that funds in the order of EUR 9 billion be earmarked for investment in smart grids as well as in electricity and gas links that are intergovernmental, promotes security of supply and improves conditions in the internal market. It also includes suggestions for a new Framework Programme for Research and Innovation, Horizon 2020. The new framework combines the EU's Seventh Framework Programme for research, technological development and demonstration activities (FP7), the innovation objective of the EU's Competitiveness and Innovation Framework Programme (CIP) and the European Institute of Innovation and Technology (EIT). As regards the energy objectives in the research programme, these are largely expected to follow the priorities of the SET plan.

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7 COM(2010) 169/3

1.3 New laws and legislative proposals presented in Sweden

Swedish energy policy is based on the same three foundations as the energy cooperation in the EU. Swedish energy and climate legislation is therefore primarily based on EU regulations and directives. Over the past year there have been a number of laws and legislative proposals in areas such as the electricity and gas markets, the electricity certificate system and the transport sector.

Consumers given a greater role in the electricity and gas market-
The goal of electricity and gas policy is to bring about efficient markets with effective competition, efficient use of resources and efficient pricing. On 23 June 2011, the Government presented Bill 2010/11:153 to Parliament. The circumstances behind the proposal are the provisions of a number of EU directives including the Third Internal Market Directive, the Renewables Directive and the Energy Services Directive. The Government Bill contains measures to help electricity consumers to gain control over their electricity bills by making it easier for them to make their use more effective, produce their own renewable electricity and recharge their electric vehicles.

The Act on guarantees of origin for electricity (2010:601) entered into force on 1 December 2010. The purpose of the Act is to allow the end user to know the origin of electricity in a clear manner. Guarantees of origin are electronic documents which guarantee the origin of electricity. The guarantee of origin indicates the type of energy source that the electricity comes from and also in which plant the electricity was produced. Producers of electricity receive a guarantee from the state for each megawatt hour of electricity produced, which can then be sold on the open market. Guarantees of origin are issued for all types of electricity production. It is the electricity producers and suppliers that are affected by the Act on guarantees of origin. Applications for guarantees of origin are still, at present, optional.

The Government Bill on the third Internal Energy Market Package for electricity and natural gas, 2010/11:70, was presented in March 2011. The Government Bill is a direct result of the EU's third Internal Energy Market Package for electricity and natural gas adopted by the European Parliament and the Council in 2009. The proposal lays out further incentives towards a common internal market for electricity and natural gas. Cross-border trade is to be promoted through the harmonization of regulations. The package contains measures in several areas. These include provisions on greater consumer protection, rules on the powers and tasks of regulators as well as measures aimed at delimiting transmission operations more clearly. Transmission operations refer to the transmission of electricity on the national grid and the transmission of gas in high-pressure pipelines.

The official report on the future management of system responsibility for gas, SOU 2011:46, looked at the design of rules for the internal market for natural gas. Furthermore, it reviewed whether the Swedish market model for natural gas required amendments. EU's efforts to formulate rules for the security of supply in accordance with Regulation (EU) No 994/2010 and the repeal of 2004/67/EC have also been monitored. The official report was reported in May 2011. Some of the report's conclusions and proposals are that:

- System responsibility for gas currently held by the public utility Swedish National Grid should partly be transferred to Swedegas AB. The tasks of this public utility should be transferred to the Energy Markets Inspectorate and the Swedish Energy Agency.
- The current Swedish market model for gas meets the formal requirements of the EU.
- The chapter on Secure natural gas supply in the Natural Gas Act (2005:403) be removed and replaced by a new Act on the security of supply of gas.
- Certain measures need to be implemented in order to ensure the Swedish application of Regulation (EU) No 994/2010 concerning gas supply.

Third-party access to district heating networks is a proposal for new regulation

The goal of heating market policy is to stimulate competition and greater efficiency through increased transparency. April 2011 saw the submission of the official report, SOU 2011:44, on creating conditions for competition in the district heating market. The background to this report are the years of criticism of the strong position of district heating companies in relation to their customers. Therefore, an official report was commissioned with the task of designing a set of regulations for third-party access to district heating networks. The official report proposes regulations to facilitate a division of the operations of district heating companies. At the same time, it is established that this will not necessarily lead to lower prices for district heating.

February 2011 saw the presentation of Government Bill 2010/11:73 with regard to the obligation of district heating companies to meter their customers' use on a monthly basis. They must also communicate the results of this metering to customers on a monthly basis. It is also proposed that billing is to be performed at least four times a year. The background to the proposal is the Energy Services Directive.

The purpose is to raise customer awareness of the link between energy use and its cost. In this way, customers are given the opportunity to secure a more efficient energy use and thus lower heating costs. The provisions are proposed to enter into force on 1 January 2015.

Tax exemption for sustainable biobased motor fuels

The Renewables Directive contains provisions on sustainability criteria for biobased motor fuels and liquid biofuels. If these fuels do not fulfil the sustainability criteria, they may not be counted towards the fulfilment of the national targets for renewable energy, receive state support or be included in quota systems such as electricity certificates.

In spring 2010, Parliament adopted amendments to the Act (2010:598) on sustainability criteria for biobased motor fuels and liquid biofuels, based on Government Bill 2010/11:152. The amendments mean that a sustainability statement is required to obtain tax exemptions and/or electricity certificates for energy and carbon dioxide. The Swedish Energy Agency, which is the regulatory authority, decides on sustainability statements on application from companies with reporting obligations. Reporting obligations are incumbent on parties liable for tax on fuel which, wholly or partially, consists of biobased motor fuels in accordance with the Energy Taxation Act (1994:1776) or parties who, in the course of professional operations, use liquid biofuel that is neither fuel nor is included in fuel that is taxable in accordance with the Energy Taxation Act. Two of the sustainability criteria are that the fuels should lead to a reduction in greenhouse gas emissions by at least 35% compared with the use of fossil fuels, and that certain uses of land for the production of the fuels is not permitted, such as land, which in 2008 consisted of forest, but has been converted to agricultural use. The amendments will come into force on 1 November 2011.

In the spring of 2010, Government Bill 2009/10:144 proposed a number of changes to facilitate a transition to a higher proportion of biogas in the energy system. These included changes in the rules for the taxation of biogas and other gaseous fuels delivered by pipeline. The changes mean that the tax exemption can follow the gas all the way to the end user. This is brought about by an agreement between the customer and the supplier of biogas to the natural gas network. The proposal was adopted on 1 January 2011.

New Act makes electricity certificates simpler

To achieve the goal of 50% renewable energy by 2020, Parliament adopted Bill 2009/10:133 to extend the electricity certificate system to the end of 2035. July 2011 also saw the submission of Government Bill 2010/11:155 regarding a new Act for electricity certificates, opening the way for simpler rules and a common market for electricity certificates. The new Act contains:

- the simplification of rules
- rules to facilitate a common market for electricity certificates with other countries
- more stringent requirements for electricity produced in hydro power stations
- exemptions from quota obligation requirements for smaller producers of renewable electricity who themselves use the electricity they have produced. See section 2.3.2 for a description of the term quota obligation requirement.

Sweden and Norway have come to a legally binding agreement on a common market for electricity certificates. This common market for electricity certificates is proposed to commence on 1 January 2012 and last until the year 2036. The agreement was signed on 29 June 2011. The purpose of the common market is to improve market function, increase its cost effectiveness and give rise to a greater production of renewable electricity. On the part of Sweden, it still remains for Parliament to approve the agreement.

More products to be subject to ecodesign and energy labelling requirements

In January 2011, Government Bill 2010/11:61 proposed amendments to the Act on ecodesign (2008:112) following a recast of the Ecodesign Directive. The amendments came into force on 1 May 2011. Previously, only energy-using products dependent on energy supply, were subject to the Act. Amendments to the Act mean that energy-related products also may be subject to implementing measures, usually in the form of regulations that set requirements for the energy and environmental performance of products. Energy-related products includes those which are not directly dependent on an energy supply, but which indirectly affects energy use. Water taps are one example of such a product. The choice of water tap affects both the amount of water used and energy use depending on how efficient it is.

On 20 July 2011, the Act on the labelling of energy-related products (2011:721) came into force with the purpose of incorporating the recast Energy Labelling Directive and also Regulation (EC) No 1222/2009 on the labelling of tyres. This Act replaces the previous Act governing this area, the Act on the labelling of domestic appliances (1992:1232). The purpose of the Act is to facilitate the end user's choice of the most energy-efficient products at the time of purchase. Suppliers selling an energy-related product subject to the regulation are to provide information on the product's use of energy and other resources. This information is to be presented on a product label and on an enclosed information sheet. Information is also to be supplied in printed advertisements and on the internet.

New Acts to reduce emissions and improve public transport

Swedish transport policy is being geared towards the incremental increase of the energy efficiency of the transport system, the breaking of dependency on fossil fuels and the reduction of climate impact. In order to adapt the provisions to the Fuel Quality Directive, a new Act on vehicle exhaust emissions control (2011:318) and a new Act on motor fuels (2011:319) based on Government Bill 2010/11:51 were introduced. They replace the Act on vehicle exhaust emissions control and motor fuels (2001:1080). What is new in these Acts are the requirements to report motor fuel emissions and that suppliers of motor fuel are to implement measures to reduce their emissions.

On 1 July 2011, in accordance with Government Bill 2010/11:118, a new Act on environmental requirements in the procurement of vehicles and certain public transport services (2011:846) came into force. This was done to facilitate the implementation of Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles The consequence of the new Act is that the public sector procurement or leasing of cars and public transport services is to take into account a vehicle's energy use and emissions of carbon dioxide and certain air pollutants in operation, during the entire period of use.

Based on Government Bill 2009/10: 200, a new Public Transport Act (2010:1065) to modernize public transport legislation and adapt it to EU regulations in the area will come into force on 1 January 2012. The Act means that public transport operators are free to establish commercial public transport, and supplements to some extent Regulation (EC) No 1370/2007. Since 1 October 2010, the market for passenger rail journey has been open. Now the restriction preventing commercial bus companies from operating local and regional public transport is also being removed. The purpose of the Act is to contribute to a wider range of public transport and increased travel and to give passengers a greater number of travel options and greater choice through improved market dynamics. For the convenience of passengers, it is also proposed that public transport operators be obligated to provide information on their range of services to a common system for passenger information.

2 Policy instruments and measures

To achieve the targets of energy and climate policy that have been set, various policy instruments are employed. Those used today are intended to guide developments towards a greater use of renewable energy. Reductions in greenhouse gas emissions and improved energy efficiency are other priority areas. Examples of economic policy instruments are taxation, electricity certificates and emissions trading systems. Various types of regulations are examples of administrative policy instruments. Information and research are often employed as supplementary policy instruments.

2.1 Four main groups of policy instruments

Policy instruments are normally divided into four main groups, depending on how they work. These four main groups are administrative, economic, informative and research-based policy instruments.

Table 1 Main groups of policy instruments with some examples

Administrative	Economic	Information	Research
Regulations	Taxes	Information	Research
Limit values (emissions)	Subsidies, grants	Advisory services	Development
Long-term agreements	Emissions trading scheme	Training	Commercialization
Environmental classification	Certificate trading		Procurement
Requirements for types of fuel and energy efficiency	Sureties		Demonstration

Administrative policy instruments are such things as prohibitions or compulsory requirements issued by political or administrative bodies and are mandatory in their nature. They may be quantitative, such as conditions on emissions, or technical, such as a requirement to use a particular fuel. Regulations in accordance with the Environmental Code are examples of administrative policy instruments and form the basis of Swedish environmental policy.

Taxes, subsidies and sureties are examples of economic policy instruments, acting by affecting the costs of an item. This in turn affects the behaviour of individuals and companies when considering purchases.

Information can modify attitudes or behaviour. Information often acts as a supplement to administrative and economic policy instruments.

Research and development is a form of policy measure in a long-term perspective. Technical development and knowledge of the effects of various changes are necessary in order to achieve various energy and environmental objectives in the long term.

2.2 The effect of taxes on energy supply and use

Originally, the primary aim of energy taxes was to assist with the financing of public activities. However, the environmental element of energy taxation has become increasingly important since the beginning of the 1990s. Current energy taxation is aimed at:

- improving the efficiency of energy use.
- favouring the use of biofuels.
- creating incentives to reduce companies' environmental impact.
- creating conditions supporting the domestic production of electricity.

Since Sweden's accession to the EU, there has been a progressive alignment of Swedish taxation with that of the EU, as expressed mainly by the Energy Taxation Directive, see 'FACTS EU directives' in Chapter 1. There are taxes on electricity and fuels, on carbon dioxide and sulphur emissions, and a levy system on nitrogen oxide emissions. The tax rates vary, depending on whether the fuel is being used for heating or as a motor fuel, whether it is being used by industry, domestic consumers or the energy conversion sector and, in the case of electricity, on what it is being used for and whether it is being used in northern Sweden or in the rest of the country.

In 2010, revenues from energy and carbon dioxide taxes raised just under SEK 73 billion, making up 9.3% of State revenue. Taxation for nuclear power is a tax on power output at production level, and must not be confused with the energy tax on electricity paid by consumers.

Tabell 2 Energy tax revenues, 2010, million SEK

Energy source or carrier	Energy tax	Carbon dioxide tax	Sulphur tax	Total
Petrol	13 479	10 671	-	24 150
Oil products[1]	6 524	15 304	-	21 828
Crude tall oil[2]	0	-	-	0
Other fuels	88	1 360	-	1 448
All fuels[3]	-	-	48	48
Electricity	21 061	-	-	21 061
Waste[4]	-	-	-	289
Production tax, nuclear power[4]	-	-	-	3 997
Total	**41 152**	**27 334**	**48**	**72 821**
Proportion of national tax revenue				*9.3%*
Proportion of GDP				*2.2%*

Source: Swedish National Financial Management Authority, Statistics Sweden.

Note:
1. Diesel is included in oil products. The same tax rates apply for both heating oil and diesel oil, and so these are reported together.
2. Projected tax revenue foregone is reported as 0. Dashes mean that there is no taxation for the category in question.
3. The sulphur tax is calculated for all fuels.
4. For these types of energy, the tax is not broken down into energy-, carbon dioxide- and sulphur tax, but are calculated as a total tax.

There is also taxation expenditure in the state's income budget. Examples of taxation expenditure include energy tax relief for biofuels and peat. Tax reductions for certain environmentally beneficial installations in detached houses and the reduction of the carbon dioxide tax for industry are other examples. The net total of the energy-related items of taxation expenditure amounted to just over SEK 37 billion in 2010[8].

Energy taxes – both environmental and fiscal

Energy tax is an umbrella name for excise duties on fuels and electricity. These can be roughly divided up into fiscal taxes and those intended to achieve environmental objectives. A fiscal tax is primarily designed to generate state revenue. Environmental taxes include the carbon dioxide and sulphur taxes. The general energy tax is essentially a fiscal tax. The distinction between these types of tax is rather fuzzy since both have an environmental effect and a fiscal function:

- General energy tax is levied on most fuels, based on various factors such as their energy contents.
- Carbon dioxide tax is levied on the emitted quantities of carbon dioxide from all fuels except biofuels and peat. The general rate of carbon dioxide tax in 2011 is 105 öre per kg of carbon dioxide.
- Sulphur tax is levied at a rate of SEK 30 per kg of sulphur emissions from coal and peat, and at SEK 27 for each tenth of one per cent of sulphur by weight per cubic metre of oil. Oil containing less than 0.05% of sulphur by weight are exempt from the tax.
- The environmental levy on the emission of nitrogen oxides amounts to SEK 50 per kg of nitrogen oxides on emissions from boilers, gas turbines and stationary combustion plants supplying at least 25 GWh per annum. The levy is, however, intended to be fiscally neutral and is repaid in proportion to each plant's utilized energy. This means that it is only those with the highest level of emissions per utilized energy produced that are net payers.

The proportion of fossil carbon in domestic waste is assumed to be 12.6% by weight. Municipalities with a lower electricity tax are all those in Norrbotten County, Västerbotten County and Jämtland County. The lower tax rate also applies to Torsby in Värmland County, Sollefteå, Ånge and Örnsköldsvik in Västernorrland County, Ljusdal in Gävleborg County as well as Malung-Sälen, Mora, Orsa and Älvdalen in Dalarna County, see Table 3.

8 Communication 2010/11:108, Reporting of taxation expenditure 2011

Table 3 General energy and carbon dioxide taxes from 1 January 2011, excluding VAT

	Energy tax	Carbon dioxide tax	Sulphur tax	Total tax	Tax öre/kWh
Fuels					
Heating oil, SEK/m³ (<0.05% sulphur)	797	3 017	–	3 814	38.3
Heavy fuel oil, SEK/m³ (<0.4% sulphur)	797	3 017	108	3 922	37.0
Coal, SEK/tonne (0.5% sulphur)	605	2 625	150	3 380	44.7
LPG, SEK/tonne	1 024	3 174	–	4 198	32.8
Natural gas, SEK/1000m³	880	2 259	–	3 139	28.5
Crude tall oil, SEK/m³	3 814	–	–	3 814	38.9
Peat, SEK/tonne, 45% moisture content (0.3% sulphur)	–	–	50	50	1.8
Motor fuels					
Petrol, unleaded, environmental class 1, SEK/l	3.06	2.44	–	5.50	60.8
Diesel, environmental class 1, SEK/l	1.52	3.02	–	4.54	45.6
Natural gas/methane, SEK/m³	–	1.58	–	1.58	14.4
Electricity use					
Electricity, northern Sweden, öre/kWh	18.7	–	–	18.7	18.7
Electricity, rest of Sweden, öre/kWh	28.3	–	–	28.3	28.3
Industry					
Electricity use, industrial processes, öre/kWh	0.5	–	–	0.5	0.5

Source: Swedish Tax Agency, additional processing by the Swedish Energy Agency.

Electricity and heat production are taxed differently

Electricity production in Sweden is exempted from energy and carbon dioxide tax. Tax is payable on electricity use and the amount of tax does not only depend on where in the country the electricity is used but also on how it is used. Since 1 July 2000, nuclear power plants have been taxed on the maximum permissible thermal power rating of their reactors. Since 2008, this tax has been SEK 12,648 per MW and calendar month. A charge of 0.3 öre/kWh is also levied in accordance with the ”Studsvik Act”. In order to finance the future costs of the final disposal of spent nuclear fuel, a charge of 0.7 öre/kWh is also levied.

Fuel used for heat production is burdened with energy tax, carbon dioxide tax and, in certain cases, sulphur tax and the nitrogen oxide levy. In principle, biofuels and peat used for the production of heat and electricity are tax-free. For CHP plants, heat produced in the simultaneous production of heat and electricity is taxed in the same way as in industry. The tax on fossil carbon in domestic waste was abolished on 1 October 2010. Electricity production plants are also subject to property tax. For example, for hydro power stations, this amounts to 2.8% of the tax assessment value of the property.

Fuel use determines taxation

The level of carbon dioxide taxation for industries that are not in the EU Emissions Trading System (EU ETS) is 30% of the general carbon dioxide tax level. For CHP plants in the EU ETS, the corresponding level is 7%. Industries in the EU Emissions Trading System were exempted from the carbon dioxide tax from 1 January 2011. This was replaced by an energy tax of 30% of the general energy tax level.

Heat production in CHP plants pay 30% of the general energy tax on fossil fuels and of the carbon dioxide tax. This tax reduction also applies to manufacturing industries, market gardening, agriculture, forestry and aquaculture. For crude tall oil, reduction rules on energy tax apply as it is not subject to carbon dioxide tax.

Energy-intensive industrial operations have special rules which, from 1 January 2011, allow a reduction of that part of the carbon dioxide tax which exceeds 1.2% of the retail value of the manufactured products when 70% of the carbon dioxide tax has been deducted. This reduction requires the company to be energy-intensive in accordance with the 0.5 per cent rule. A company is energy-intensive according to the 0.5 per cent rule if the remaining tax (excluding sulphur tax), after the general tax reduction for fuels used for heating or the operation of stationary engines in manufacturing industries or market gardening, amounts to at least 0.5% of the value added by processing. The maximum carbon dioxide tax relief of 70% is obtained for an electrical efficiency of 15%. Exemption from energy tax is obtained for an electrical efficiency of 5%.

There are various tax levels for transport, depending on the type of fuel, its environmental class and its application. No energy tax, carbon dioxide tax or sulphur tax is payable on the use of diesel oil or heating oils used in commercial shipping or rail

Table 4 Energy and environmental taxes on industry, agriculture, forestry, aquaculture and heat production in CHP plants not in the European Emissions Trading Scheme, from 1 January 2011

	Energy tax	Carbon dioxide tax	Sulphur tax	Total tax	Tax öre/kWh
Heating oil, SEK/m^3	239	905	–	1 144	11.5
Heavy fuel oil, SEK/m^3	239	905	108	1 252	11.8
Coal, SEK/tonne	182	788	150	1 119	14.8
LPG, SEK/tonne	307	952	–	1 259	9.9
Natural gas, SEK/1000m^3	264	678	–	942	8.6
Crude tall oil, SEK/m^3	1 144	–	–	1 144	11.7
Peat, SEK/tonne, 45% moisture content (0.3% sulphur)	–	–	50	50	1.8

Source: Swedish Tax Agency, additional processing by the Swedish Energy Agency.

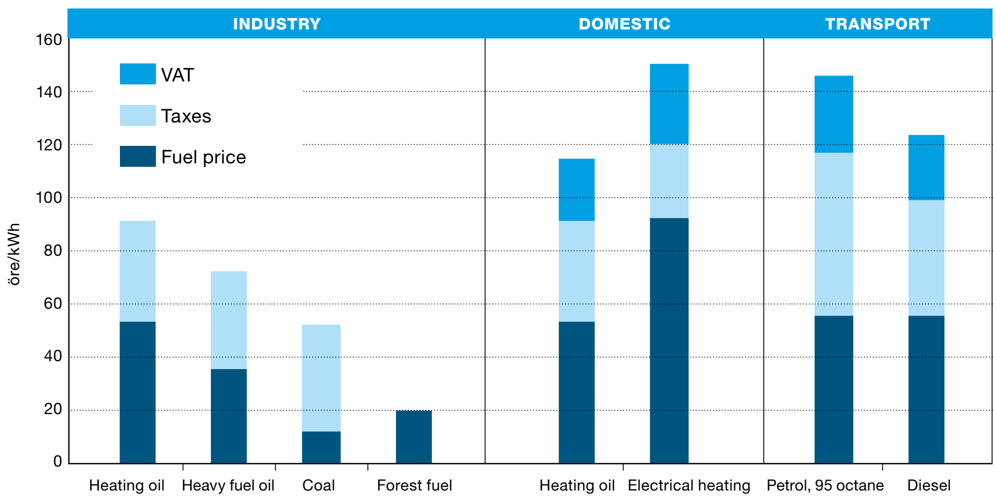
traffic or payable on aviation petrol or aviation paraffin for commercial flights. Electricity for rail and tram traffic is also exempt from tax. Aviation fuel used for private traffic has been brought within the tax remit with effect from 1 July 2008 No energy tax or carbon dioxide tax is charged on ethanol, rapeseed oil methyl ester (RME) or biogas.

Natural gas used as a motor fuel is exempt from energy tax but is subject to carbon dioxide tax, albeit at a 30% reduction. Tax exemptions for biogas are obtained from 1 January 2011 through deductions submitted on tax returns, in keeping with Government Bill 2009/10:41. Changes in the rules for the taxation of biogas and other gaseous fuels delivered by pipeline were also introduced at this time, in keeping with Government Bill 2009/10:144. These changes mean that the tax exemption will follow the gas all the way to the end user, brought about by an agreement between the customer and the supplier of biogas to the natural gas network. The purpose of the new rules is to facilitate a transition to a higher proportion of biogas in the energy system.

For electricity use in manufacturing processes or in professional market gardening, a tax rate of 0.5 öre/kWh applies for the year 2011. Electricity used in northern Sweden is taxed at 18.7 öre/kWh, as opposed to 28.3 öre/kWh in the rest of the country. In addition to these excise taxes, value-added tax at 25% is also payable. For companies, this VAT is tax deductible.

For a consumer heating a house with heating oil, taxes accounted for 53% of the total price in 2010. This may be compared with petrol, for which the proportion of taxes, including VAT, was 61%.

Figure 1 Total energy price for various customer categories in 2010, in öre/kWh



Source: SPBI, Swedish Energy Agency, Statistics Sweden, Swedish Tax Agency, additional processing by the Swedish Energy Agency.
Note: Prices for industry do not include any volume discounts.

Adopted changes in energy taxation

Various changes to the taxation system have been adopted in accordance with the Government Bill 2009/10:41. The changes in the tax system affect fossil motor fuels and fuels used for heating purposes. These will also be included in the EU's Energy Taxation Directive. The purpose of these changes is to achieve

- the targets for greenhouse gas emissions
- the targets for the proportion of renewable energy
- more efficient energy use

On 1 January 2011, the energy tax for diesel was increased by an initial increment of SEK 0.2/litre. The second increase, also by SEK 0.2/litre, will take effect on 1 January 2013. This will be offset by a lower motor vehicle tax for diesel cars. Furthermore, the reduction of carbon dioxide tax on natural gas will brought down in 2013 to 20%. The tax reduction applies in the case of motor fuel consumption and will be discontinued completely in 2015[9].

2011 saw the introduction of an energy tax of 30% of the general level, representing 2.4 öre/kWh, for diesel oil use in certain industrial mining operations. The level of carbon dioxide tax will be increased in 2015 to 60% of the general carbon dioxide level. Industries that are not in the EU Emissions Trading System, agriculture, forestry as well as heat production in CHP plants will be affected by the increase.

These new changes in taxation form part of government efforts to reduce the number of exceptions in the energy tax system. In this way, energy and carbon dioxide taxation will be made more effective.

9 Communication 2010/11:108, Reporting of taxation expenditure 2011

2.3 The electricity certificate system aids renewable electricity production

The electricity certificate system will give Sweden an increase in electricity production from renewable energy sources. The goal is to increase the production of electricity from renewable energy sources by 25 TWh by the year 2020, compared with 2002. The system is intended to run until the end of 2035 and will help Sweden to achieve a more ecologically sustainable energy system.

Production entitled to electricity certificates

Electricity production in the form of wind power, certain forms of hydro power, certain biofuels, solar energy, geothermal energy, wave energy and peat in CHP plants qualifies for electricity certificates. In 2010, electricity production qualifying for electricity certificates came to 18.1 TWh, see Table 5.

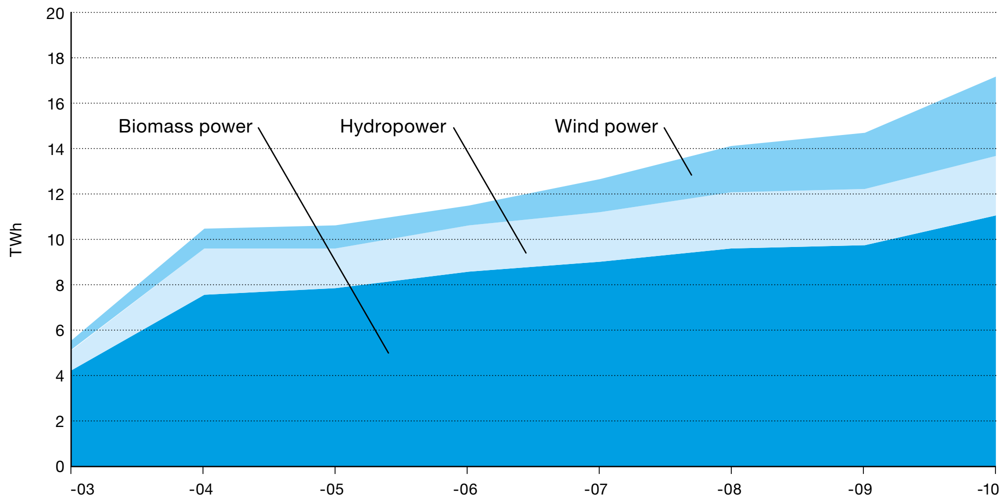
Table 5 Number of plants, production and installed capacity, by type of production, 2003–2010

	2003 May-Dec	2004	2005	2006	2007	2008	2009	2010
Number of plants[1]	1 597	1 759	1 848	1 909	2 075	2 219	2 419	2 711
Hydro	966	1 040	1 060	1 075	1 094	1 120	1 144	1 164
Wind	543	613	668	706	846	948	1 108	1 371[3]
Biofuels, peat	87	105	118	125	131	142	156	163
Solar	1	1	2	3	4	9	11	13
Installed capacity, [MW][2]	4 049	4 161	4 471	4 765	5 066	5 123	5 935	6 674
Hydro	491	504	517	540	558	598	602	620
Wind	401	472	530	583	831	1 074	1 440	1 998
Biofuels, peat	3 157	3 185	3 424	3 643	3 676	3 451	3 892	4 056
Solar	0.008	0.008	0.011	0.036	0.043	0.309	0.369	0.575
Electricity production – renewable and peat [GWh]	5 638	11 048	11 298	12 157	13 256	15 037	15 570	18 053
Hydro	964	1 968	1 799	2 019	2 195	2 607	2 442	2 611
Wind	456	865	939	988	1 432	1 996	2 490	3 486
Biofuels	4 218	7 671	7 926	8 594	9 049	9 599	9 766	11 163
Peat	-	545	634	556	580	834	871	792
Solar	0.004	0.006	0.005	0.020	0.019	0.129	0.212	0.275

Source: Swedish National Grid and the Swedish Energy Agency.
Note: 1. Number of plants allocated one or more electricity certificates for the year in question.
2. For plants allocated one or more certificates.
3. 1,371 wind farms consisting of 1,606 wind power turbines.

The Renewables Directive does not count peat as a renewable fuel. Electricity production from renewable energy sources in the electricity certificate system, excluding peat, came to 17.3 TWh in 2010, see Figure 2.

Figure 2 Renewable generation in the electricity certificate system by hydropower, wind power and biomass power (excluding peat), 2003-2010, in TWh



Source: Swedish Energy Agency.

Producers and users of electricity certificates

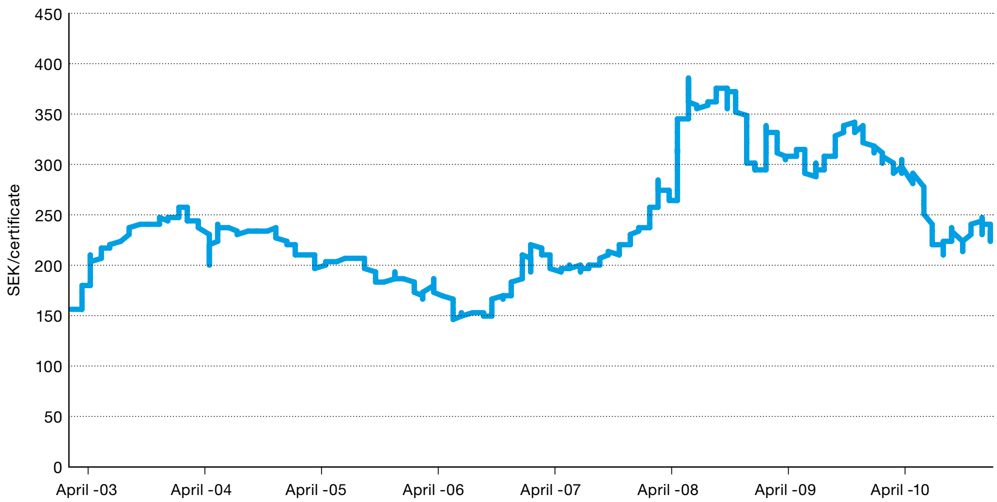
The system is based on producers of renewable electricity receiving one electricity certificate for each megawatt hour of electricity produced. On sale of these certificates, producers receive an extra income in addition to revenues from electricity sales, which creates better economic conditions for the environmentally compatible production of electricity.

Electricity suppliers that deliver electricity to end users and certain electricity consumers are covered by quota obligation requirements. In addition to electricity-intensive industries, the system covers all electricity consumers who themselves have produced, imported or purchased electricity on the Nordic electricity exchange. This means that, as consumers, they have to buy a certain number of electricity certificates in proportion to the electricity delivered to them or used by them.

This has been done in order to create a demand for electricity certificates. In 2010, electricity consumers were required to purchase certificates corresponding to 17.9% of their electricity use.

The price of electricity certificates is determined in a competitive market through the interaction of supply and demand. Several factors affect the price levels. One example is the expected demand for electricity and expected future production. Figure 3 shows the spot price of electricity certificates since the system started on 1 May 2003.

Figure 3 Average spot price of electricity certificates, 2003–2010, in SEK/certificate



Source: Svensk Kraftmäkling AB.

2.4 Flexible mechanisms supplement national measures

The Kyoto Protocol and the Marrakech Accords include what are known as 'Flexible Mechanisms'. They serve to supplement measures intended to reduce greenhouse gas emissions on a national level. These were decisive in bringing about the commitments of the Kyoto Protocol. They will also play a central role in a climate agreement for the period after 2012. The flexible mechanisms consist of:

- International Emissions Trading, IET
- Joint Implementation, JI
- Clean Development Mechanism, CDM

Emissions trading is an important instrument for climate policy

The European Emissions Trading Scheme (EU ETS) is an important policy instrument employed by the European Climate Change Programme, the goal of which is to fulfil Union commitments on reduced emissions in accordance with the Kyoto Protocol. The purpose of the trading system is to achieve a reduction in greenhouse gases at the lowest cost. This will be brought about by allowing companies to trade in carbon dioxide emissions allowances, subject to a cap on emissions. From 2008 to 2012, the EU ETS runs in parallel with the Kyoto Protocol's first commitment period. EU emissions trading is regulated by the Emissions Trading Directive, which covers all 27 member states.

Each year during the 2008–2012 trading period, Sweden will allocate 19.8 million emissions allowances to existing plants. There is also a reserve for new participants totalling 13.1 million allowances. This is detailed in a national allocation plan inspected and approved by the European Commission. Taken together, the various member states' allocation plans form a total cap for the number of emission allowances.

Since 2008, the EU has been undertaking a revision of emissions trading regulations ahead of the third trading period starting in 2013. The changes mean that more greenhouse gases and activities will be included. Aviation will be included earlier, from 2012. The main principle guiding the allocation of emission allowances will be auctioning. Certain sectors of industry facing international competition will, however, receive an allocation free of charge based on benchmarks designed to favour the most efficient plants in the EU. Decisions on the levels of these benchmarks and the allocation rules were adopted by the European Commission in spring 2011. Swedish companies affected by this apply for an allocation for the period 2013–2020 during the summer and autumn of 2011.

Energy-intensive industries and producers of electricity and heat covered by the system

The Emissions Trading Sheme covers companies in energy-intensive industries as well as producers of electricity and heat. In addition to these, other companies, individuals and organizations may also trade in emission allowances. Each year, operators are required to surrender emission allowances equivalent to the annual emissions from their plants. One emission allowance represents one tonne of carbon dioxide.

Operators that exceed their allocation must either reduce their emissions or buy allowances from others. It is also possible to use credits for emission reductions units from the project-based mechanisms CDM and JI.

The companies' right to use credits from CDM and JI during the period 2008–2012 has been restricted by the European Commission. Swedish companies may use credits up to 10% of the total national allocation. This restriction has been redistributed at plant level in order to give more plants the opportunity to surrender credits instead of emission allowances.

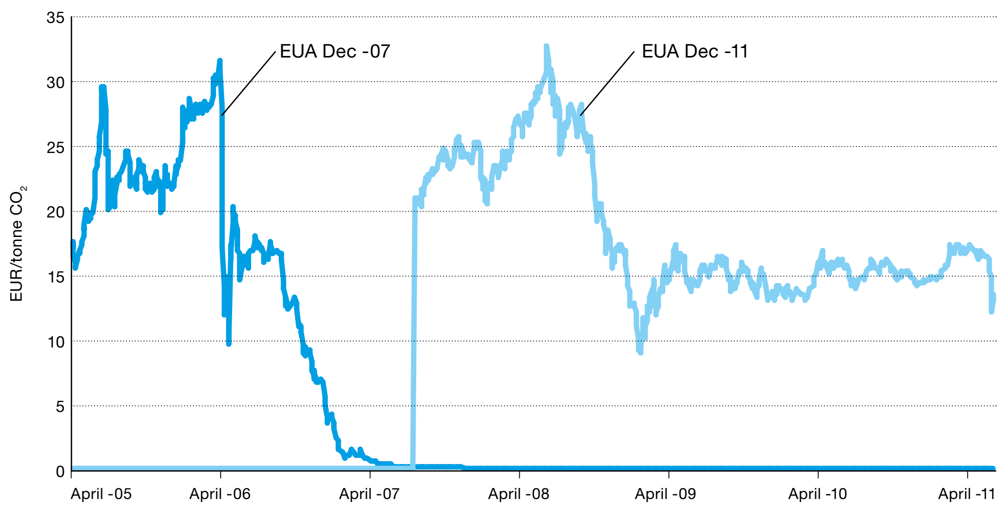
World events affect the price of emission allowances

During spring 2011, the price has been affected by events such as the nuclear power disaster in Japan, the economic crisis in Greece and Germany's decision to end its nuclear power programme. The price of an emission allowance is determined by supply and demand in the market. Supply consists of the total allocation of emission allowances and the availability of credits for emission reductions from the project-based mechanisms. Demand is in turn governed by how high emissions levels are and depends on the requirements for e.g., electricity and heat production, fuel prices and trends in the economy.

For the period 2008–2012, the European Commission cut the allocation by 9.5% compared with the period 2005–2007, as there was a heavy surplus of allowances during the first trading period. It is now possible to carry over allowances to the coming trading period 2013–2020 and use them to cover any future deficits. During the first two years of the 2008–2012 trading period, the price of allowances fluctuated greatly. The price of an emission allowance went up to around EUR 30 when prices for, e.g., oil and gas rose. In conjunction with the financial crisis, the price of emission allowances began to fall. The beginning of 2009 saw the lowest levels; around EUR 8. The market recovered somewhat in spring 2009, and thereafter the price stabilized, resting between EUR 12 and EUR 16. The gradual economic recovery is one of the reasons behind the price rise.[10]

10 Utvecklingen på utsläppsmarknaden 2010 – en beskrivning och analys av den globala utsläppshandeln (Developments in the emissions market in 2010 – a description and analysis of the global trade in emissions), Swedish Energy Agency, ER2010:42

Figure 4 Prices of European Union Allowances, April 2005–June 2011, in EUR/tonne CO_2



Source: www.pointcarbon.com

The Energy Agency's role regarding the CDM and JI

The flexible mechanisms JI and CDM make it possible or one country to contribute to emissions reductions in another country through concrete projects in different plants. These projects can be credited towards the fulfilment of their own commitments. By investing in a project to reduce emissions in a country in which the costs of so doing are lower than in the country of the first part, the project becomes cost-efficient. Besides reducing emissions of greenhouse gases, the project-based mechanisms also contribute to important technology transfer and construction of physical capacity in the host countries.

The Swedish Energy Agency is the official Swedish Designated National Authority for the project-based mechanisms. This means approving participation in CDM and JI project activities. The roel of the project authority also includes deciding whether proposed JI-projects in Sweden meet requirements of the rules set out in the Kyoto Protocol.

The task of the Swedish Energy Agency is to assist in making CDM and JI credible and effective instruments in the international climate collaboration. This will primarily be brought about through the establishment and development of a portfolio of CDM and JI projects. The intended result is cost effective reductions in greenhouse gas emissions, which the Swedish Energy Agency will administer through the Swedish CDM and JI projects. Acquiring emissions reductions through CDM and JI is cost effective, as the cost for doing so via the project-based mechanisms is lower than the marginal cost of emissions reductions in Sweden.

Emissions reductions acquired via the Swedish CDM and JI programmes are estimated to total 7.4 million tonnes of carbon dioxide equivalents in August 2011. The accumulated funds for international CDM and JI climate actions amount to about SEK 1,500 million for the period 2008–2014.

CDM and JI focus on energy efficiency improvement and renewable energy projects

In terms of the CDM and JI programme, Sweden's goal is to put together a geographically balanced portfolio, concentrating on small and medium-scale projects in the categories of energy efficiency improvement and renewable energy. Special priority should be given to projects in the least developed countries, particularly in Africa and South-East Asia and to small island nations, which are in the process of development. At the end of August 2011, the Swedish Energy Agency had signed agreements for the purchase of emissions reductions with 46 individual CDM and JI projects, the latest being in Benin, Mauritius, India, Thailand, Vietnam, Tanzania, Nigeria, Uganda and Kenya.

In addition to engagements in bilateral projects, the Swedish Energy Agency also participates in seven multilateral CDM and JI funds. A selection of these is listed below:

- The World Bank's Prototype Carbon Fund's (PCF) total capital amounts to USD 180 million. The Swedish Energy Agency has represented Sweden since the spring of 2009. Sweden increased its contribution to the fund in 2010 and has now contributed USD 17 million. In 2010, the PCF delivered a further 124,000 emissions reduction units to Sweden.
- The World Bank's Umbrella Carbon Facility Tranche 2 (UCG T2). This fund started in December 2010, and Sweden's contribution amounts to EUR 10 million. The projects in UCF T2 have already existing agreements, or have been negotiating, with the World Bank's other funds in which UCF T2 will acquire the emissions reductions the projects generate after 2012.
- The Carbon Partnership Facility (CPF) is an innovative fund for the acquisition of emissions reduction units after 2012. The fund, which holds EUR 140 million, focuses on large-scale action programmes and investments. Sweden and Norway each committed EUR 20 million in 2010, and both countries will join the fund's board.

Constant evaluation of Sweden's climate work

Sweden's climate work and its national targets will be constantly monitored and evaluated. Sweden reports its greenhouse gas emissions to the UN climate secretariat and to the European Commission once a year. In addition, it submits a national report on climate changes once every five years, describing what Sweden is doing to achieve the commitments and requirements agreed in the Climate Convention and the Kyoto Protocol. The report includes emissions data, emissions forecasts and information on aid to developing countries.

2.5 Submission time for two-year reports in the Programme for Improving Energy Efficiency in energy-intensive industries

In 2011, it is time for the companies participating in the Programme for Improving Energy Efficiency in energy-intensive industries, PFE, to submit their two-year reports. These reports will be collated in the autumn, and the document will give an indication of the results the companies can be expected to achieve in PFE's second period.

New EU rules on state aid for environmental protection will take effect from 2013. The Government has chosen to apply to the European Commission for renewed approval of PFE for a further five years. In anticipation of the decision, the Swedish Energy Agency has opened a second programme period, making it possible for companies to participate in a new five-year period. Companies that have not previously participated may apply to join the second programme period. All except six of the previously participating companies have applied to join the new programme period immediately following on from the previous period.

Excellent results from the first period

The 100 companies participating in the first period of PFE achieved an annual electricity efficiency improvement totalling 1.45 TWh. This is equivalent to the annual electricity use of 80,000 houses with electric heating or the entire annual electricity demand of the City of Uppsala. The companies have achieved these results through their efficiency improvement measures and improved procedures for energy-efficient purchases and project designs. The overall result exceeded the original target by a wide margin.

The PFE companies have invested over SEK 700 million in the more than 1,200 electricity efficiency improvement measures implemented during the programme period. It has been calculated that these measures alone have generated savings of SEK 430 million per year. The average payback time for the measures is 1.5 years. In addition to the direct improvement in the use of electricity, the companies have also been able to increase their internal electricity production by 1 TWh per year, through such means as discharging process steam or making turbines more efficient. In total, the PFE companies produce 6 TWh of electricity per year.

Companies' undertakings reduce electricity tax

On 1 July 2004, an energy tax was introduced for electricity used in manufacturing industries at a rate equivalent to the minimum tax rate as set out in the Energy Taxation Directive. This hitherto non-taxable electricity used in manufacturing industries was made subject to an electricity tax of 0.5 öre/kWh. In June 2004, the Government tabled a bill setting out an Energy Efficiency Improvement Programme, which came into force on 1 January 2005 in accordance with Act (2004:1196). A requirement for participation in the programme is that the company must be an energy-intensive company. The Energy Taxation Directive gives a number of definitions of energy intensity.

Companies participating in the five-year programme can receive a full reduction of the energy tax on electricity that they would otherwise have to pay. In return, they undertake to introduce, within the first two years, an energy management system and to perform an energy audit. The audits are then used to determine the companies' potential for improving the efficiency of their energy use. Through these undertakings that form part of the programme, the companies gain a greater awareness of their potential for cost effective energy efficiency improvements. In addition, the companies benefit from the introduction of a process for continuous, structured improvement of their efficiency of energy use

The companies also undertake to implement, during the programme period, all the energy efficiency improvement measures that have been identified andwhich have a payback time of less than three years. The measures implemented should cost the equivalent to the amount that the electricity tax would have raised. PFE has the overall aim of promoting the efficient use of energy.

2.6 Energy use in buildings regulated by legislation and financial support

A variety of policy instruments are employed to influence energy conservation in buildings. Some of the more important are building regulations, energy performance certificates and financial support. At present, tax reductions are available for renovation and maintenance, for example. Financial support is also provided for the installation of solar cells and solar collectors.

Building regulation requirements to be tightened

In May 2011, an updated version of the building regulations, BBR18, entered into force. The Swedish National Board of Housing, Building and Planning (Boverket) intends to tighten requirements further for energy conservation. Changes in the section are expected to be completed in autumn 2011.

Boverket's building regulations, BFS 2011:6, set technical performance standards for new buildings. The section on energy conservation details requirements for energy use. A building's energy use is expressed in terms of energy per square metre per year. The requirements are given for residential and non-residential premises and for three different climate zones. Stricter requirements apply if the building is heated using electricity.

Energy Performance Certificates give advice on improving energy efficiency

Energy performance certificates provide information about a building's energy use. With the help of reference values, a building's energy performance can be compared with that of similar buildings. A property owner also receives proposals for cost effective measures for reducing energy use in the building.

The Act on energy performance certification of buildings (2006:985) requires certification for multi-dwelling buildings and non-residential premises since the beginning of 2009. Also one- and two-dwelling buildings are to have a valid energy performance certificate when they are sold. An energy performance certificate is valid for ten years, and the property owner is responsible for obtaining certification for a building.

An energy performance certificate is drawn up by an independent energy expert. The expert then enters the data into Boverket's register for energy performance certificates. The registered details constitute information about the building, including energy use, area, technical systems and proposals for cost-effective measures for saving energy.

Financial support for reduced energy use and increased proportion of renewable energy

December 2008 saw the introduction of financial support in the form of tax reductions for renovation, maintenance, conversions and extensions (known in Sweden as the ROT deduction). The main purpose of the ROT deduction is to increase demand for building services. The ROT deduction also serves to reduce energy use through covering a number of measures for saving energy.

Financial support is also available for fitting solar cells in installations begun no earlier than 1 July 2009 and completed no later than 31 December 2011. This support is intended to speed up the adaptation of the energy system and the development of the energy technology sector. The support can be sought by all actors – individuals, businesses and public organizations.

Financial support for investments in solar heating which was previously available to individuals, businesses and public organizations will no longer exist after 2011. Individuals will instead have to make use of the ROT deduction.

2.7 EU requirements affect the development of the transport sector

There are many policy instruments that affect development of the transport sector in Sweden. At the EU level, this includes the Renewables Directive, which specifies the use of at least 10% of renewable energy in the transport sector by 2020. This directive also contains provisions on sustainability criteria for biobased motor fuels and liquid biofuels. The Fuel Quality Directive specifies permitted levels of low-admixture additives in diesel and petrol. This directive allows 7% by volume of fatty-acid methyl ester, FAME, in diesel and 10% by volume of ethanol or 3% by volume of methanol in petrol. The directive also places requirements on the suppliers of fossil fuels for the transport sector. The life cycle greenhouse gas emissions per energy unit of fuel must, from a base value that has not yet been decided, be reduced by 6% by 2020.

Regulation (EC) No 443/2009 states that the emissions of new passenger cars in the EU may not, on average, exceed 130 g carbon dioxide/kilometre. These requirements are being implemented gradually to include 65% of all new vehicles by 2012. All new vehicles will be covered from 2015. Aviation will be included in the EU Emissions Trading System from 2012. This will apply to all flights landing or taking off from an airport in the EU.

Economic policy instruments in the transport sector to increase numbers of low-carbon vehicles

Significant economic policy instruments in the transport sector are the taxes on carbon dioxide and energy. The levels of these taxes are based on the environmental class and type of fuel. At present, the energy tax on diesel is lower than that on petrol. This is offset by a higher vehicle tax. As the energy tax on diesel is increased, vehicle tax will be reduced. With effect from 1 January 2011, the carbon dioxide differentiation of vehicle tax was increased from SEK 15 to SEK 20 per gram of carbon dioxide per kilometre, making vehicles which have a high carbon dioxide efficiency a more advantageous choice. The emissions level at which the tax begins to be levied was also raised from 100 g of carbon dioxide per kilometre to 120 g of carbon dioxide per kilometre. From 2011, the vehicle tax for newly registered light goods vehicles, buses and motor caravans are also subject to carbon dioxide differentiation. The vehicle tax for heavy goods vehicles does not include carbon dioxide differentiation, but is levied by weight and exhaust class.

The benefit value of a company car is subject to income tax, and tax for this is also levied through the social insurance contributions paid by employers. Free motor fuel may also be part of a company car package. How these benefits are taxed, affects which cars are selected and how they are used. The present structure of benefit value tends to even out the effect of price differences between cars, with the result that company cars emit more carbon dioxide per kilometre than the average for new cars. Benefit taxation is also reduced for clean vehicles[11].

Increased use of public transport and biobased motor fuels will reduce the environmental impact

From 1 July 2011, a new Act (2011:846) requires that the procurement or leasing of cars and public transport services take into account a vehicle's energy use and emissions during the entire period of use. With effect from 1 January 2012, public transport operators will be free to establish commercial public transport in accordance with the new Public Transport Act (2010:1065). The aim is to give passengers a greater number of travel options and increase the use of public transport, which will lead to positive effects for the environment.

Biobased motor fuels are exempt from energy and carbon dioxide taxation until 2013. This will affect the profitability of using biobased motor fuels. From 1 January 2011, the maximum tax-exemption levels for low-admixture additives is 6.5% by volume for ethanol in petrol and 5% by volume for biodiesel in diesel. All ethanol and biodiesel used as low-admixture additives beyond these levels is taxed as petrol or diesel, in keeping with Government Bill 2010/11:1.

11 Underlagsrapport 2 – Styrmedel i klimatpolitiken (Background report 2 – Policy instruments in climate policy) ER2007:28, the Swedish Energy Agency and the Swedish Environmental Protection Agency

Tighter clean vehicle definition and super-green car rebate underway

From 1 July 2009, clean vehicles are exempt from vehicle tax for five years. 'FACTS Clean vehicle definition' gives the definition of a clean vehicle that attracts exemption from vehicle tax. At present, there is no single definition of a clean vehicle, but different definitions are used in different contexts. A tightening of the definition is being investigated.

FACTS CLEAN VEHICLE DEFINITION

The following requirements must be met for a passenger car to be classified as clean vehicle:

- For conventional passenger cars, including hybrid vehicles, carbon dioxide emissions must not exceed 120 g/km. For diesel cars, there is an additional requirement that particle emissions must not exceed 5 mg/km.
- For passenger cars running on alternative fuels, fuels other than petrol, diesel or LPG, fuel consumption must not exceed 0.92 litres of petrol per 10 km or 0.97 cubic metres of gas per 10 km.
- For electric cars, electrical energy use per 100 km must not exceed 37 kWh.
- The definition giving a reduction of a car's benefit value, for taxation at 20–40%, is that the vehicle can be wholly or partly powered by alcohol, gas (not LPG) or electricity. This means that, for example, all types of hybrid vehicles qualify.

The Swedish Transport Agency has been commissioned to draw up a proposal for a super-green car rebate. Its findings were reported on 28 March 2011. The proposed requirements for a passenger car to obtain the premium are a maximum of 50 g of carbon dioxide per kilometre, 0.3 kWh per kilometre and a maximum of 72 decibels. Safety will also be taken into account. The final draft of the criteria is scheduled for autumn 2011. Following consultations, the Government has broadened the scope of the premium to include not only individuals, but also car sharing schemes, the public sector and companies such as taxi firms and the car rental sector. The size of the premium is proposed to be SEK 40,000 for individuals and 35 per cent of the additional cost of producing a super-green car or a maximum of SEK 40,000 for legal entities. The introduction of the super-green car rebate is scheduled for 1 January 2012.

Regional policy instruments

There are many local and regional policy instruments. A congestion charge was introduced in Stockholm in 2007, and will be introduced in Göteborg on 1 January 2013, with the purpose of funding investments in infrastructure and improving traffic flow and the environment. Other examples are subsidized public transport, free parking for clean vehicles and higher parking charges for all vehicles.

2.8 Procurement promotes the development of new technology

Technology procurement is a process, rather than a project, consisting of a number of different phases (activities) and several different groups of actors. The phases are performance of a feasibility study, assembly of a purchaser group, drafting of performance specification, requests for tenders, evaluation of results, dissemination and continued development. The purpose of technology procurement is to encourage and accelerate the development of new technology. The aim is to develop new products, systems or processes that meet purchasers' needs better than do existing products on the market. Another way of describing this is to say that technology procurement is a policy instrument intended to start a process of market change and to encourage the spread of new, efficient technology in the form of new products and systems.

Technology procurement is intended to work within normal market forces and limitations, with the aim of creating long-term results for the industry. It provides incentives for innovative companies, and several efficient products have been developed and spread by the process. Today, technology procurement is carried out in close conjunction with permanent purchaser groups for residential buildings, non-residential premises and food retailers. Other procurement projects are performed in conjunction with networks in the public sector, sector organizations etc.

Most technology procurement is carried out in the fields of heating and control systems, domestic hot water and sanitary systems, ventilation, white goods, lighting and industry. The Swedish Energy Agency has prepared a list of all technology procurement projects in the energy field that have been carried out by it or by its forerunners. Since the 1990s, about 60 different technology procurement projects have been initiated and co-financed. Current technology procurement projects include heat recovery in existing multi-dwelling buildings, additional insulation for multi-dwelling buildings by means of prefabricated wall elements, climate screen-integrated systems for solar shading and daylight penetration in non-residential premises, and the use of cooling towers rather than chillers in non-residential premises. The industrial sector is currently carrying out technology procurement for improving the energy efficiency of cooling water systems in the processing industry.

During 2010, the Swedish Energy Agency agreed to provide an SEK 62 million subsidy to the City of Stockholm which, in collaboration with Vattenfall AB, will carry out Sweden's largest technology procurement project for electric vehicles. The purpose of the procurement is to start a Swedish market for electric vehicles, and thus assist the country's changeover to a sustainable energy system. The target of the procurement project is that 1,050 electric vehicles should be in operation in Sweden by the end of 2012.

2.9 Research to support a transition to a sustainable energy system

Research, technical competence and employment of the appropriate technology are some of the things needed for a transition to a sustainable energy system and to strengthen Swedish industry and its competitiveness. With an investment proportion of 3.6% of GDP, Sweden is among the world leaders in terms of investment in research and development (R&D)[12]. Public R&D funding is attained through grants directly to universities and through grants to research councils and sectoral research agencies. Sectoral research agencies fund research and development, both to meet the individual sectors' skills requirements and to accelerate the development of society. In total, there are about twenty sectoral research agencies with R&D resources.

The main task of the Swedish Energy Agency is to implement the Programmes of Energy Policy adopted by Parliament in the years 1997, 2002 and 2009. The work aims at a transition towards an ecologically sustainable and financially sound energy system in Sweden and internationally. The goal is to develop the energy system and generate growth.

Energy research is conducted as part of the National Energy Research Programme. The programme spans from fundamental research and technological development to demonstration activities and business development. Energy research is divided into six thematic areas:

- Energy System Studies
- The Buildings as an Energy System
- Energy-intensive Industry
- The Power System
- The Transport Sector
- Fuel-based Energy Systems.

The objective for each thematic area is to ensure that the universities, industry and the public sector possess necessary knowledge and sompetence in order to support the transition to a sustainable energy system. As well as guarantee that the research results and methods gained from energy system studies are integrated into the activities of the Swedish Energy Agency. Also the National Energy System Programme aims at promoting the development of Swedish businesses and to bring new products and services on the market in order to accelerate the transition to an ecologically sustainable energy system, both in Sweden and around the world.

12 Swedish research: Larger funders of research, forskning.se

The Swedish Energy Agency monitors international developments in energy research and to promote Swedish participation in international work. Sectorial advisory boards have been established for each of the six thematic areas bringing together experts from industry, public authorities and other stakeholders who make use of research results. The boards support the Swedish Energy Agency in developing strategic research plans for each thematic area. For example, the boards assist in identifying and analysing the needs of different actors and obstacles in order to improve the interplay between research and other policy instruments. In accordance with appropriation directions[13] for the financial year 2011, the Swedish Energy Agency has budgeted SEK 1,312 million for energy research.

Energy system studies

Energy system studies is a thematic area with an overall approach which covers the other thematic areas to a varying degree. Research on smart grids and smart cities, for example, combine several of the Swedish Energy Agency's thematic areas such as power, buildings, and transport in a system perspective. The interaction between various types of actors, technical systems and the institutional frameworks they are a part of, is central in the thematic area. Research in this thematic area is oriented towards systems as well as general issues and perspectives with the purpose to increase the level of expertise in the energy system and its dynamics. The research results, gained from energy system studies, are important for drawing up energy and climate policy documents used for decisions on policy instruments, targets and the influence/impact of these on international climate policy.

Buildings as energy systems

Research on buildings as energy systems includes the supply and distribution of heat and electricity as well as systems for buildings. The goal is to reduce/improve energy use and to develop supply and distribution technology.

Energy-intensive industries

Improved energy efficiency in processes with high energy intensity has for a long time been a high priority. This is especially the case for processes in the paper, pulp and steel industries. There are also opportunities to increase reutilization of material in the processes and to provide energy products, such as steam, electricity, energy gases and solid biofuel, for their own use or to outside customers.

13 Government directive putting an appropriation at the disposal of the spending authority and specifying the allocation of the appropriated funds.

The transport sector

Research in the transport sector prioritizes the production of renewable motor fuels and energy-efficient vehicles. The development of renewable motor fuels centres primarily on ethanol, DME/methanol, biogas and synthetic natural gas through gasification (SNG), i.e. methane. The development of internal combustion engines is aimed primarily at reducing fuel consumption in passenger cars and heavy-duty vehicles as well as reducing harmful emissions. Research on electric drive systems is concentrated on electric and hybrid vehicles, the distribution of energy for electric vehicles and on fuel cells. Development and commercialisation of hybrid vehicles has been intensified and now extended so that it also includes rechargeable hybrid vehicles.

The power system

Research on the power system covers hydro power, wind power, solar electricity, marine energy and the transmission and distribution grid. Hydro power research is designed primarily to secure expertise in the long term, but also to improve the efficiency of existing hydro power. Wind power research serves to create conditions for increasing the proportion of electricity produced from wind and to reduce the production costs. Solar cell research centres on the development of cheaper and more efficient solar cells. Marine energy focuses on the development of new ideas in wave power. Research on power transmission and energy storage in the power system aims at creating a secure and efficient system adapted to new technologies and production methods. This research also includes smart electricity grids and touches upon several of the thematic areas.

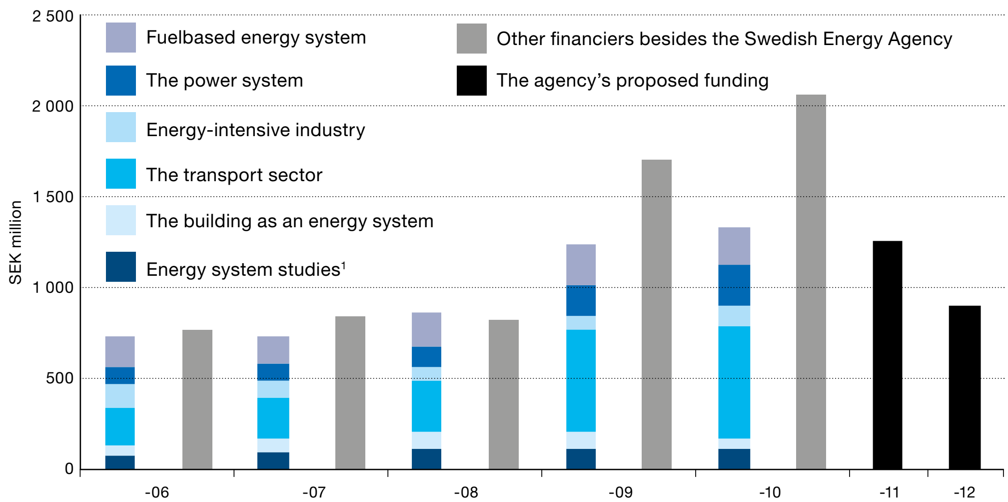
Fuel-based energy systems

Sweden is one of the leading countries in the production and use of solid biofuels, such as wood chips and pellets. In fuel-based energy systems, the chain from raw material to product is to be made more cost and resource effective while maintaining environmental sustainability. The supply of fuels from both forestry and agriculture is to increase, to fulfil the future demand from the energy and transport sectors. Solid waste should be minimized and wherever possible be combusted or digested with energy recovery if it cannot be reused or recycled. Heating and CHP technology is being studied to gain knowledge that can improve the efficiency of established techniques. This concern, for example, improved electricity yield and increased fuel flexibility. The conditions for introducing new techniques with improved performance are also being studied.

Sweden and international energy research and development

Sweden participates in several international research collaborations, particularly within the framework of Nordic Energy Research, the EU's Seventh Framework Programme, and the International Energy Agency's Implementing Agreements. 2010 saw the launch of the first four European Industrial Initiatives within the framework of the EU's strategic R&D plan for energy research, the SET Plan. The purpose of the SET Plan is to increase the involvement of the industrial sector in energy research and thus create conditions for achieving the energy and climate targets adopted in the EU. The SET plan runs until 2020. The four areas Sweden has made a priority are wind, smart cities, smart electricity grids and bioenergy. Other areas are carbon capture and storage (CCS), fuel cells, nuclear power and solar energy.

Figure 5 Energy research, development and demonstration funding, 2006–2012, in SEK million



Source: Energy in Sweden 2010 (ET 2010:45), the Swedish Energy Agency's Annual Report 2010 (ER 2011:01), Budget Bill 2009/10:1 category 21 Energy.

Note: For the period 2006–2010, actual figures are shown. 2011 and 2012 refers to expected funding. The figures are therefore not strictly comparable.

2.10 Agencies cooperate on energy information

Information is often used to supplement other policy instruments in order to increase knowledge, create involvement and contribute to understanding and confidence. The Swedish Energy Agency works very actively with information in its various fields of expertise and is continuously developing information both for the public and for businesses. This year, this section outlines some examples of the Agency's various collaborative activities to spread energy information in Sweden.

The Swedish Energy Agency supports education on energy issues

The Swedish Energy Agency website has been redesigned with a new appearance and some new structure and now devotes a section to the public sector. The reason for this is the Swedish Energy Agency's expanded commission to support authorities to improve their energy efficiency.

The third phase of the Sustainable Municipality programme has started. A manual has been written for energy-related indicators for municipalities, and good examples from the participating municipalities have been collected and circulated. In addition, two major conferences for Sustainable Municipality have been arranged.

The electronics and white goods trades have received information about new energy labelling. In addition to this, a survey of households and personnel in the electronics and white goods trades has been conducted to study knowledge, behaviour and attitudes towards energy labelling.

The Swedish Energy Agency assists municipal energy and climate consultants to communicate information to households as well as small and medium-sized businesses. Energy and climate consultation is available in all municipalities, with free and impartial advice. The Agency arranges an annual conference, Kraftsamling, with the intention to train and enthuse the country's energy and climate consultants. In addition, the consultants have received training on energy efficient windows, solar heating, transportation and business consultations. The Swedish Energy Agency's online information for households and businesses has been updated.

Coordinated information from authorities simplifies matters for the target groups

It is characteristic of these informative activities that more and more is being done through the collaboration of two or more agencies. The purpose is to make matters simpler and clearer for the target groups and to bring greater coordination to the message and contents.

Spring 2010 saw the launch of an energy efficiency improvement grant which municipalities and county councils can apply for. The Swedish Energy Agency conducted an information tour of six cities with the Delegation for Sustainable Cities and introduced a newsletter for municipalities and county councils. Now it is the county administrative boards that run and coordinate regional activities.

The Swedish Energy Agency and the Swedish National Board of Housing, Building and Planning (Boverket) run the website energiaktiv.se together. The website aims to increase the implementation of proposal measures in energy performance certificates. Boverket's website has also added a quick guide to energy performance certification for home owners. The guide offers practical tips about how to obtain certification for a house and how to contact an accredited expert to do this.

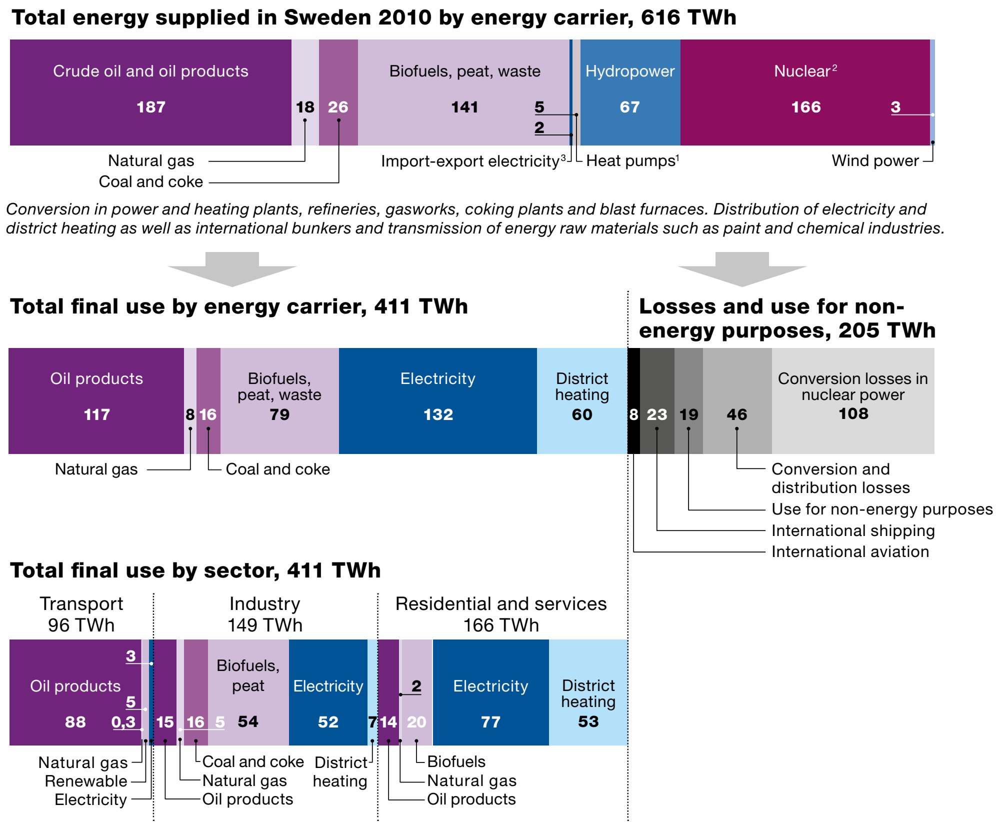
The Swedish Energy Agency also collaborates with the Swedish Environmental Protection Agency on information measures and reporting on the commission Energieffektiva myndigheter (Energy-efficient authorities). A seminar with the relevant authorities has been conducted, the website has been developed and a newsletter launched.

The campaign Renovera energismart (Renovate Energy Smart) is run by the Swedish Energy Agency in conjunction with Boverket and the Environmental Protection Agency. The goal is to inspire and justify energy efficiency improvement measures of the Million Homes Programme's multi-dwelling buildings. To reach the target group, agencies run a campaign booth in the form of a renovated, energy-smart apartment as well as a website, renoveraenergismart.se. The primary target groups are owners and managers of multi-dwelling buildings and the boards of housing cooperatives. The apartment presents the different forms of energy-saving renovation advice and the cost of not implementing them. Renovate Energy Smart has participated in trade fairs around the country and the work is planned to run until the end of 2012.

3 Sweden's energy balance

Energy can never be destroyed or consumed, but only converted. The total quantity of energy used must therefore always be balanced by a corresponding quantity of energy supplied. The supply of energy in Sweden is increasing more rapidly than the demand for it, but this is a statistical effect due to certain losses having been moved from the user side to the supply side. Sweden's proportion of renewable energy is considerably higher than the proportions in many other countries, which is due largely to the fact that Sweden has major renewable energy resources, such as hydro power and biomass.

Figure 6 Energy supply and use in Sweden, 2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.

Note:
1. Heat pumps refer to large heat pumps for district heating.
2. Nuclear power is calculated gross in accordance with the UN/ECE method.
3. Net import of electricity is added to the total energy supply.

Figure 6 shows – aggregated and simplified – Sweden's energy system in terms of the energy flows from supply to use. Energy is supplied in order to meet users' demand for energy, which in turn depends on their needs in terms of functions such as transport, lighting, heating, cooling, miscellaneous processes etc. It is this use that determines the amount of energy in the form of electricity or heat that needs to be supplied.

FACTS ENERGY STATISTICS

There are short-term statistics and yearly statistics. At the time of writing, only short-term statistics are available for 2010. For the yearly statistics, 2009 is the most recent year of publication. This edition of Energy in Sweden therefore presents yearly statistics up to and including 2009, complemented by short-term statistics for 2010. There are differences in level between these two, as they are based on different investigations and because the methods of allocating energy between different energy carriers and sectors differ to some extent. There are also differences for individual energy carriers, as well as for the total energy use per sector.

3.1 End use in constant change

Energy use consists of the total final energy use in various user sectors, energy losses, the provision of fuels for foreign shipping and aviation, and the use of energy materials for non-energy purposes. Total energy use in 2010 amounted to 616 TWh: of this, total final energy use in industry, transport and the residential sector amounted to 411 TWh.

The remainder, 205 TWh, consisted of losses, the use of fuel oils for overseas transport, and use for non-energy purposes. Overseas transport covers both shipping and aviation. The losses that are shown in Figure 6 are made up of the thermal energy that is of necessity removed by cooling when producing electricity in nuclear power stations. Other losses include conversion losses in energy plants and distribution losses in connection with the supply of electricity, district heating, natural gas and town gas, coke oven gas and blast furnace gas. Energy plants cover the production of electricity and district heating, refineries, gasworks, coking plants and blast furnaces. Note that losses that occur in connection with final use are included in their respective user sectors and are therefore not shown separately. Losses in hydro and wind power production are also excluded.

The use of energy products for non-energy purposes includes raw materials for the chemical industry, lubricating oils and oils used for surface treatments in the building and civil engineering sectors. Total use for these purposes amounted to just under 19 TWh in 2010.

Electricity and oil are today's main energy carriers

Electricity is the dominating energy carrier. Final use of electricity in 2010 amounted to 132 TWh, of which the industrial sector used 52 TWh and the residential and services sector used 77 TWh. Use of electricity in the transport sector amounted to 3 TWh.

Final use of oil products in 2010 amounted to 117 TWh, most of this use being in the transport sector. The use of biofuels, peat and waste amounted to 79 TWh, 54 TWh of which was used in industry. The fuel used for the production of electricity and heating in industry is not included in this figure but is reported in the statistics for electricity and heating. 20 TWh were used in the residential and services sector, and 5 TWh in the transport sector.

60 TWh of district heating were supplied in 2010, an increase of 28% on the previous year. Of the total quantities, about 88% were used for heating residential and non-residential premises, and 12% were used in industry. Some industries sell their own heat production facilities to district heating companies and then buy the heat back ready for use. This then appears in the statistics as district heating, which has the effect of upward distortion of the short-term statistics for the industrial use of district heating. A corresponding decrease appears in industrial use of biofuels.

The final use of coal and coke in 2010 amounted to 16 TWh, all of which was used in industry, where coal and coke are used as reducing agents in blast furnaces.

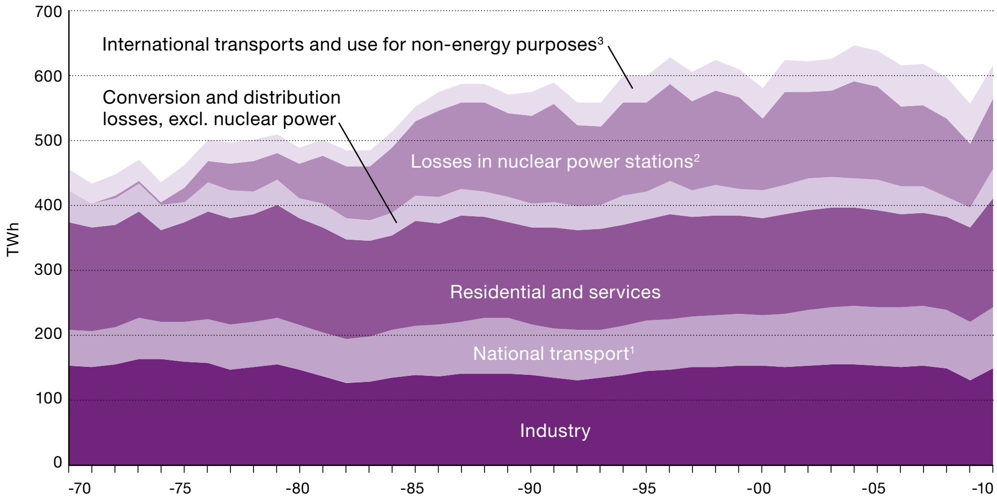
The final use of natural gas increased in comparison with earlier years to the extent that it now supplies just over 2% of the total energy use. Among the user sectors, industry accounted for 67% and the residential sector for 29%. The remaining proportion is used in the transport sector as vehicle fuel.

Sweden's total energy use again over 600 TWh

Figure 7 shows Sweden's total energy use, including losses, from 1970 to 2010. Since the 1990s, the total energy use has been around 600 TWh. Variations between individual years may be due to fluctuations in the economy and cold winters.

Developments are different from sector to sector. Industry uses about the same amount of energy today as it did in 1970, despite the fact that industrial production is considerably higher today. The residential and services sector has reduced its energy use since 1970, but this is due to several structural changes. The change from oil to electricity, for example, has meant that some of the losses have been transferred to the supply side of the energy system. Energy use in the transport sector has increased by 71% since 1970.

Figure 7 Total energy use in Sweden, 1970–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: 1. International aviation is included until year 1989.
2. In accordance with the method used by UN/ECE to calculate the nuclear fuel energy input.
3. International aviation is included since 1990.

3.2 Supply in balance with use

The quantity of energy used always corresponds to the quantity supplied. In 2010, Sweden's energy supply amounted to 616 TWh.

Low nuclear production in 2010

Despite electricity production increasing in 2010 compared with 2009, which saw nuclear power production at a record low, continued work to increase capacity led to a low level of nuclear power production. In 2010, a total nuclear fuel input of 166 TWh was used, producing 56 TWh of electricity.

Hydro power production depends on the amount of precipitation during the year. In 2010, hydro power produced 67 TWh of electricity, which is on a par with the average annual production of hydro power in Sweden. The average production of hydro power in Sweden is 66.9 TWh, based on production from 1986 to 2010. The hitherto lowest production was 52 TWh in 1996, which was a dry year, and the highest production was 79 TWh in 2001, which was a wet year. Fuel-based thermal power production yielded 16 TWh of electricity, and wind power 3.5 TWh.

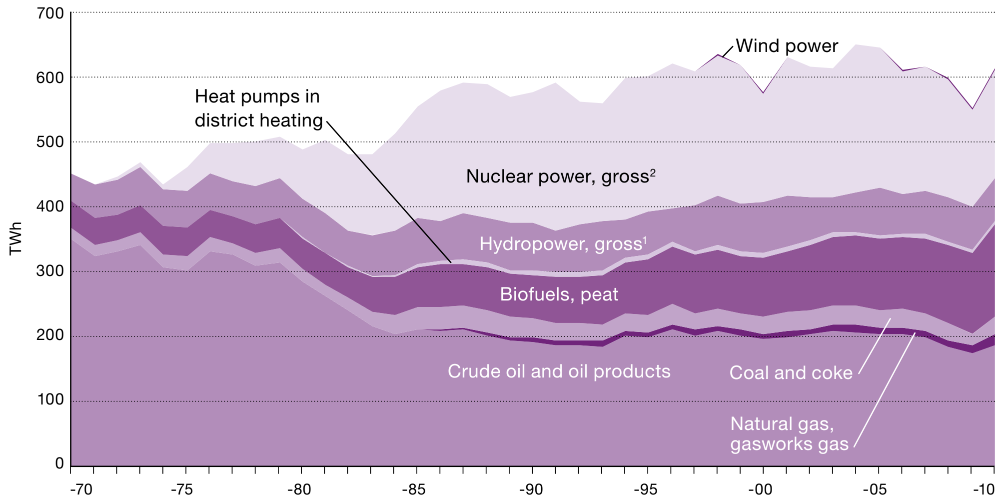
Sweden uses less oil and more biofuels

Figure 8 shows Sweden's energy supply from 1970 to 2010. Since 1970, the nature of the energy supply has changed so that the use of crude oil and oil products has declined by over 47%. Through the expansion of nuclear power and hydro power, the net production of electricity has increased by 131% since 1970.

The supply of biofuels, peat and waste has increased by just over 230% since 1970. During the 1980s, municipal energy companies installed large heat pumps to produce district heating. At the same time, natural gas was brought to towns along the west coast, and wind power construction started in the middle of the 1990s. The use of coal and coke as fuels increased during the 1980s, but has since declined somewhat.

Fuel used for district heating amounted to 68 TWh, of which biofuels, peat and waste accounted for the largest proportion; 47 TWh.

Figure 8 Total energy supply in Sweden, excluding net electricity exports, 1970–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: 1. Including wind power up to and including1996.
2. In accordance with the method used by UNECE to calculate the nuclear fuel energy input.

3.3 Losses important in a system perspective

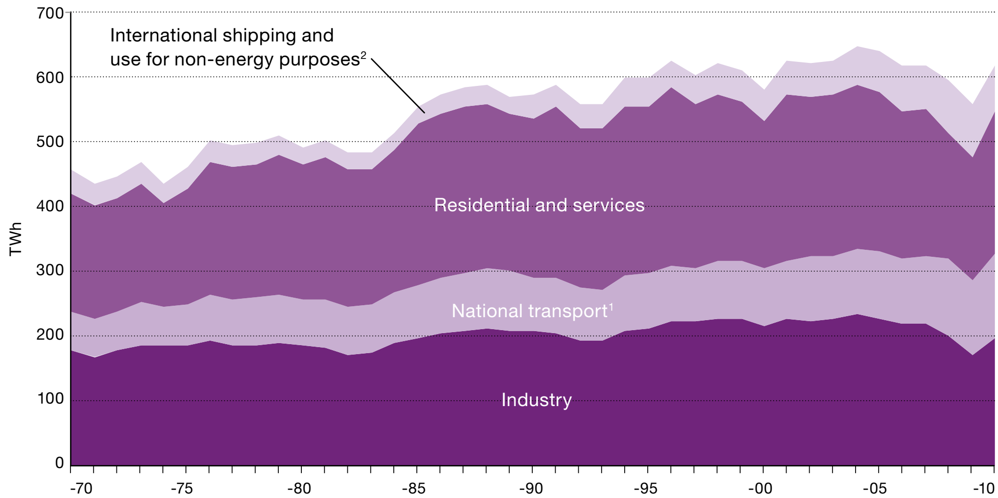
In 1970, the final energy use was 376 TWh. In 2010, this amounted to 411 TWh, a return to the use level before the financial crisis of 2008/2009. During the same 40-year period, the total energy supply increased from 457 TWh to 616 TWh. From this, it can be seen that the increase on the supply side has been considerably greater than the increase in final energy use.

The reason for this is that during this period the user sectors, in particular the industrial and residential and services sectors, have undergone a major shift in energy carriers, moving from oil to district heating and electricity. Although electricity is a very efficient energy carrier as far as users are concerned, it is associated with great losses on the production side, particularly when produced in nuclear power stations. There are also losses in district heating production and in refineries. These are not reported as losses for the end users but as a separate item, see Figure 7.

A different view of the development of energy use in the various user sectors can be obtained by including the losses in the user sectors to give a distribution as shown in Figure 9. Figure 9 is based on exactly the same statistics as Figure 7, but without showing the losses separately. The losses have been assigned proportionally to the respective uses by the user sectors of electricity, district heating and oil products. The difference between the two ways of presenting the information as shown in Figure 7 and Figure 9 depends on where the system boundaries are drawn. Placing these at the factory gate or just outside a house gives the result as shown in Figure 7. Setting the system boundaries where the electricity, district heating or oil products are produced gives Figure 9. Other system boundaries are possible[14].

14 Agneta Persson, Camilla Rydstrand and Pia Hedenskog, Allt eller inget – systemgränser för byggnaders uppvärmning (All or Nothing – Systems Boundaries for the Heating of Buildings), www.energimyndigheten.se

Figure 9 Total energy use in Sweden, with losses in the energy conversion sector allocated to end users, 1970–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: 1. International avation are included until year 1989.
2. International aviation are included since 1990.

3.4 Renewable energy use increasing

In 1990, Sweden's proportion of renewable energy amounted to 33%. By 2009, this had increased to 47%[15]. Of the total renewable energy in 2009, 187 TWh, renewable electricity production and the industrial use of biofuels constituted the largest items. Of the total use of renewable energy, biofuels accounted for 57%. The increase in the proportion of renewable energy since the 1990s is due in large part to the use of biofuels in electricity and heat production and in the forest industry. Renewable energy in the transport sector accounts for a very small part of the total use of re-newable energy.

15 Energiindikatorer 2011 (Energy Indicators 2011), the Swedish Energy Agency, ER2011:12

Figure 10 Share of renewable energy in Sweden, 1990-2009, in per cent

Source: Swedish Energy Agency and Eurostat.
Note: Calculations according to the RES directive. Data for 2005–2009 differ from the previous years.

The Renewables Directive defines how calculations of the proportion of renewable energy are performed. The proportion of renewable energy is counted as the ratio of renewable energy and final energy use, including transmission losses and the use of electricity and heat in the actual production of electricity and heat.

Sweden has the highest proportion of renewable energy in relation to final energy use in the EU. The fact that Sweden's proportion is significantly higher than that of other countries is not only due to an abundance of renewable energy assets but also to an active engagement in energy policy.

Summary

In 2010, the total energy supply to the Swedish system amounted to 616 TWh, compared with 457 TWh in 1970. Oil and nuclear fuel still constitute the largest proportions within this supply. But renewable forms of energy, primarily biofuels and wind power, are growing steadily.

The nature of the energy supply has changed over time as the need for energy has changed. Despite an overall increase in energy supply, the supply of crude oil and oil products has declined by 47% since 1970. The net production of electricity during the same period increased by almost 131%. This increase has mainly come through the expansion of nuclear power and hydro power. Furthermore, the supply of biofuels has increased by over 230% since 1970.

4 Energy use

All sectors of society are extremely dependent on energy: for heating, for travel and for the production of goods. Over the last 20–30 years, the use of energy in the residential and services and industrial sectors has remained fairly constant, whereas the energy use in the transport sector has risen sharply since 1970. Energy use in the industry and transport sector is, in contrast to the residential sector, vulnerable to trends in the economy, and recent fluctuations have clearly affected energy use in these sectors.

4.1 Heating dominates energy use in the residential and services sector

In 2010, energy use in the residential and services sector was 166 TWh, representing 40% of Sweden's total final energy use. Of the sector's energy use, residential premises, holiday homes and non-residential premises (excluding industrial premises) account for almost 90%, land use for almost 6% and other service activities for the remainder. Land use includes agriculture, forestry, market gardening and fisheries. Other service activities include the construction sector, street lighting, sewage treatment plants, electricity and waterworks.[16]

Almost 60% of the sector's energy use is for heating and hot water. As energy use for heating is affected by outdoor temperature, the variations from year to year can be great. A cold winter will increase energy use for heating, and a mild winter will reduce it. To compare energy use of different years, regardless of outdoor temperature, it is necessary to correct for climatic conditions. 2010 was 14% colder than a normal year and the temperature corrected energy use was 156 TWh.

FACTS STATISTICS FOR ENERGY USE IN THE RESIDENTIAL AND SERVICES SECTOR

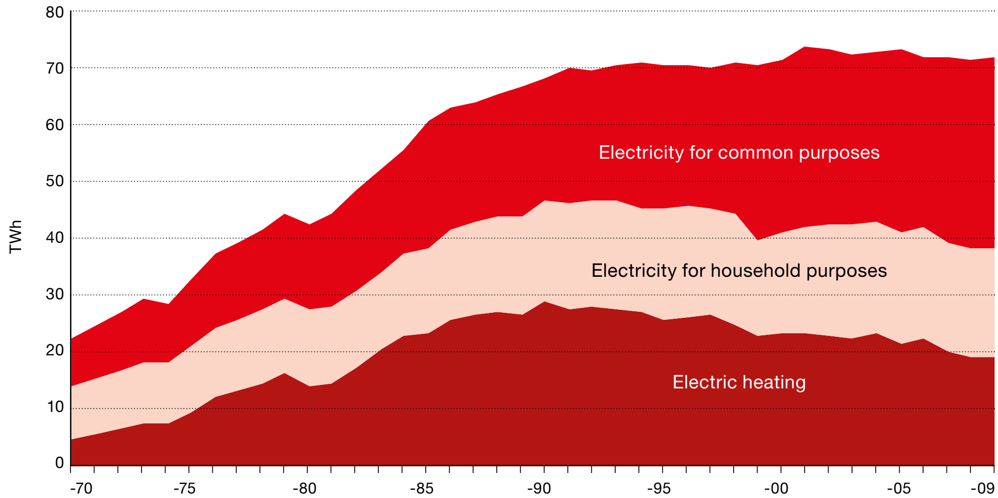
The statistics for the total energy use in the sector for 2010 is derived from the quarterly energy balances. Energy use statistics for heating, as well as the distribution of electricity use for electric heating, operational electricity, electricity for activities in non-residential buildings and domestic electricity, as given in this section, are not available for 2010.s Instead, the statistics for 2009 will be used.

Electricity use has remained relatively constant over the last ten years

Figure 11 shows the total temperature corrected electricity use in the sector, broken down by domestic electricity, operational electricity and electric heating since 1970. Electricity use grew steadily from the 1970s to the mid-1990s. Since then, it has been relatively stable at just over 70 TWh.

16 Energy statistics for one- and two-dwelling buildings 2009, Energy statistics for multi-dwelling buildings 2009 and Energy statistics for non-residential premises 2009, Energy consumption in the fisheries sector 2005, ER2006:35, Energy consumption in the construction sector 2004, ER2006:02, Energy consumption in forestry 2005, ER 2007:15 and Energy consumption in agriculture 2007, the Swedish Energy Agency and Market gardening production 2005, the Swedish Board of Agriculture

Figure 11 Electricity use in the residential and services sector, 1970-2009, in TWh, temperature corrected



Source: Swedish Energy Agency and Statistics Sweden.

The use of domestic electricity has increased from 9 to 19 TWh between 1970 and 2009. The greater part of this increase occurred during the 1970s and 1980s and may be explained by a greater number of households and domestic appliances. Since 2001, the use of domestic electricity has remained relatively constant. The use of domestic electricity is affected by two conflicting trends. On the one hand, there is a development towards more energy-efficient appliances which, everything else being equal, leads to a reduced energy use. On the other hand, both the number of domestic appliances and the number of functions on many appliances are increasing, which counteracts the trend towards efficiency improvement.

The use of operational electricity in non-residential premises accounts for a large portion of the electricity used in the sector. Operational electricity combines electricity for building services systems and for work activities. Electricity for building services is used for fixed equipment for climate control in the building and for such applications as lifts, escalators and general lighting. Electricity for activities in non-residential buildings is used for activities performed in the building, such as for computers, equipment and lighting. Operational electricity has increased from 8 to 34 TWh between 1970 and 2009.

Since 2005, the Swedish Energy Agency has conducted studies of electricity use in various types of premises[17]. A common feature found in all of them is that lighting and ventilation fans account for a substantial proportion of electricity use. Operational electricity is also subject to the influence of conflicting trends. Measures for improving energy efficiency are implemented at the same time as other measures partly counteract this effect, for example, heat recovery. Heat recovery increases electricity use through the installation of ”return-air” heat pumps, but the effect of increased heat recovery is still a decrease of the total energy use.

The use of electric heating in the sector increased from 5 TWh/year in 1970 to 29 TWh/year in 1990. After peaking in the early 1990s, this use has declined. In 2009, the use of electric heating was 19 TWh. Significant reasons for the decline of electric heating are the relatively high electricity prices coupled with conversion grants which serve as great incentives for changing to heat pumps, district heating and pellets.

Electric heating, district heating and biofuels in residential and non-residential premises

In 2009, a total of 79 TWh was used for heating and hot water in residential and non-residential premises. Of this 44% were used in one- and two-dwelling buildings, 30% in multi-dwelling buildings and 26% in offices, shops and public buildings.

Electricity is the most common form of energy used for heating and hot water in one- and two-dwelling buildings. In total, 14 TWh were used in 2009. The greatest increase in the last few years was in biofuels (firewood, wood chips, sawdust and pellets). In 2009, use was the equivalent of 13 TWh. District heating use was 5 TWh. Oil use for heating continues to decline and was only 1.5 TWh. Since the 1990s, the number of one- and two-dwelling buildings installing heat pumps has steadily increased. In 2009, a heat pump of some kind was used in 754,000 one- and two-dwelling buildings in Sweden, representing 40% of all such homes.

District heating is the most common form of energy used for heating multi-dwelling buildings. In total, use was 22 TWh in 2009, the equivalent of 91% of the total energy use for heating and hot water. Electric heating accounted for only 1 TWh, and oil use amounted to 0.4 TWh. Next to district heating, electricity is the most common form of energy used for heating and hot water in multi-dwelling buildings.

District heating is most common for heating and hot water in non-residential premises. In 2009, district heating use was 16 TWh, representing 79% of the total energy use for heating and hot water in non-residential premises. At 2 TWh, electricity was the form of energy with the next highest use, after district heating. Oil use for heating and hot water continues to decline, even in non-residential premises. The total annual use was the equivalent of 0.8 TWh of oil.

17 http://www.energimyndigheten.se/sv/Statistik/Forbattrad-energistatistik-i-bebyggelsen/

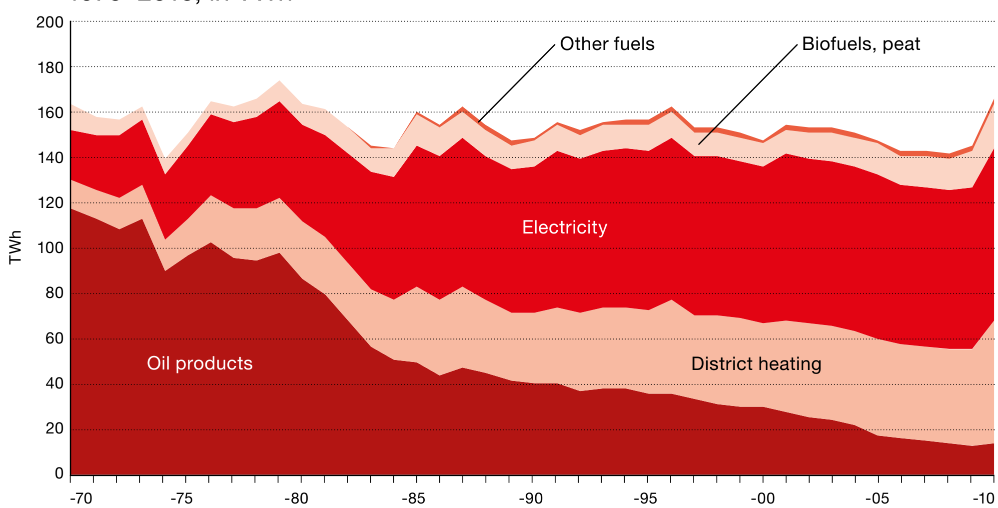
The decline of energy use in the sector and the gradual phase-out of oil

The relative proportions of the different energy carriers in Figure 12 have changed over time. Availability of particular energy carriers and the application of various policy instruments have affected the relative prices of different energy carriers, resulting in a transition from oil to electricity, district heating and biofuels. In 2010, the total use of oil products in the residential and services sector amounted to 14 TWh, a reduction of 65% since 1990.

It can be seen from Figure 12 that energy use in the sector has fallen over the period 2000-2009, but has been followed by a sharp increase in 2010. A contributory factor to the increase in energy use in 2010 was the cold weather, but when corrected for temperature, energy use in the sector has declined between 2000 and 2010.

It is primarily energy supplied for heating and hot water which is in decline. This development has at least three causes. The first is that oil has been replaced by electric heating or district heating. This leads to a reduction in losses in the residential and services sector but greater losses in the conversion sector. The second is that the number of heat pumps has increased. Heat pumps deliver up to three times more energy than is required for operation, which means that their use reduces the metered energy use for heating and hot water in a building. The heat extracted from the air and delivered by the heat pump is not included in the statistics of the total energy use in the sector. The third cause is that measures for saving energy, such as additional insulation and window replacements in old houses, also contribute to a reduced energy use.

Figure 12 Final energy use in the residential and services sector, 1970–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.

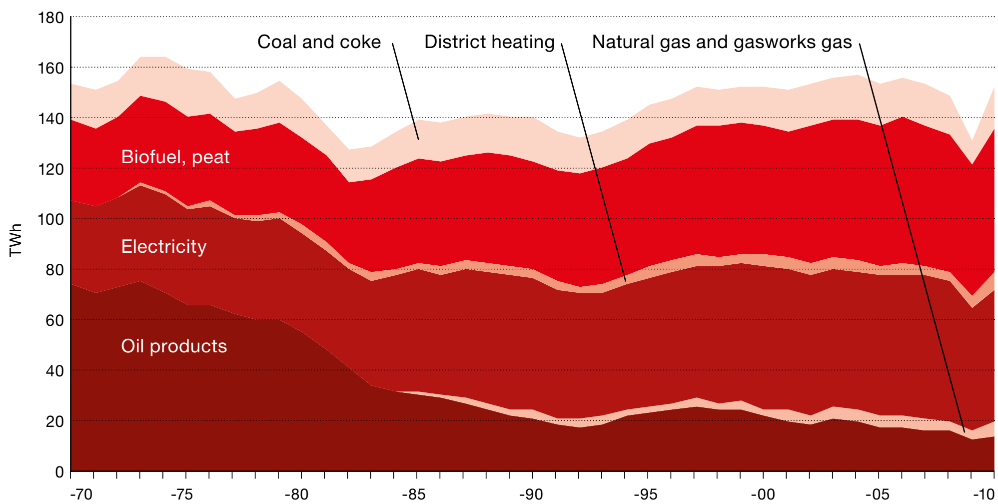
4.2 Industrial energy use rising

FACTS DIFFERENCES BETWEEN SHORT-TERM AND YEARLY STATISTICS IN THE INDUSTRIAL SECTOR

Differences between the short-term and the yearly statistics for the industrial sector may be explained by different methods of data collection. The short-term statistics for industry are based on delivery statistics as well as on actual energy use for a sample group of workplaces with more than 10 employees within Swedish Standard of Classification of Economic Activities industry codes 05-33 (SNI 2007). A model is used to estimate these figures based on the previous year's statistics for industry's annual energy use. Where there are no data on actual energy use in industry, the statistics are reported based on the total supply to industry.

In the yearly statistics, industrial energy use is based solely on the actual use and can therefore achieve a better distribution between sectors and fuels. For statistics based on deliveries to the market, certain use for other purposes may be included, such as raw materials for processing. At the same time, some use may also be excluded, such as the use of oil and petrol.

Figure 13 Final energy use in the industrial sector, 1970–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: The fuel used for the production of electricity and heating in industry is not included in this figure but is reported in the statistics for electricity and heating.

In 2010, the energy use in industry increased by 13%, compared with 2009, to 149 TWh. The increase is due to the recovery in industry after the recession. Industry accounted for 36% of Sweden's total energy use in 2010.

Industry primarily uses biofuels and electricity, representing 36% and 35% of industrial energy use, respectively. Fossil fuels, including oil products, coal and coke as well as natural gas, accounted for 24% of industrial energy use. District heating accounted for 5%, see Figure 13. For certain fuels, such as district heating and natural gas, the increase may seem greater than it actually is due to differences between yearly statistics and quarterly statistics.

A few sectors account for the bulk of industrial energy use

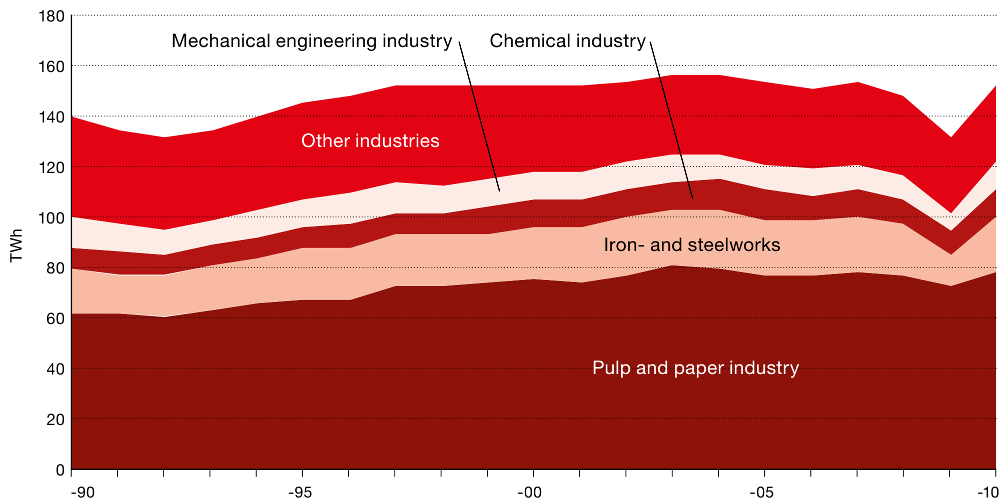
In Sweden, a few sectors account for the bulk of industrial energy use, see Figure 14. Of the total energy use in the industrial sector, the pulp and paper industry accounts for about half, primarily as electricity or from black liquors. A by-product of pulp production, black liquors contain chemicals and energy which can be extracted. The electricity is used mainly for wood grinders producing mechanical pulp, while the black liquors provide fuel for soda recovery boilers in sulphate mills.

Iron and steel industries primarily use the energy carriers coal, coke and electricity and accounts for 14% of industry's energy use. Coal and coke are used the reducing agents in blast furnaces, while the electricity is used chiefly for arc furnaces for melting steel scrap.

The chemical industry accounts for 8% of industry's energy use, using electricity for electrolytic processes. These three sectors account for three quarters of industry's energy use.

The mechanical engineering industry, although not regarded as an energy-intensive sector, nevertheless accounts for over 7% of industry's total energy use due to its high proportion of Sweden's industrial output. The remaining 20% of industry's energy use are associated with other sectors: the mining industry, metals industries, the food industry, the textiles industry, the graphics industry, other non-metallic mineral industry, and ”other industry” (SNI 31-33). Although some of them can be regarded as energy-intensive, their total energy use is relatively low. These other sectors include sectors with a dominant use of fossil energy, such as the other non-metallic mineral industry, and sectors with a dominant use of electricity, such as aluminium industries.

Figure 14 Energy use in industry per sector, 1990–2010, in TWh

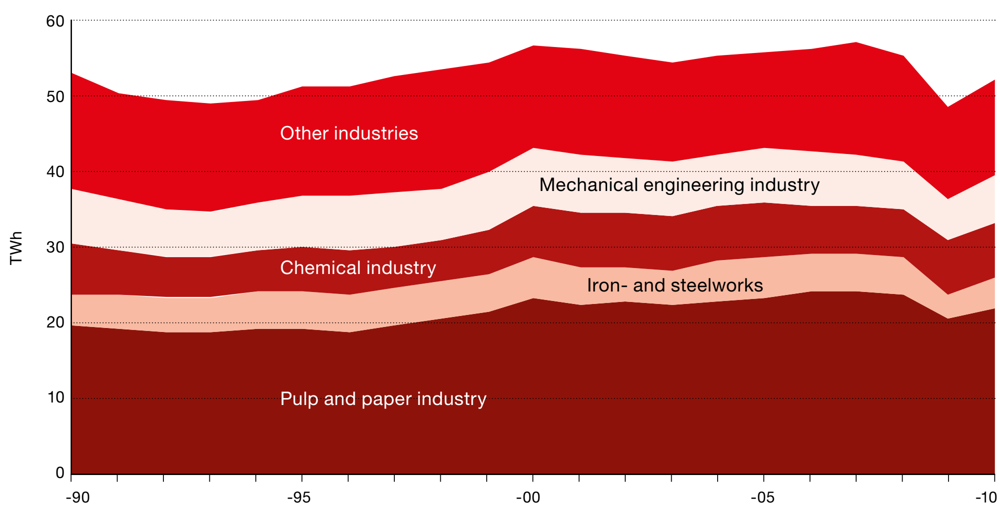


Source: Swedish Energy Agency and Statistics Sweden.

Production volume affects energy use

Industry's energy use is governed in the short term by production volume. In the longer term, it is also affected by such factors as taxation, changes in energy prices, energy efficiency improvements, investment, technical development, structural changes in the sector and changes in the types of goods produced.

Figure 15 Use of electricity in industry, 1990–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.

2010 saw a marked increase of 16% and 13% respectively for production volumes and energy use in industry. The background to this was the effects of the recession on Sweden's industries in the second half of 2008 and in 2009. This period was characterized by loss of production and reduced energy use by 22% and 14% respectively. The recession affected certain sectors more than others. The iron and steel industry was the sector with the greatest reduction in energy use, which also resulted in a marked reduction in its use of coal and coke.

The proportions of electricity and biofuels increasing in industry

Industry's energy use has remained fairly constant since 1970 despite increased industrial production. This is a result of energy efficiency improvements as well as a gradual transition from oil to electricity. The proportion of electricity use making up industry's total energy use has increased from 21% to 35% since 1970. This development began because of the oil crises of the 1970s, which led to both business and society in general embarking on intensive work to reduce oil use. In 1970, oil use represented 48% of the total energy use in industry, compared with 10% today. Oil use did see an increase for a period between 1992 and 1997, but this later began to decline. The use of oil and other fuels declined sharply during the recession, but oil use increased again in 2010.

The proportions of biofuels and peat making up industry's total energy use increased from 21% to 36% during the period 1970 to 2010. In the pulp and paper industry and the wood products industry, biofuels are the dominant energy carrier.

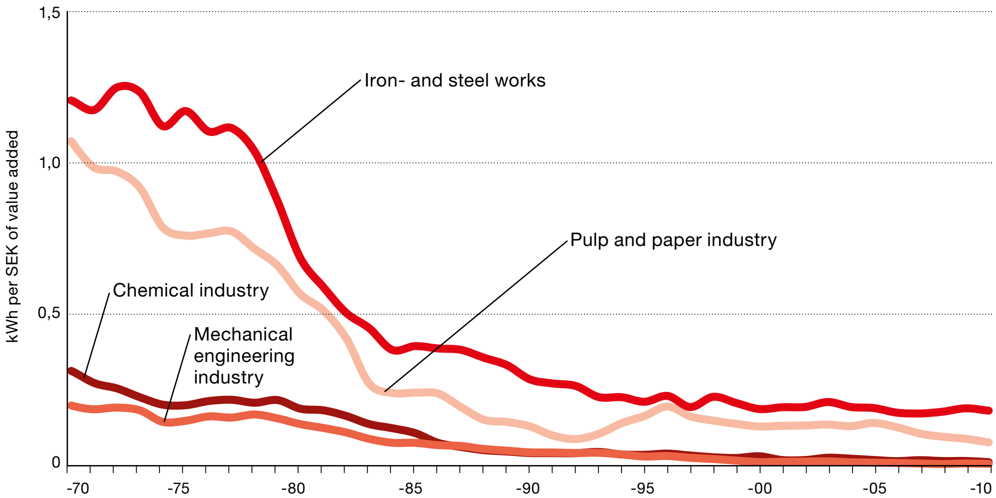
Steady decline in specific energy use

Specific energy use – i.e., the amount of energy used per monetary unit of value added – provides a measure of the efficiency of energy use. Since 1970, specific energy use in industry has fallen continuously: between 1970 and 2010, it fell by 66%, or on average by 3% per year, reflecting a clear trend towards less energy-intensive products and production processes, together with structural changes in the sector.

Both energy use and the value added by processing fell during 2008 and 2009, although the value added fell more. The reason for this increase in specific energy use in 2009 is that a certain amount of energy must still be used despite smaller production volumes and reduced capacity usage. This is why specific energy use increased in 2009. In 2010, the value added increased more than energy use, which meant that specific energy use saw a reduction of 2%.

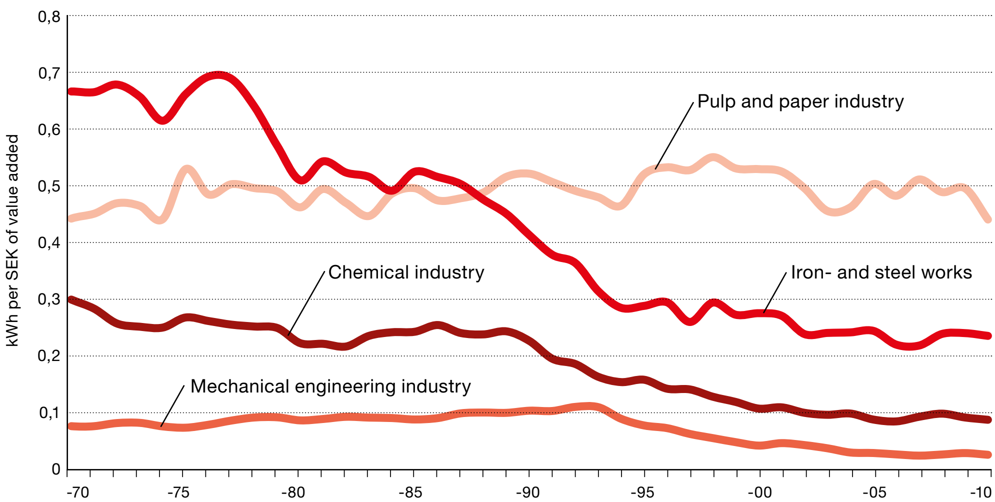
The transition from oil to, above all, electricity is reflected in the specific energy use figures for oil and electricity. Between 1970 and 1992, the specific energy use for oil fell by 81% while that of electricity rose by 23%. The specific energy use for both oil and electricity increased in 2009 due to the recession, and decreased in 2010 by 7% and 8% respectively.

Figure 16 Specific use of oil in industry, 1970–2010, in 2005 price levels, in kWh per SEK of value added



Source: Swedish Energy Agency and Statistics Sweden.

Figure 17 Specific electricity use in industry, 1970–2010, in 2005 price levels, in kWh per SEK of value added



Source: Swedish Energy Agency and Statistics Sweden.

4.3 Diesel increases while petrol decreases in the transport sector

Energy use in the transport sector is broken down into road traffic, rail traffic, aviation and shipping. Domestic transport in 2010 used 96 TWh, 23% of the country's total final energy use. Bunkering for foreign shipping amounted to 23 TWh and bunkering for foreign aviation transport accounted for 8 TWh. Total energy use in the transport sector, including foreign transport, amounted to 128 TWh.

Energy use in the transport sector is dominated entirely by oil products, primarily petrol and diesel. In 2010, these two fuels constituted 87% of the country's energy use for domestic transport. This is a reduction of 1 percentage point compared with the previous year.

Freight transport grew in 2010 after a sharp fall the previous year

The need for freight transport is directly linked to activity in society in general, which meant that the transport sector was severely affected by the recession in 2009. Freight transport fell by 14% from 2008 to 2009[18], which is the greatest percentage drop ever recorded. 2010 has instead been characterized by economic recovery, and this is reflected in the statistics. Freight transport grew in 2010, reaching 98 billion freight tonne kilometres compared with 90 billion freight tonne kilometres the previous year.

Passenger transport is not as vulnerable to trends in the economy as freight transport. The total figure for domestic passenger transport in 2010 was 131 billion revenue passenger kilometres, which is the same level as in 2009. Road traffic constituted 83% of total passenger transport, while rail traffic accounted for just over 10%, air traffic 2% and domestic shipping just under 1%. Energy use for passenger transport on roads has increased by 6% between 1990 and 2009, while the amount of passenger kilometres has increased by 14%. The increase in energy efficiency is mainly a result of the increased energy efficiency of passenger cars.[19]

18 Trafikanalys, www.trafa.se
19 The Swedish Transport Administration Annual Report 2010, the Swedish Transport Administration

Energy use changes rapidly

Energy use in the transport sector has changed relatively rapidly since the beginning of the 2000s. Between 2000 and 2009, the use of diesel fuel has risen by 51%, while that of petrol has fallen by 15% over the same period.

Energy use in the transport sector appears to have increased between 2009 and 2010, from 123 TWh in 2009 to 128 TWh in 2010, but this does not give a completely correct picture of the situation as the statistics for 2009 and previous years are not delimited in the same way as the statistics for 2010. 'FACTS' in this section describes this difficulty, explaining the difference between short-term and yearly statistics. The short-term statistics are always higher than the yearly statistics. To get a true idea of developments in 2010, the short-term statistics for 2009 may be used as a comparison. Such a comparison gives an increase in the total energy use from 127 TWh to 128 TWh.

FACTS DIFFERENCES BETWEEN SHORT-TERM AND YEARLY STATISTICS IN THE TRANSPORT SECTOR

Somewhat simplified, the difference between short-term and yearly statistics for the transport sector is that the short-term statistics reflect the delivery of petrol and diesel to the market while the yearly statistics reflect use. Differences between delivery and use arise because petrol and diesel delivered to the market may be used for a range of purposes which are not necessarily related to transport.

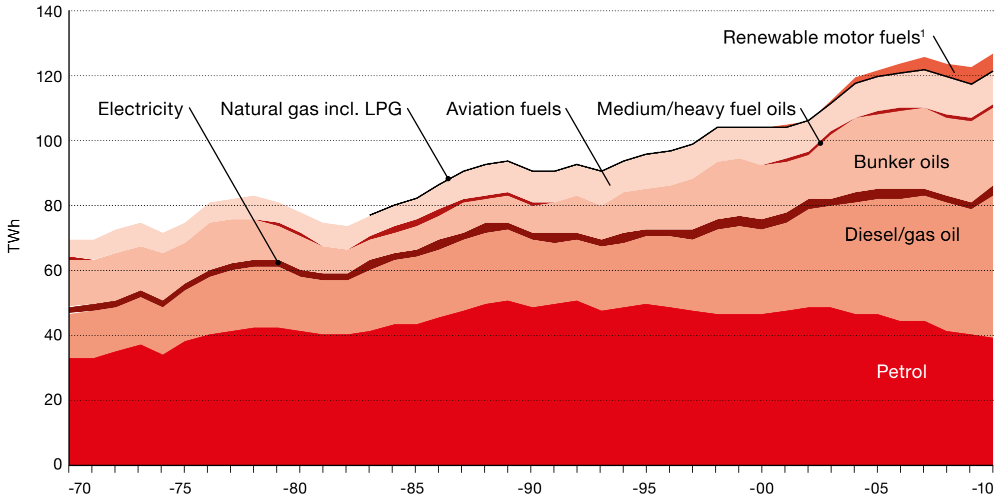
The short-term statistics report the figures from a delivery perspective, which means that certain use of another nature (primarily use by machines) is included in the transport sector instead of in the residential sector or the industrial sector. The yearly statistics give greater opportunity to proceed from the use of petrol and diesel in various sectors, which means that the breakdown between sectors is considerably more detailed in the annual figures.

The total volume of petrol and diesel is the same, however – it is only the distribution between various sectors that differs.

The increase in energy use in the transport sector since 2009 can be explained by the fact that the economy has rapidly begun to recover after the tangible decline between 2008 and 2009. The increase has taken place in domestic transport where the energy use has gone from 93 TWh to 96 TWh between 2009 and 2010, while energy use for foreign transport decreased by 2 TWh.

Petrol use has decreased by 6% between 2009 and 2010, while diesel use has increased by 9%. One reason for the increase in diesel use is the change in the stock of passenger cars. The proportion of newly registered diesel cars grew to 51% in 2010 compared with the previous year when the proportion of new diesel car sales was 41%[20]. Another reason for increased diesel use is the rise in heavy goods transports due to the economic recovery.

Figure 18 Final energy use in the transport sector, 1970–2010, including international transport, in TWh



Source: Swedish Energy Agency, Statistics Sweden and the Swedish Gas Association.
Note: 1. In 1999, only ethanol was reported, the remaining years include ethanol, FAME and biogas.

The use of renewable motor fuels continues to rise

The proportion of renewable motor fuels in road traffic has continued to increase and amounted to 5.7% in 2010. The corresponding figure for 2009 was 5.4%. The proportion of renewable motor fuels is calculated as the quantity of biobased motor fuels divided by the combined quantity of biobased motor fuels, petrol and diesel.

The alternative motor fuels currently used for operating vehicles are chiefly natural gas, biogas, ethanol and FAME. Natural gas and biogas are known as 'vehicle gas' and are mainly used as motor fuels for buses and passenger cars. Ethanol is used both as a low-admixture additive in petrol and as a component of fuels such as E85 and ED95. FAME is used both in a pure form and mixed with diesel.

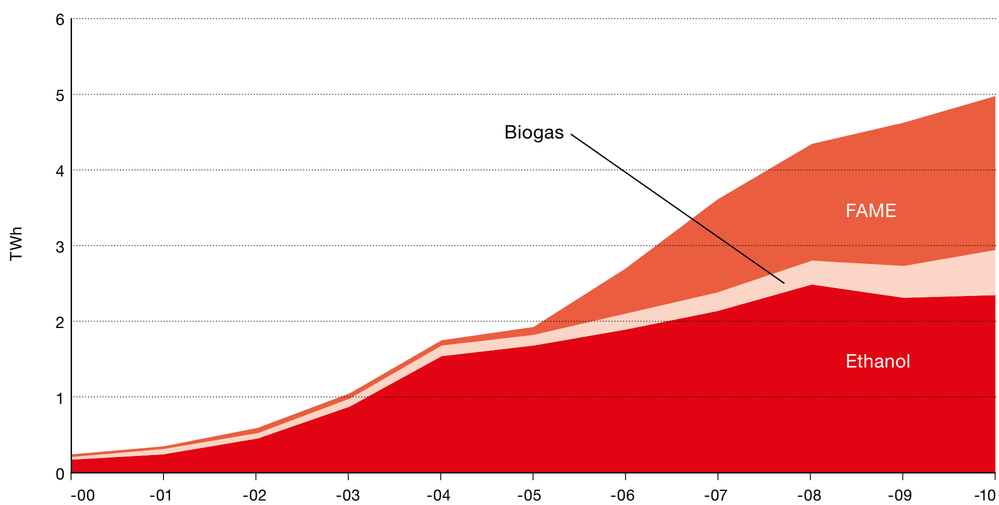
20 Definitiva nyregistreringar under 2010 (Definitive new vehicle registration figures for 2010), Bil Sweden

Ethanol as a low-admixture additive in petrol increased gradually during the early 2000s and has, since 2005, had an admixture level of 5% in almost all petrol on the Swedish market. FAME as a low-admixture additive in diesel became permitted from 1 August 2006 and has, since then, increased steadily. The statistics for 2010 show that there was an admixture of 5% FAME in just over 80% of all diesel delivered to the Swedish market.

Vehicle gas consists of either pure biogas, pure natural gas or a mixture of the two. The proportion of natural gas in vehicle gas varies depending on where in the country it is sold; it is generally higher in areas covered by the natural gas grid. In terms of the total use of vehicle gas in 2010, its constituent proportion of biogas was just under 64%.

There has been a significant increase in the use of E85 in 2010 compared with the previous year. This is because E85 prices have dropped while petrol prices have risen during the same period. In 2010, E85 prices were lower than petrol prices, when compared on the basis of petrol equivalence. As passenger cars that can run on E85 can also run on petrol, the effect on use is immediate when the price of E85 is lower than that of petrol. The average price of a litre petrol was SEK 12.97 in 2010, while the average price of a litre E85 was SEK 9.48, which is 13 öre lower per litre compared with 2009[21]. This means that despite the fact that ethanol with its lower energy content necessitates a 25–35% greater E85 use compared with petrol, the overall cost for E85 was lower than that of petrol in 2010.

Figure 19 Final energy use of renewable motor fuels, 2000–2010, in TWh



Source: Swedish Energy Agency, Statistics Sweden and the Swedish Gas Association.

21 Priser & Skatter (Prices & Taxes) 2011, Svenska Petroleum Institutet

Summary

The total final energy use in 2010 amounted to 411 TWh of which 132 TWh consisted of electricity.

In 2010, use in the residential and services sector was 166 TWh, representing 40% of the total energy use in the country. 2010 was considerably colder than normal, resulting in a high energy use, and the use of oil products in the sector rose for the first time since 1996. Energy is supplied primarily through district heating networks, electric heating or through the combustion of oil or biomass for heating buildings or work premises. Within the sector, almost 60% of energy use is for heating purposes. The residential and services sector is also the sector with the highest electricity use, 77 TWh in 2010.

Energy use in the industrial sector was 149 TWh in 2010, representing 36% of the total final energy use. Industry uses energy both as a raw material and to power ancillary processes such as pumps, air compressors and lighting. Electricity use was 52 TWh for the year.

Transport of passengers and goods used 128 TWh in 2010. Domestic use, excluding bunkering for foreign shipping and aviation transport, was 96 TWh, representing 23% of the country's total final energy use. Energy use in the transport sector consists largely of oil products in the form of petrol and diesel, but an increased use of renewable motor fuels is also discernible. Electricity use in this sector amounted to 3 TWh.

5 Energy markets

Energy supply has traditionally been viewed as a national concern, but the energy market is becoming increasingly globalized. This is evident in increased competition for raw materials and markets, deregulation and greater collaboration with other countries. Common regulatory frameworks affect such factors as fuel choice among Swedish energy suppliers and facilitate the establishment of a functioning international energy market.

5.1 High electricity prices during the winter

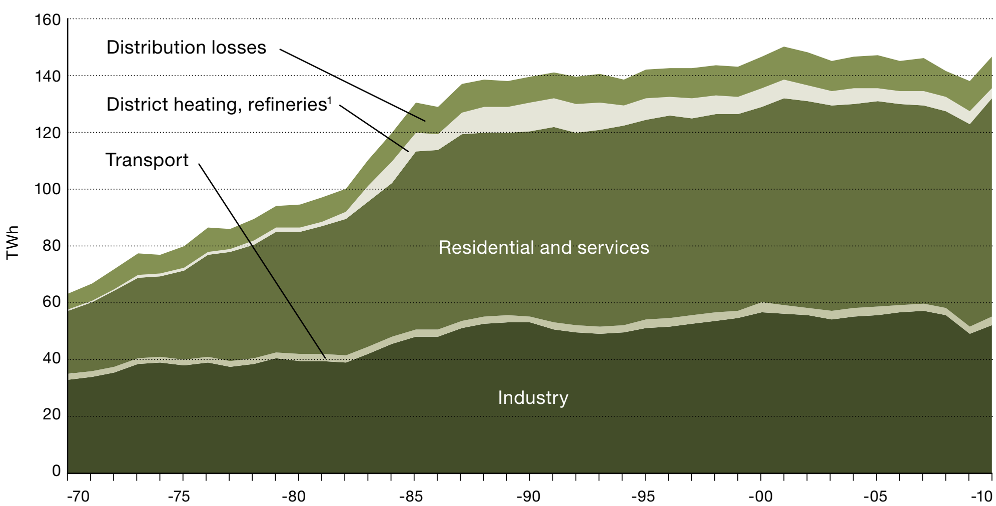
2010 saw an economic recovery leading to an increased demand for electricity. Despite the total electricity production increasing compared with the previous year, Sweden was still a net importer of electricity; both the first and the last months of 2010 were characterized by high electricity prices. The price in Sweden reached the highest yearly average ever.

Improved economic conditions resulted in higher electricity use

Between 1970 and 1987, electricity use in Sweden rose on average almost 5 % per year. Since then, this use has levelled off. Economic and technological development, development of energy prices, business structures, population changes and outdoor temperatures are all factors that affect electricity use.

The total electricity use, including distribution losses, amounted to almost 147 TWh. This represents an increase compared with 2009 when the total electricity use reached 138 TWh. This increase is due to the improved economic conditions. Figure 20 shows the development of Sweden's electricity use by sector.

Figure 20 Use of electricity in Sweden by sector, 1970–2010, in TWh



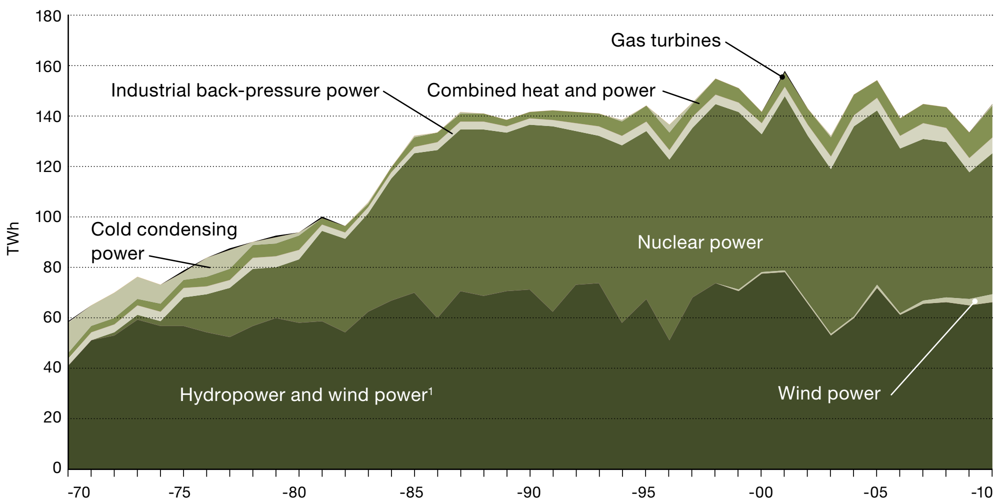
Source: Swedish Energy Agency and Statistics Sweden.
Note: 1. Includes gasworks.

Swedish electricity production is dominated by hydropower and nuclear power

In the early 1970s, hydro power and oil-fired condensing power plants produced most of the electricity in Sweden. The oil crises of the 1970s coincided with Sweden's expansion of nuclear power. In 2010, hydropower accounted for 46%, nuclear power for 38% and wind power for 2.4% of production. The remaining proportion consisted of production based on fossil and biomass fuels. Nuclear power production increased somewhat compared with 2009 when availability was low, but it should also be noted that production in 2010 was lower than normal. Total electricity production in 2010 amounted to 145 TWh. Figure 21 shows Sweden's electricity production by type of production.

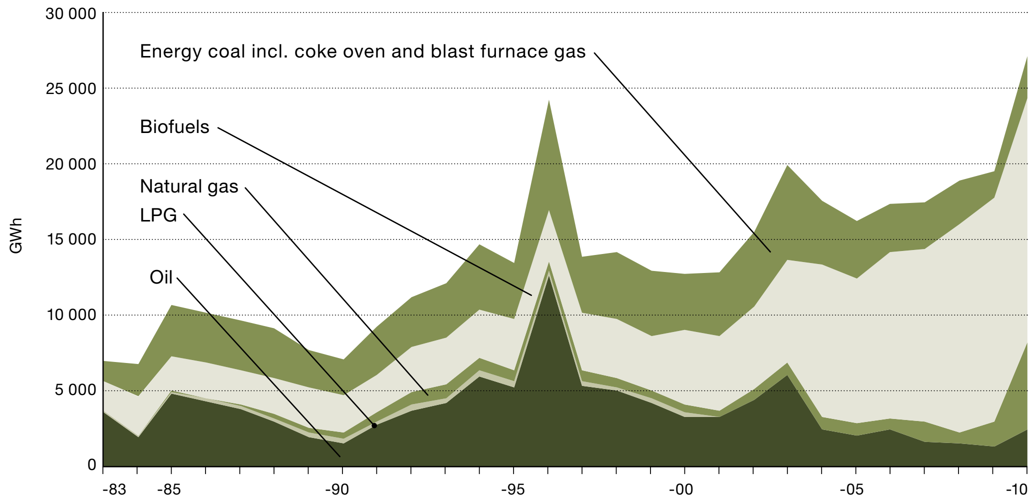
Combustion-based electricity production accounted for 19.5 TWh, of which 60% of the fuel used consisted of biofuels and the rest of fossil fuels, see Figure 22. Combined heat and power (CHP), at 12.8 TWh, and industrial back-pressure power, at 6.3 TWh, dominate combustion-based electricity production, while oil-fired condensing power plants and gas turbines serve primarily to provide reserve capacity.

Figure 21 Electricity production in Sweden, 1970–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: 1. Hydropower and wind power were not reported separately until after 1996, when each was given its own category.

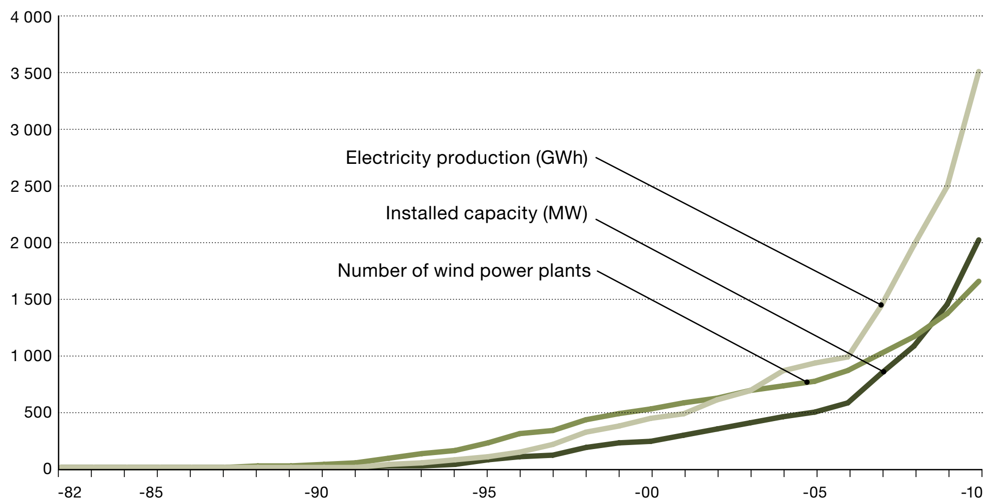
Figure 22 Supply of fuel in electricity production (excluding nuclear fuel), 1983-2010, in GWh



Source: Swedish Energy Agency and Statistics Sweden.

The contribution of wind power towards electricity production in 2010 amounted to 3.5 TWh, see Figure 23. The corresponding figures for 2008 and 2009 were 2.0 TWh and 2.5 TWh respectively. Wind power production has thus seen an extremely sharp rise over the last few years.

Figure 23 Wind power development, 1982–2010, number of wind power plants, installed capacity and electricity production



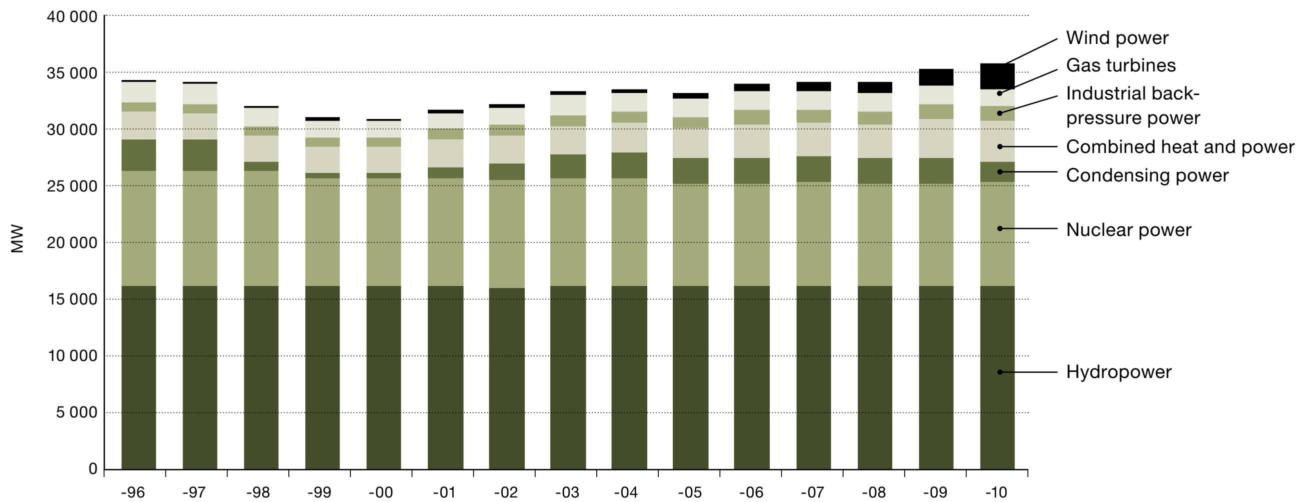
Source: Elforsk and Swedish Energy Agency.

Total installed capacity is greater than what is available

During the second half of the 1990s, the installed production capacity of Swedish power plants dropped significantly. After 2000, this capacity increased once more and has passed the level from before deregulation. New capacity includes wind power and biomass power through the electricity certificate system and the increased capacity of nuclear power plants.

All installed capacity is not available at the same time but depends on the availability of the plants. All hydro power capacity is not used at the same time and the availability of nuclear power plants depends on their operational situation. For wind power, availability depends on where and if the wind is blowing. The different types of production are thus not strictly comparable in terms of their available capacity. The capacity situation may become strained in extreme winter conditions or, as was the case the last two winters, when nuclear power plants experience operational difficulties at the same time as it is cold.

Figure 24 Installed electricity production capacity in Sweden, 1996–2010, in MW



Source: Swedenergy.

Production and use must be in balance

As electricity cannot be stored, there must at all times be a balance between production and use in the national electricity system. In Sweden, Svenska kraftnät is responsible for maintaining this balance as well as for the management and operation of the country's national grid.

At present, Sweden has power transmission links with Norway, Finland, Denmark, Germany and Poland. A new cable link between Finland and Sweden, Fenno-Skan 2, is expected to come on line in autumn 2011. There is also a project, the South-West Link project, to increase operational reliability and address the limitations of transmission capacity to southern Sweden and between Norway and Sweden. At present, the total transmission capacity from Sweden to other countries amounts to 8,760 MW and, to Sweden, 9,140 MW.

The power grid must also be adapted to new sources of energy. An expansion of wind power production calls for greater flexibility of the grid as it must be possible to compensate for major production variations by power from other sources.

FACTS THE ELECTRICITY GRID

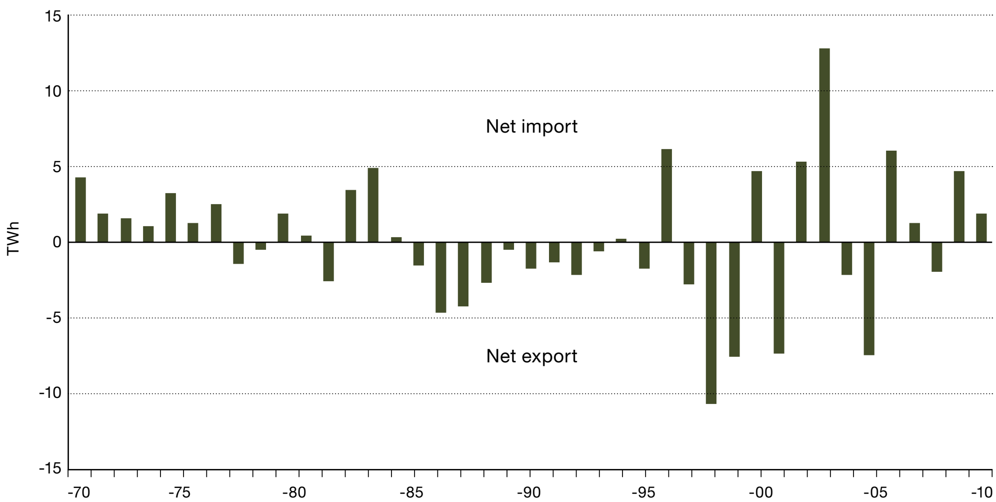
Sweden's electricity grid has three levels: the national grid, regional grids and local networks. The national grid is a high-voltage grid that carries electricity over long distances and to neighbouring countries. It consists of 15,000 km of cable and is owned by Swedish National Grid. The regional grids, owned chiefly by Vattenfall, E.ON and Fortum, have a cable length of 33,000 km. The regional grids transport electricity from the national grid to local networks and in some cases directly to larger electricity consumers. The local networks consist of 479,000 km of cable and are owned primarily by the major power companies and municipal companies. In 2010, 173 companies undertook local network operations. In total, Sweden's electricity grid covers 528,000 km, of which 59% consist of underground cables.

Reduced net imports during 2010

In 2010, net imports to Sweden amounted to 2 TWh of electricity, compared with net imports of 4.7 TWh the year before. Trade flows between Sweden and its neighbouring countries vary both from year to year and during any given year. Exchange between countries is governed by price differences between different price areas. The differences arise from such factors as the inflow of water into reservoirs and their storage levels. In 2010, net imports of electricity to Sweden came mainly from Finland. The Nordic countries as a whole were also a net importer in 2010, with net imports of almost 19 TWh, compared with net imports of 8.2 TWh the year before.

In December 2010, the total installed capacity of the Swedish electricity production system amounted to 35,701 MW. The distribution of this capacity by type of production was as follows: hydro power 45%, nuclear power 26%, wind power 6% and other thermal power 23%. The highest demand for electricity in 2010 occurred between 5 p.m. and 6 p.m. on 22 December and amounted to 26,700 MW.[22] On that occasion, Sweden imported electricity through all its links with other countries, except Poland. The total domestic production amounted to 23,310 TWh. The highest demand ever registered in Sweden was 27,000 MW in January 2001.

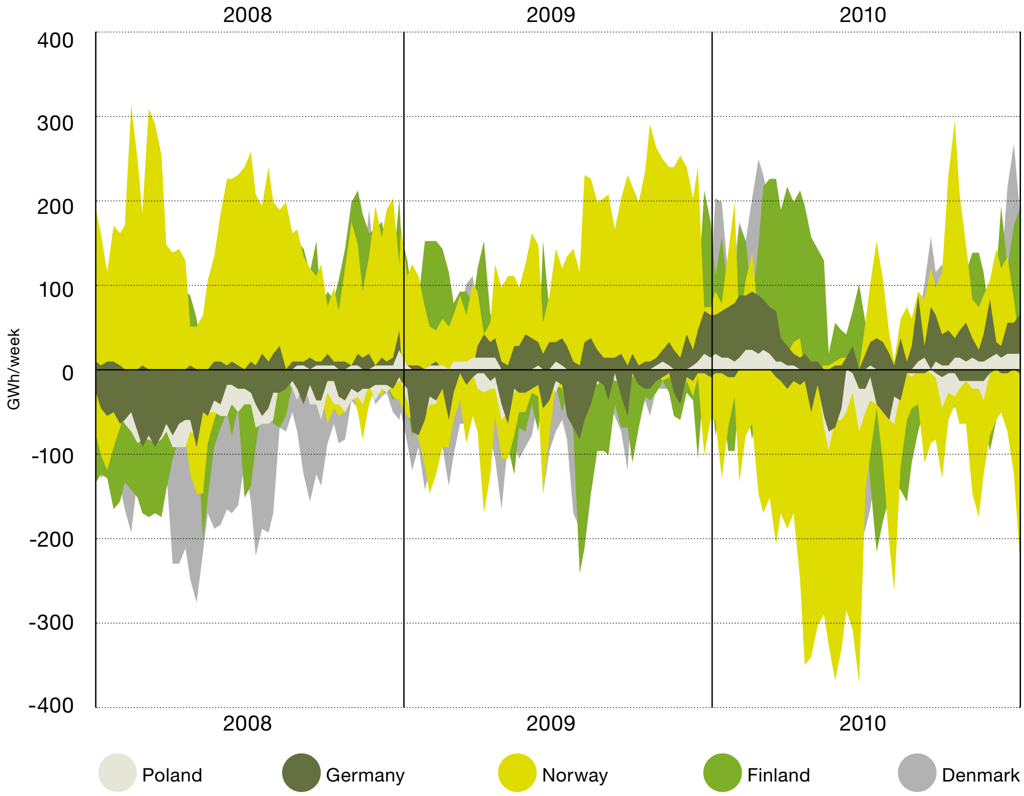
Figure 25 Electricity net import (+) and net export (–) in Sweden, 1970-2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.

22 The Swedish power balance in the winters of 2010/2011 and 2011/2012, Swedish National Grid.

Figure 26 Electricity import (+) and export (–) in Sweden, January 2008–December 2010, in GWh/week



Source: Swedenergy, additional processing by the Swedish Energy Agency.

The year began and ended with high electricity prices

The common Nordic electricity exchange enables Nordic power plants to be used in the most economic way and affords transparency in pricing. Nord Pool Spot runs the physical trade in electricity (the Elspot and Elbas markets). Financial trading on the Nordic electricity market is organized by NASDAQ OMX.

In 2010, 305 TWh were traded on Nord Pool's physical market Elspot, representing 74% of the electricity use of the Nordic countries.[23] This is the highest level ever recorded. The remaining physical electricity was traded internally within the electricity companies or through bilateral agreements. Nord Pool's actors include power producers, electricity suppliers, larger end users, portfolio managers, asset managers and brokers.

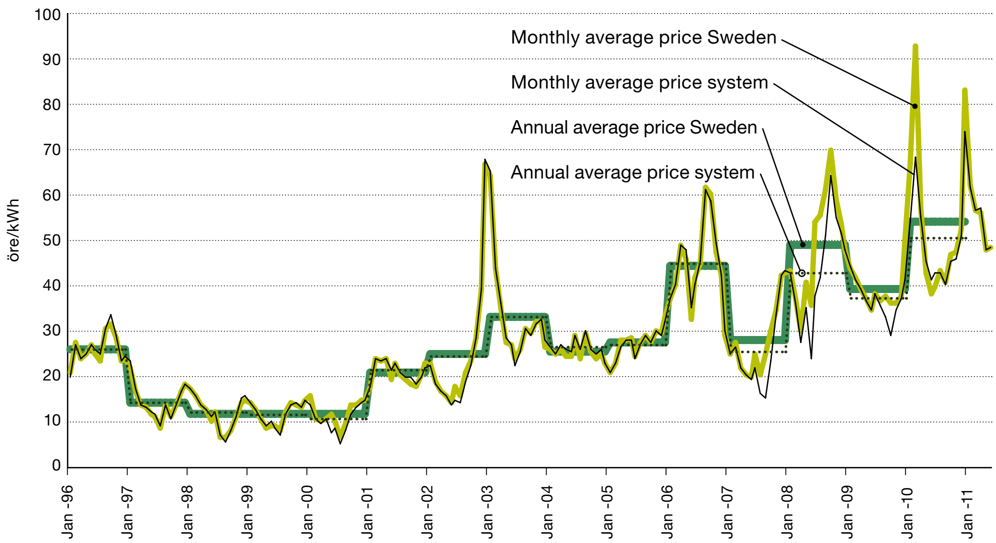
Both the beginning and end of the year were characterized by cold weather which caused electricity demand to rise. This, in combination with other factors, resulted in high prices on Nord Pool. Reduced nuclear power capacity during the first few months

23 Nord Pool Spot, HYPERLINK "http://www.nordpoolspot.com" www.nordpoolspot.com.

of the year was a contributing factor behind these high prices. A number of nuclear reactors had been taken out of service and some were running with limited capacity. On 22 February 2010 the highest average daily price was recorded, reaching just under SEK 5/kWh. Certain individual one-hour periods registered even higher prices of up to almost SEK 14/kWh. On these occasions, reserve capacity was activated in the form of, e.g., oil-fired power plants. During the spring and summer, electricity prices fell compared with the levels recorded at the beginning of the year. During the last two months of the year, electricity prices rose again mainly because of the cold weather, low water levels in reservoirs and continued difficulties with nuclear power.

The average spot price on Nord Pool for Sweden in 2010 was 54.25 öre/kWh, which is the highest average price ever recorded. Figure 27 shows the development of electricity prices from 1996.

Figure 27 Spot prices on Nord Pool. Monthly and annual average prices for the system and for Sweden, January 1996–May 2011, in öre/kWh



Source: Nord Pool Spot.

In May 2010, Svenska kraftnät made the decision to divide Sweden into four bidding areas for electricity. This decision was based on a request from the European Commission that Sweden change its method of managing limitations in transmission capacity in its electricity grid. The purpose of this division into bidding areas is to make it clear where the Swedish national grid needs to be expanded. It also gives a clear indication of which parts of the country need an increase in electricity production to better match use in those areas. Sweden's division into bidding areas will take effect on 1 November 2011.

Variable rate contracts still most common

The total cost of electricity for an end user consists of distribution charges, payable to the network operator, and the electricity price to be paid to the electricity supplier the customer has chosen to have a contract with. Distribution charges are based on where in the country the electricity is used. Distribution charges usually consist of a fixed and a variable component which is related to the energy supplied. There are also network operators which offer subscriptions linked to a main fuse rating, which means that the distribution charges are based on utilized or subscribed capacity. Electricity prices include the cost of electricity certificates, but not tax and VAT. Households pay either 18.7 öre/kWh or 28.3 öre/kWh in energy tax depending on the municipality.

For a customer in a house with electric heating, the total cost of electricity in January 2011 consisted of the supply price (45%), network tariffs (17%) as well as tax and VAT (38%), according to a statement from the Energy Markets Inspectorate. Just under 29% of customers had variable rate contracts, making it the most common form of contract in June 2011. The 'current rate' contract form has continued to decline and in June 2011, about 23% of customers had a current rate price. Among the other forms of contract, contracts with a fixed rate for three or more years are most common. Table 6 shows the total cost of electricity for different customer categories with the most common contract forms.

Table 6 Total cost of electricity for different customer categories including electricity certificates, network charges, taxes and VAT, in öre/kWh. The table relates to contracts with a variable rate and a current rate.

	Small-scale industry[1]		Det. house with electric heating[2]		Det. house without electric heating[3]		Apartment	
	Variable	Current	Variable	Current	Variable	Current	Variable	Current
1 January 2002, total price[4]	40.5	43.8	84.1	87.9	108.5	111.3	122.3	122.8
1 January 2003, total price[4]	78.6	59.9	139.4	111.4	164.0	135.4	178.3	148.4
1 January 2004, total price[4]	47.1	62.6	99.0	118.1	125.8	144.3	140.8	157.3
1 January 2005, total price[4]	41.0	55.2	92.0	109.9	118.9	135.9	134.8	150.5
1 January 2006, total price[4]	57.1	61.3	113.1	117.4	139.9	144.3	155.9	159.3
1 January 2007, total price	48.1	82.1	102.1	144.4	129.3	171.3	145.9	187.5
1 January 2008, total price	67.8	78.8	127.1	140.6	155.3	168.6	172.0	185.0
1 January 2009, total price	71.4	97.8	133.3	165.3	164.0	195.9	181.3	213.0
1 January 2010, total price	96.0	86.2	164.4	151.1	196.4	183.0	214.6	201.0
1 January 2011, total price	91.4	106.8	159.4	180.6	193.4	214.9	211.9	234.1

Source: Swedish Energy Agency and Statistics Sweden, additional processing by the Swedish Energy Agency.

Note: 1. Annual use 350 MWh, capacity 100 kW or 160 A.
2. Annual use 20,000 kWh, 20 A main supply fuse (3-phase).
3. Annual use 5 000 kWh, 16 A main supply fuse (3-phase).
4. Excluding price of electricity certificates.

5.2 District heating and district cooling are markets undergoing change

District heating has existed in Sweden since the 1950s, while district cooling was first introduced in the 1990s. District heating is the leading heating method for multi-dwelling buildings and non-residential premises, taking 92% and 80% of the market share, respectively. In the market for one- and two-dwelling buildings, district heating has a market share of 15%. District cooling is used mainly for air conditioning in offices and shops as well as for cooling in industrial processes and large computer centres.

Thanks to improved technology, a greater level of network utilization and an increased proportion of ready heat, distribution and conversion losses in the district heating system have become smaller over the years. Ready heat is hot water produced locally. In the 1980s, the losses amounted to an average of 19%, coming down to 16% in the 1990s and finally levelling off at around 11% in the 2000s. In 2010, losses accounted for 12% of the total district heating input. Figure 28 shows the energy input for district heating, 1970–2010. The marked increase for the last two years is primarily the effect of unusually cold winters. This is especially the case for 2010.

Figure 28 Use of district heating, 1970–2010, in TWh

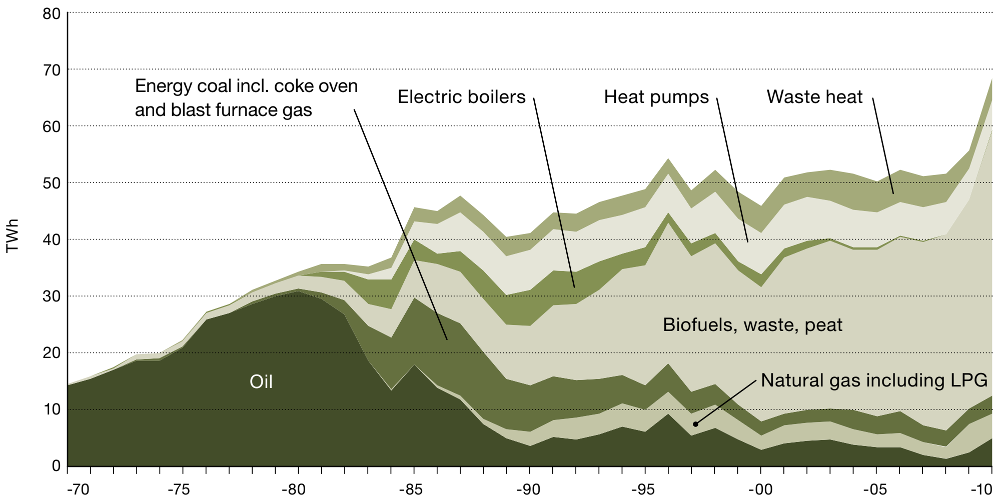
Source: Swedish Energy Agency and Statistics Sweden.

The proportion of renewable energy in district heating is increasing

One advantage of district heating is that it is flexible enough to be able to utilize different fuels. Since the 1970s, there has been a major transition towards the use of renewable fuels. In 2010, wood fuels accounted for 46%, waste for 17%, peat for 4% and waste heat for 5% of the energy used to produce district heating in Sweden.

The use of waste has increased over the past decade, and in several Swedish cities, heat from waste incineration forms the foundation of district heating, according to the Swedish District Heating Association's report, 2009:38. The increase is a result of the 2002 ban on combustible waste in landfills and a similar ban regarding organic waste in 2005. It is primarily the decrease in electric boilers, and to some extent heat pumps, in the district heating system that indicates a reduction in electricity use in the district heating sector. Figure 29 shows the energy supplied to district heating between 1970 and 2010.

Figure 29 Energy supplied to district heating, 1970–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: Peat and biofuel are presented together, even if peat is not considered to be renewable. It should be noted that the development in the last two years is primarily a result of unusually cold winters. This is especially the case for 2010.

The district heating market has significant price differences

There are significant differences in the price of district heating from place to place. The price in the most expensive municipality is more than twice the price in the cheapest. These price differences are due to factors such as ownership structures in the district heating companies, profitability requirements, which fuels are being used as well as geographical conditions for district heating installation. A given customer's choice of options on the heating market depends largely, then, on where that customer lives.

On 1 October 2009, the Energy Markets Inspectorate's regulations[24] entered into force, defining the companies' obligations to provide price information and how this should be done. The district heating companies are, since 2007, required to submit separate accounts for their various divisions in order to avoid cross subsidization, but this did not prove to be an effective method. In 2009, the companies also began to report operational and business details to the Energy Markets Inspectorate[25]. The purpose of this was to give a greater degree of transparency within the market and to counteract overcharging.

Ownership of the district heating companies very different now

Up until the mid-1990s, district heating companies were mainly run by municipalities and district heating was sold at cost price. The electricity market reform in 1996 brought requirements, however, for district heating to be operated on a commercial, and therefore competitive, basis. This led to many municipally-owned companies passing into private ownership. Between 1990 and 2004, around 70 municipal energy companies with district heating operations were sold to private companies, but since then this privatization has halted.

Municipal district heating companies currently provide 63% of the combined delivery of district heating in Sweden, while private and state-owned district heating companies account for 37%. There are only eight municipalities where district heating operations are under municipal administration and where, in accordance with the Swedish Local Government Act, these operations must be run at cost price. However, of the total delivery of district heating, these eight local governments account for just 0.3 TWh. In survey of 150 companies, 42 stated that they had profit maximization as a business principle, while 16 stated the cost pricing principle. The remaining companies took municipal and political interests and objectives in their strategy[26]. In total, there are 200 district heating companies in the market.

A possible opening for increased competition

Current regulations governing district heating operations mean that only owners of a district heating network have the right to access the network. For this reason, the possibility of legislating for third-party access (TPA) has been investigated. The TPA investigation (SOU 2011:44) proposes a split in the market to give network access to competing producers and suppliers. Where competition arises, a distinction between the various operations of distribution, production and supply will be made. A central idea behind legislated third-party access is to help open up the district heating market to more waste heat from the industry.

The TPA investigation also finds that it is unclear how district heating prices will

24 EIFS 2009:2
25 Uppvärmningen i Sverige 2011 (Heating in Sweden 2011), the Energy Markets Inspectorate, EIR2011:06
26 Ganslandt, M. (2010). Lönsamhet och avkastning i fjärrvärmebranschen (Profitability and yield in the district heating sector), CELEC, consultancy report commissioned by Fortum Värme 28-06-2010

be affected if the legislative proposal is adopted. The cost of realizing these objectives in relation to the energy- and environmental goals has not been investigated either.

The District Heating Board mediates between market parties

Since 2008, the district heating market in Sweden has been governed by the District Heating Act. The Energy Markets Inspectorate is the supervisory authority tasked with enforcing the provisions of the District Heating Act. District heating companies have, for example, an obligation to negotiate certain contractual terms with individual district heating customers. If the parties are not able to come to an agreement themselves, they may apply to the District Heating Board for mediation. The Board also mediates between district heating companies and other actors wishing to gain access to the distribution networks.

An introduction of legislated third-party access would mean that the role of the District Heating Board would come to an end as well as the introduction of a new, replacement District Heating Act.

Improved conditions for combined heat and power generation promote district heating

In recent years there has been a renewed surge of interest in CHP based primarily on bioenergy. This is partly due to increased carbon dioxide tax, changes in CHP taxation structures, the electricity certificate system and increased electricity prices. On 1 December 2010, a new Act on guarantees of origin of electricity (2010:601) entered into force, replacing the Act on guarantees of origin for high-efficiency CHP electricity and renewable electricity (2006:329).

This Act makes it possible for a CHP producer to obtain guarantees of origin from Svenska kraftnät for the purpose of marketing its production. This presupposes, however, that the CHP production is at least 10% more efficient than the otherwise separate production of heat or electricity. All CHP production in Sweden today is high-efficiency CHP. At the same time, the licensing requirement for laying district heating pipes was removed. Together, these changes mean that the conditions for CHP production have become more favourable. Only one CHP company, however, has taken advantage of the Act on Guarantees of Origin.

The use of district cooling continues to increase

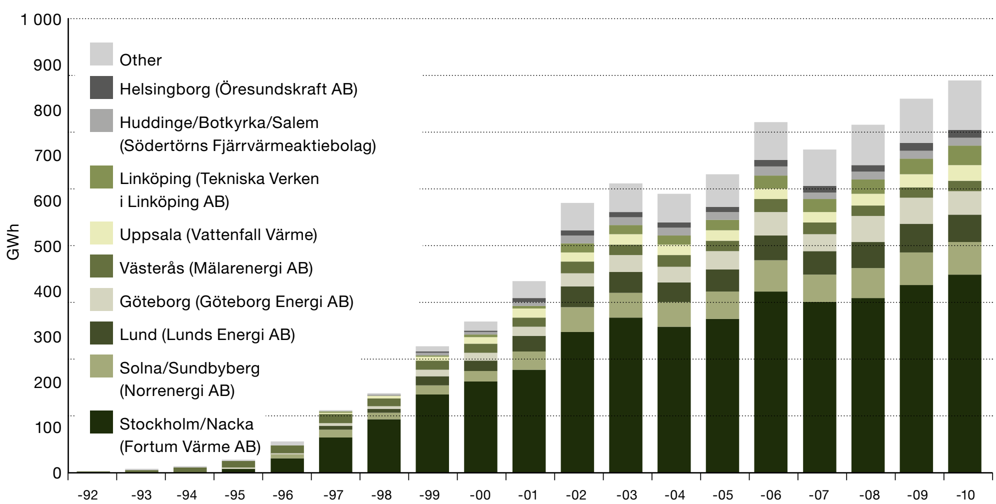
District cooling is used mainly in offices and shops and for cooling in industrial processes. The principle behind district cooling is the same as that for district heating, meaning that cooled water produced at a large plant is piped to customers.

The statistics show only commercial district cooling where the supplier and the property owner constitute separate companies.

It is primarily district heating companies which have established commercial district cooling in Sweden. The most common method of production is to utilize waste heat or lake water to produce district cooling with the help of refrigerating machines. Sometimes, this is done parallel to the production of district heating. Another common production method, known as free cooling, is to utilize cold water from the bottom of a lake or the sea. Yet another method is to install heat-driven refrigerating machines in or near the customer's property. These absorption refrigerating machines are normally supplied from the district heating network, something which increases the network's degree of use in the summer.

The district cooling market has undergone a significant expansion since the first plant was established in 1992. In 2010, 31 companies provided district cooling on a commercial basis, some of which operate more than one district cooling network. In 2010, a total of 871 GWh of district cooling was delivered, 5% more than the previous year. Some of the causes of this increase are greater heat generation inside offices and shops, stricter requirements on good working conditions and the phasing out of ozone-destroying refrigerants. Figure 30 reports district cooling delivered in Sweden by supplier.

Figure 30 Supply of district cooling, 1992–2010, in GWh



Source: Swedish District Heating Association.

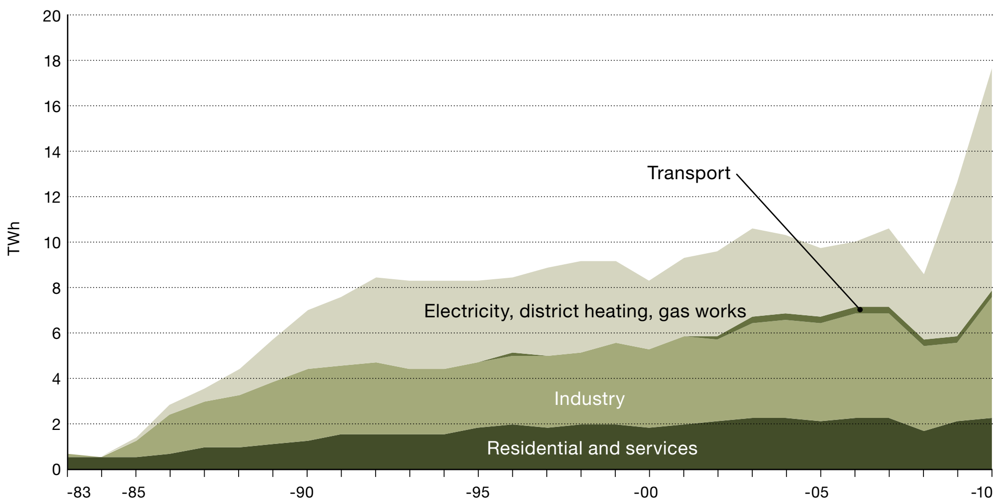
5.3 Natural gas, the largest energy gas

Energy gases is an umbrella name for natural gas, LPG, biogas, town gas and hydrogen gas. Natural gas is by far the most widely used energy gas, meeting about a quarter of the world's energy demand. Sweden uses relatively small quantities of gas. Europe, on the other hand, has an extensive natural gas network. The use of natural gas in Europe has increased by 50% since the beginning of the 1990s. Both in the EU and in the world, natural gas covers a quarter of the energy use.

Sharp rise in the import of natural gas

The import of natural gas to Sweden increased greatly in 2010 to 17 TWh, almost all of which is facilitated by pipeline from Denmark. The Danish system is in turn linked to the continental system. Smaller quantities are also imported in a liquid form known as liquefied natural gas (LNG).

Figure 31 Use of natural gas in Sweden by sector, 1985–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.

Natural gas was introduced to Sweden in 1985. Use increased rapidly until it levelled off in the early 1990s. Use of natural gas has in the last few years begun to grow again, mainly due to investments in gas-fired CHP. When operating at full capacity, the Öresundsverket power plant in Malmö, which was taken into operation in autumn 2009, has an estimated natural gas use of over 5 TWh a year.

At present, the natural gas network runs from Trelleborg to Göteborg, with branches along the route spreading out to places such as Gnosjö and Stenungsund. A terminal for LNG was opened in Nynäshamn in 2010, and there are plans to build LNG terminals on the west coast also. LNG, because of its high costs, has until now been unable to compete to any great extent with piped natural gas, but the costs of the production and transport of LNG have begun to decline. LNG is produced through extreme cooling and can be transported by lorry or boat.

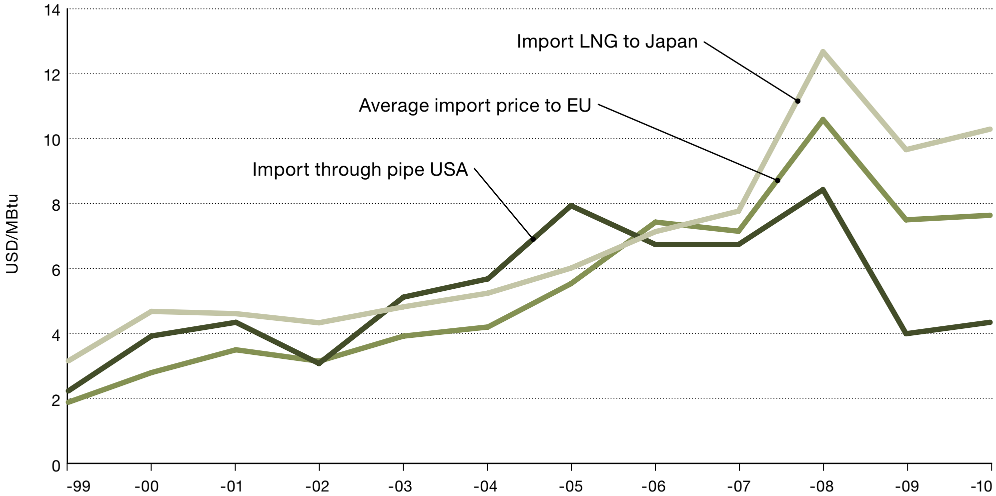
A small number of large consumers dominate

Households make up about 90% of the number of natural gas customers, but their consumption represents only 5% of the total. CHP plants and industry are the large consumers.[27] Few customers take advantage of the opportunity to change supplier. A deregulation of the natural gas markets in most EU countries, including Sweden, occurred in July 2007. The fundamental reason for deregulation was to create conditions for an efficient use of resources, thereby keeping gas prices down. The Swedish natural gas market previously consisted of local monopolies, but is now a competitive market.

Svenska kraftnät is the authority with system responsibility on the Swedish natural gas market, which means that it has an overall responsibility for maintaining the short-term balance between the supply and demand of natural gas in the national natural gas system. However, responsibility for operations, maintenance and expansion of the pipeline system lies with the owners of individual pipelines.

27 The Swedish electricity and natural gas markets 2010, the Energy Markets Inspectorate, EIR2011:07

Figure 32 Import price of natural gas, 1999–2010, in USD/MBtu[1]



Source: IEA Energy Prices & Taxes, Quarterly Statistics, Second Quarter 2011.
Note: 1. Mega British Thermal Unit.

Biogas produced locally in Sweden

Biogas today is produced primarily from domestic raw materials such as waste or sludge from sewage works. There is also some digestion of waste together with plant material. An increased demand would, however, require importation of more raw materials for digestion, such as straw or waste. In 2009, 230 biogas production plants were in operation,[28] producing a total of 1.4 TWh of biogas in Sweden.

The raw materials first decay to develop a crude gas, the quality of which must be upgraded before it can be used as vehicle gas or as an admixture with natural gas. Biogas is at present upgraded in just over 30 plants in Sweden, and is sold both as pure biogas and mixed with natural gas. The existing natural gas network in southern Sweden offers users the option to purchase pure biogas. This requires careful reporting of the input and output quantities of biogas to and from the system. The methane molecules cannot be physically separated from each other; rather it is the input and output quantities that are offset against each other, thus guaranteeing the consumer that a corresponding quantity of biogas has been delivered to the system.

Recently, distribution of upgraded biogas has increasingly been provided by actors other than the producers themselves. Gas can be distributed either by road

28 Produktion och användning av biogas år 2009 (The production and consumption of biogas in 2009), the Swedish Energy Agency ES2010:05

tanker or via a pipeline. In many cases, the biogas pump at the petrol station is also owned by the producer or distributor of the gas. At the end of 2010, there were 122 public filling stations for vehicle gas in Sweden[29]. Within Sweden, however, there are great differences in the development of gas infrastructure. The majority of the gas filling stations are to be found in the southern part of the country or in major urban areas.

LPG and town gas

LPG is a petroleum product and is therefore included in the statistics for oil products. The environmental characteristics of LPG share great similarities with natural gas. LPG is chiefly used in industry, but also in the restaurant trade and in agriculture. In 2010, the use of LPG was 4.0 TWh in industry, 1.1 TWh in the residential and services sector and 0.2 TWh in the production of electricity and district heating.

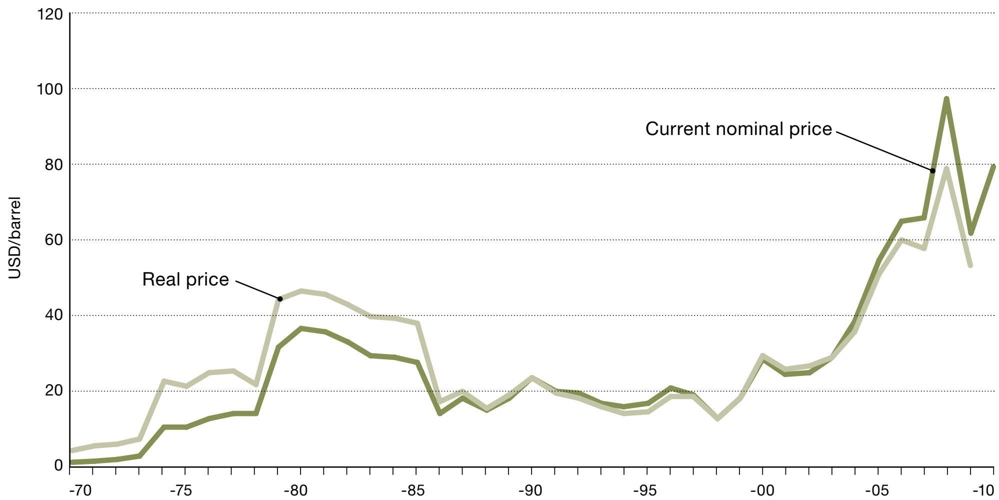
Town gas was previously manufactured by cracking naphtha. The town gas networks of Göteborg, Malmö and Stockholm now carry natural gas or a mixture of natural gas and air. Town gas is used for heating one- and two-dwelling buildings, multi-dwelling buildings, non-residential premises and industries as well in domestic and restaurant cookers. In 2010, use of town gas was 0.19 TWh.

29 Transportsektorns energianvändning 2010 (Energy consumption in the transport sector 2010), the Swedish Energy Agency

5.4 Large price fluctuations on the oil market

The last few years have seen large price fluctuations on the oil market. In 2008, the price of oil reached a temporary peak of USD 140 per barrel, but by the start of 2009, it had plummeted to USD 35 per barrel. The price stabilized through a drop in production and was again at USD 75 per barrel during 2009 and the first half of 2010. However, during the latter part of 2010 and the spring of 2011, the prices had gone up again. In April 2011, the price of oil climbed to over USD 120 per barrel.

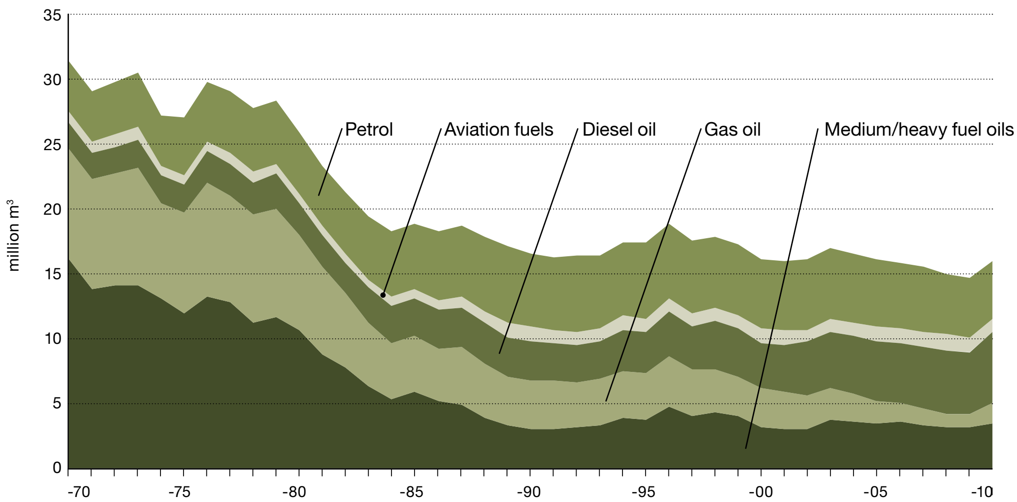
Figure 33 Current nominal and real prices of light crude oil, 1970–2010, in USD/barrel



Source: BP and the World Bank.
Note: 1. Due to revision of statistics at BP the timeseries have been revised back to 1984.
2. Global real prices deflated with MUV-index from the World Bank.

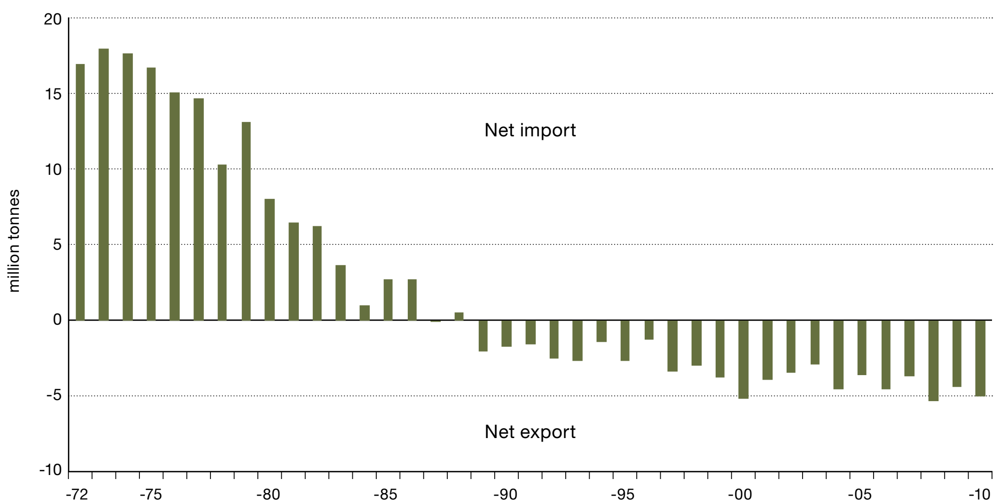
Oil use in the Swedish energy system has halved since 1970. It is primarily the use of heating oils which has decreased over the last few years, especially for houses, as shown in Figure 34. Another important change is that Sweden is now an exporter, rather than an importer, of refined oil products, see Figure 35. An increase in refinery capacity has been an important measure to safeguard the Swedish economy against excessive cost escalation.

Figure 34 Use of oil products in Sweden, including international shipping and aviation, 1970–2010, in million m³



Source: Swedish Energy Agency and Statistics Sweden.

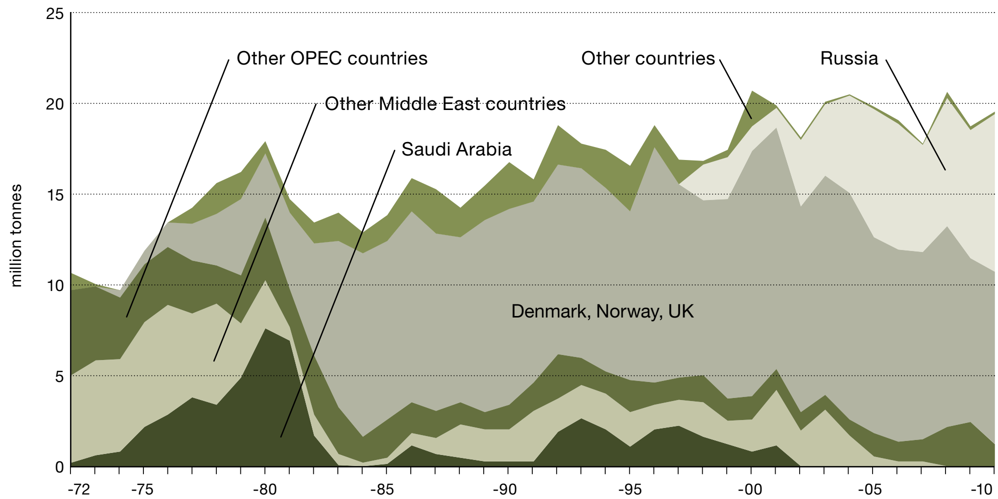
Figure 35 Net import (+) net export (–) of refinery products, 1972–2010, in million tonnes



Source: Swedish Energy Agency and Statistics Sweden.

Sweden's import of crude oil in 2010 was just over 19 million tonnes, which may be compared to the net export of refinery products of 5.1 million tonnes, see Figure 36. About half of Sweden's total import of crude oil comes from the North Sea, primarily from Norway and Denmark. In addition, the proportion of crude oil imported from Russia has risen greatly in the last decade, amounting to 44% of the total import of crude oil in 2010.

Figure 36 Swedish import of crude oil by country of origin, 1972–2010, in million tonnes



Source: Swedish Energy Agency and Statistics Sweden.
Note: Until 1997, imports from Russia are included in the category 'Other countries'.

Oil products are held in stock in order to reduce vulnerability to conflicts that affect the oil market. Disruptions to the supply of oil are regulated primarily through the agreements signed with the IEA and the EU. The size of these oil stocks for peacetime crises is decided each year by the government. The Swedish Energy Agency is the regulatory authority which lays down who has the obligation to maintain stocks and how large these are to be. On 12 June 2009, the EU's energy ministers adopted a new proposal for the Oil Storage Directive presented in 2008, see 'FACTS EU directives' in Chapter 1. The Directive requires all member states to maintain stockpiles corresponding to 90 days' net imports. The Directive is to be introduced no later than 31 December 2012, though Sweden's total stockpile of crude oil and oil products already has a yearly average corresponding to 145 days' net imports. The new directive will mean that current Swedish legislation for oil storage (LBOK) has to be rewritten.

5.5 Coal pricing is difficult

FACTS COAL

Carbon is a chemical element, but in nature, it occurs in compounds with various minerals. Some of these minerals can be burned and are called coal in everyday language. Traditionally, coal is divided into hard coal and brown coal according to its heating value or energy content, though this is not a very exact science as no two coalfields are alike. Quality differences between coals form a continuous scale. Hard coal is a relatively high-value coal, while brown coal has a lower energy content and a higher moisture content.

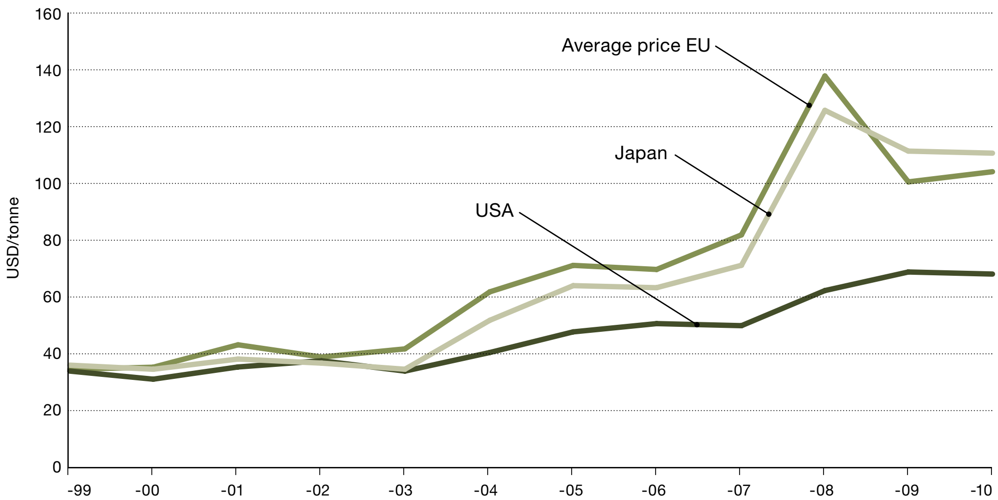
Sweden uses almost exclusively hard coal, which is traditionally divided into two different categories according to its area of use: metallurgical coal (coking coal), which is used in the iron and steel industry, and steam coal or energy coal, which is used for energy purposes in industry and the energy sector.

Coal accounts for just over a quarter of the world's energy supply and is the second largest source of energy after oil.[30] Coal is the largest source of emissions in the world and only surpassed oil as recently as 2004. World production and use of coal is increasing, primarily in China. China alone accounts for just over 40% of the world use of coal. China, USA and India are the countries which have the greatest production and use of coal in the world. China accounts for almost half of the production of hard coal. In 2009, China became a net importer of coal for the first time. The largest exporting countries of hard coal are Australia, Indonesia and Russia. Of the global production of hard coal, 15% is exported.

In terms of pricing, coal is a relatively difficult product to manage because the quality of coal varies from coalfield to coalfield. Coal is traded through individual contracts and not on exchanges in the same way as oil. In July 2008, the price of energy coal reached record levels. The coal price subsequently plummeted, but in 2010 has seen an upturn again. If the annual world production of coal continues at its present level, the proven and economically viable coal reserves will last for 144 years.[31]

30 World Energy Outlook 2010, IEA
31 Coal Information 2010, IEA

Figure 37 Import prices of energy coal in EU, USA and Japan, 1999–2010, in USD/tonne



Source: IEA Energy Prices & Taxes, Quarterly Statistics, Second Quarter 2011.
Note: Including costs, insurance and freight (CIF).

Coal in Sweden is mainly used in industrial processes

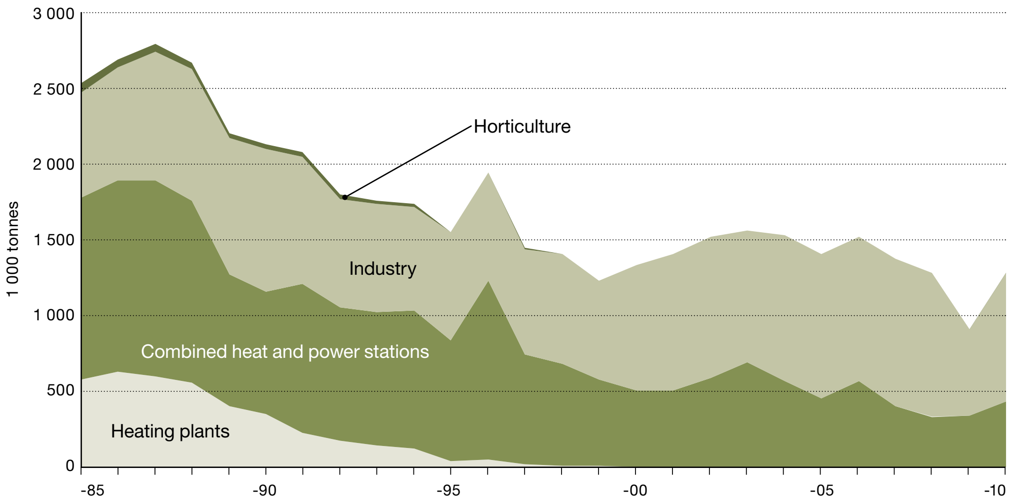
Industry uses energy coal, coking coal, coke and smaller quantities of other coal products such as graphite and pitch. Coke is essentially pure carbon, produced from coking coal in coking plants. The country's two coking plants also produce coke oven gas. Coke oven gas is used for heat and electricity production in iron and steelworks and in the district heating sector. Coke is used in the iron and steel industry to remove the oxygen from iron ore and also inputs energy into the process. In the blast furnaces, some of the coke's energy content is transferred to blast furnace gas, which is used in the same way as the coke oven gas. In addition to coking coal and coke, energy coal is also used in industry, primarily in the cement industry and the iron and steel industry.

In 2010, industry in Sweden had a use of 1.8 million tonnes of coking coal and 0.8 million tonnes of energy coal. These amounts correspond to 9.8 TWh of coking coal and 6.4 TWh of energy coal. Coking coal is used, as previously described, to manufacture coke, coke oven gas and blast furnace gas. The use is now up to more normal levels after the dip in 2009, which is explained by the global recession and financial crisis.

Coal use has declined in the Swedish district heating sector

The use of coal in the Swedish district heating sector declined greatly in the 1990s following the introduction of the carbon dioxide and sulphur taxes. This coal has been replaced by biofuels. CHP plants, however, still use coal to a certain extent, partly because the taxation rules for CHP production are not as stringent as for pure heat production. This difference in taxation aims to increase the competitiveness of CHP plants as opposed to plants which only produce electricity or heat. In 2010, the use in the district heating sector for the production of electricity and district heating was equivalent to 3.3 TWh of energy coal and 2.0 TWh of coke oven and blast furnace gas.

Figure 38 Use of energy coal in Sweden, 1985–2010, in 1000 tonnes



Source: Swedish Energy Agency and Statistics Sweden.

5.6 Supply of biofuels, peat and waste has doubled

The use of biofuels, peat and waste in the Swedish energy system has increased over the years. In 1983, the use was 53 TWh, accounting for just over 10% of the total energy supply. In 2010, biofuels, waste and peat accounted for 23%, having increased to 141 TWh.

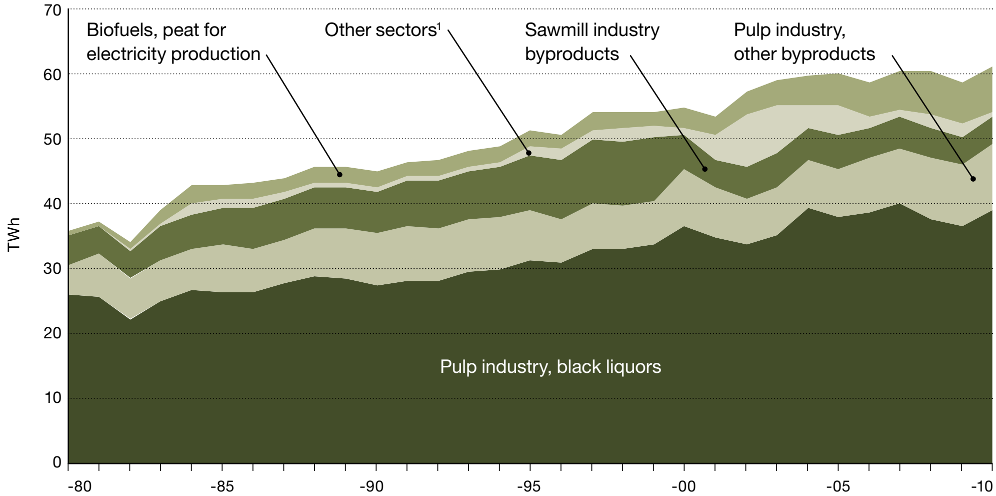
Biofuels, waste and peat are used primarily in the forest industry, for heat and electricity production and for heating residential buildings. The greatest increase is being seen in industry and in district heating plants. The use in the residential sector and transport sector is also increasing.

FACTS BIOFUELS

The bulk of the biofuels, peat and waste used in the Swedish energy system is made up of:

- Wood fuels, non densified (bark, sawdust, recycled wood, logging residues and energy forest) and densified (pellets, briquettes and powder)
- Black liquors, tall oil and tall pitch oil (intermediate products and by-products in chemical pulp production)
- Grain, energy grass and straw (biofuels from agriculture)
- Peat
- Combustible waste from industries, households etc.
- Ethanol 100% for industry (admixture in 95 octane petrol and main constituent of the vehicle fuels E85 and ED95)
- FAME (umbrella term for fatty-acid methyl esters, of which the vehicle fuel RME, rapeseed oil methyl ester, is the most common)
- Biogas.

Figure 39 Use of biofuels, peat and waste in industry, 1980–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: 1. Other sectors includes the food sector, the chemical industry and the manufacturing (engineering) industry among others.

Waste products generated by the forest industry

A large amount of by-products and waste products are generated by the forest industry. The energy sector mainly uses logging residues, branches and tops, and split fire wood from forestry. The wood products industry and the pulp and paper industry create solid by-products such as bark and sawdust. Some by-products, for example sawdust, are densified into pellets, briquettes and powder. This is done to raise the fuel's energy density, facilitate handling and distribution and improve transport economy.

The forest industry uses by-products and waste products from various manufacturing processes, as well as raw materials which fall short of the quality requirements for the production of heat and electricity. Both the pulp industry and sawmills use sawdust and bark as fuel in their industrial processes. In 2010, 14.4 TWh of solid by-products and waste products was used by industries for heat production.

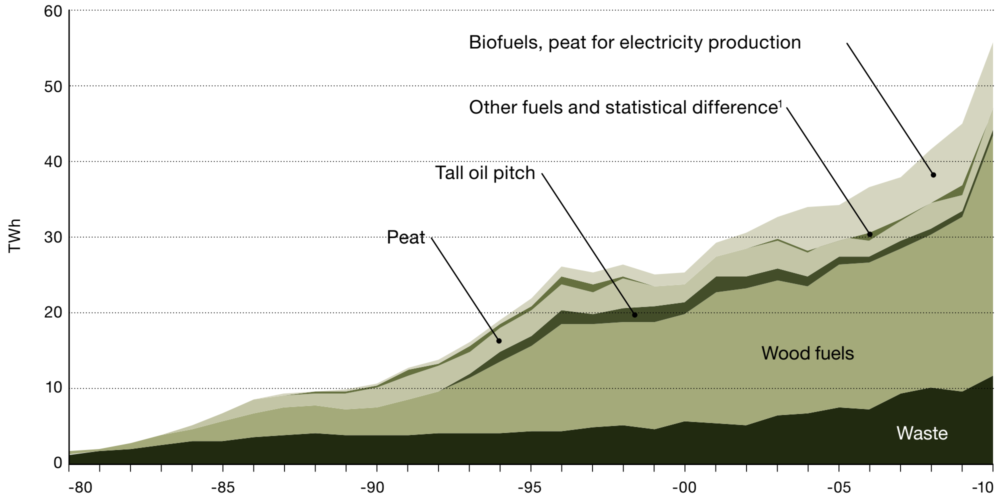
When manufacturing chemical pulp, the companies recover chemicals through burning black liquors containing cooking chemicals, lignin and extractives. Crude tall oil is a by-product from the recovery of the cooking chemicals, and through refining, tall oil and tall pitch oil are separated. Crude tall oil and tall oil can be used as fuel but because they are taxed as heating oil, they are mainly used as a raw material in industry. Tall pitch oil, on the other hand, is untaxed as a biofuel, and so is seeing a greater degree of use. Energy from the combustion of black liquors is utilized internally within the pulp industry and amounted to 39 TWh, excluding electricity production, in 2010.

Use in district heating plants multiplied since 1990

In 2010 the use of biofuels, peat and waste for heat production in district heating plants, excluding electricity production, increased to 47 TWh. Wood fuels accounted for 32 TWh, black liquors and crude tall oil for 1 TWh, waste for 12 TWh and peat for 3 TWh. The use of biofuels in the district heating sector has increased more than fivefold since 1990, see Figure 40. These biofuels are mainly wood fuels in the form of logging residues and low-grade round wood, as well as solid by-products from the forest industry. Densified fuels such as briquettes and pellets are being used to an increasing extent.

Waste has been used for district heating production since the 1970s, and the quantity increased from 4 TWh to 12 TWh between 1990 and 2010. The increased level of waste incineration is largely due to the fact that there has been a ban on recovered combustible waste in landfills since 2002, and from 2005, there has also been a ban other organic waste in landfills.

Figure 40 Use of biofuels, peat and waste in district heating plants, 1980–2010, in TWh



Source: Swedish Energy Agency and Statistics Sweden.
Note: 1. The difference is due to two different statistical sources.

Biofuels for electricity production increasing

In 2009, the use of biofuels, peat and waste for electricity production was 16 TWh: 9 TWh in CHP plants and 7 TWh in industrial backpressure plants.

Since 1 April 2004, peat-fuelled electricity production has qualified for the electricity certificate system when this production has taken place in approved CHP plants. In 2010, the use of peat in electricity production was 1 TWh.[32]

Large proportion of imported biofuels, peat and waste goes to district heating

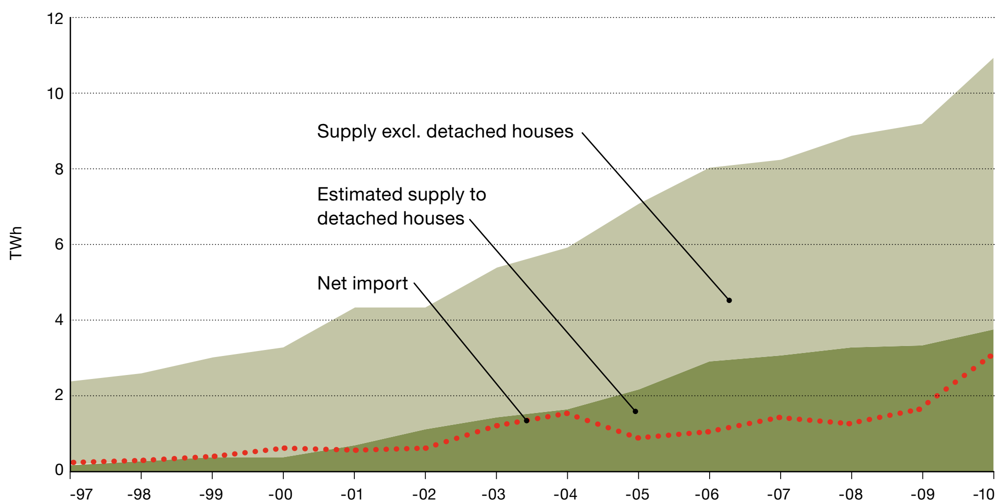
The bulk of the biofuels, peat and waste used in Sweden is produced domestically, but there is however an extensive import of primarily ethanol, wood pellets and peat. The proportion of the net import of wood pellets is estimated to just under one tenth. An equivalent of 3.4 TWh of wood pellets was imported and 0.3 TWh exported in 2010. In 2010, peat imports amounted to 1.0 TWh.

32 Peat 2010. Production, use, environmental impact, Statistics Sweden, MI 25 SM 1101

One cubic metre of peat weighs 300 kg and has an energy content of 0.8 MWh. There is currently no comprehensive compilation of statistics for the import and export of biofuels, which makes it difficult to estimate the extent of these imports. This import volume is however represented in the country's energy balance as domestically produced, based on consumption statistics. Investigations into biofuel imports indicate a figure of between 5 and 9 TWh, thus constituting a significant source of fuel. The majority of imports goes towards supplying district heating.

There is an existing import of waste, demolition wood and similar fuels, but the extent of this is difficult to estimate. The extent of imports is affected partly by the way Sweden and the exporting countries structure their taxation of waste as regards unsorted and sorted waste, and partly the levels within each waste taxation system. Emissions trading systems can also affect imports, but it is nevertheless likely that the incineration of waste in Sweden will continue to increase over the next few years.

Figure 41 Supply of pellets to the Swedish market, 1997–2010, in TWh



Source: The Swedish Association of Pellet Producers.

5.7 Ethanol and biodiesel markets increasingly important

The use and production of biobased motor fuels have increased greatly in the last ten years, both in Sweden and in the world as a whole. Today, biobased motor fuels account for about 2% of the global use of motor fuels in the transport sector. In global terms, ethanol is the biggest biobased motor fuel, followed by biodiesel. Biogas as a motor fuel has not yet found a widespread global use, but does exist in Sweden, for example.

Ethanol and biodiesel are used widely in countries which produce biobased motor fuels; that is, only a small proportion is traded between different countries. The largest producers of ethanol are the USA and Brazil, while Europe dominates in the production and use of biodiesel. Europe is also a large net importer of ethanol since demand is considerably greater than production.

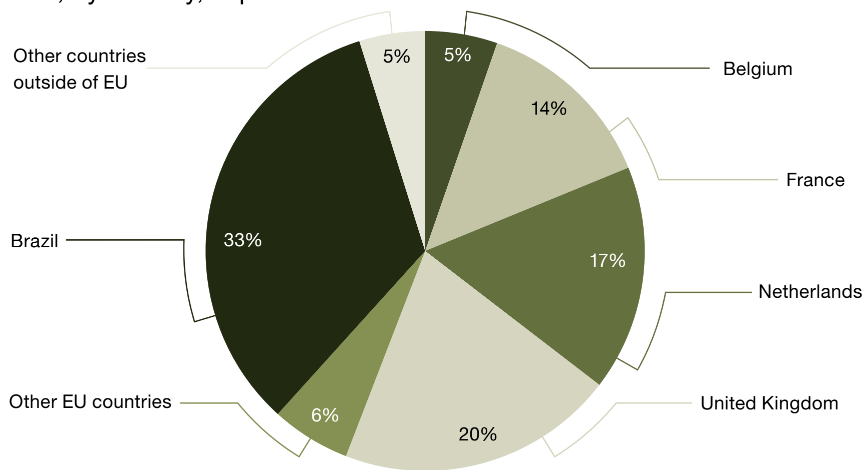
Sweden has two producers of ethanol and around ten producers of biodiesel. It is however mainly two producers which account for almost all the domestic production at present: Lantmännen Agroetanol, which produces ethanol, and Perstorp BioProducts, which produces biodiesel. Their respective production capacities are 210,000 cubic metres of ethanol and 180,000 cubic metres of biodiesel. In addition to these, from 2011, the oil company Preem produces biodiesel in the form of hydrogenated vegetable oil (HVO). The finished product is a conventional diesel fuel, with the difference that it can contain a greater proportion of biobased raw materials than is possible with FAME as a low-admixture additive in diesel. At present, Preem has a stated production capacity of 100,000 cubic metres per year.

In 2010, the use of ethanol and biodiesel as motor fuels amounted to 400,000 cubic metres of ethanol and 225,000 cubic metres of biodiesel, which means that Sweden is a net importer of biobased motor fuels. In the last two years, 55% of the biodiesel used in Sweden has been produced in the country[33]. In 2010, Sweden's import of ethanol amounted to just over 240,000 cubic metres, and export to 73,000 cubic metres.

The majority of Sweden's imports of both ethanol and biodiesel comes from other EU countries. However, it is not necessarily the case that the country of export is the country of production. The Netherlands, for example, is a major importer of ethanol from countries outside the EU. The ethanol is then sold on within the EU, to Sweden for example, and is registered in Sweden's trade statistics as imports from the Netherlands. There are no official statistics for the country of origin for this ethanol.

33 Förslag till nationell lägesrapport om utvecklingen av förnybar energi (Proposal for national progress report on the development of renewable energy) ER 2011:19, Swedish Energy Agency.

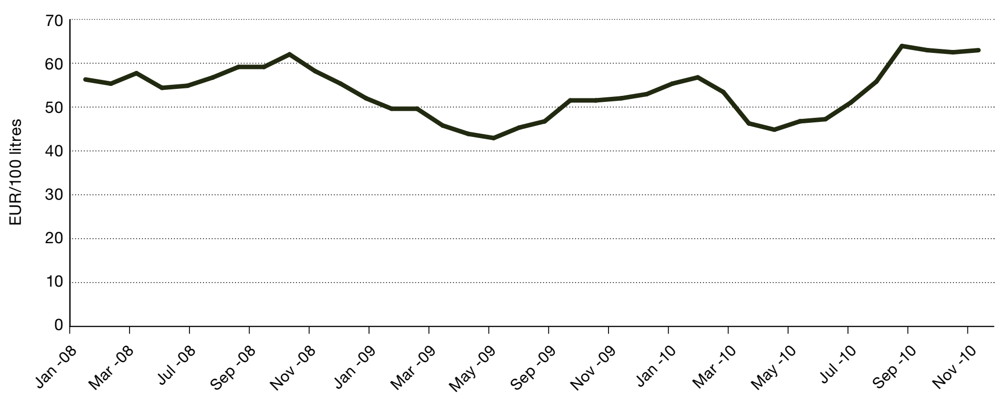
Figure 42 Import of undenatured and denatured ethanol, in total 243,253 m^3 in 2010, by country, in per cent



Source: Statistics Sweden.
Note: Included here are fuel ethanol, ethanol for industrial use and beverage ethanol.

Ethanol is classified as an agricultural product, which means that it is not subject to the same customs regulations as biodiesel, which is classified as an industrial product. The customs duties for the respective forms of ethanol on import to the EU amount to EUR 10.2 and 19.2 per 100 litres. For Swedish actors to obtain tax exemption for ethanol as a low-admixture additive, the ethanol must have been imported at the higher rate of customs duty corresponding to about SEK 1.7 per litre. Biodiesel is imported as an industrial product with a customs duty amounting to 6.5% of the product value.

Figure 43 Ethanol price on the European market, January 2008 – December 2010, in EUR per 100 litres

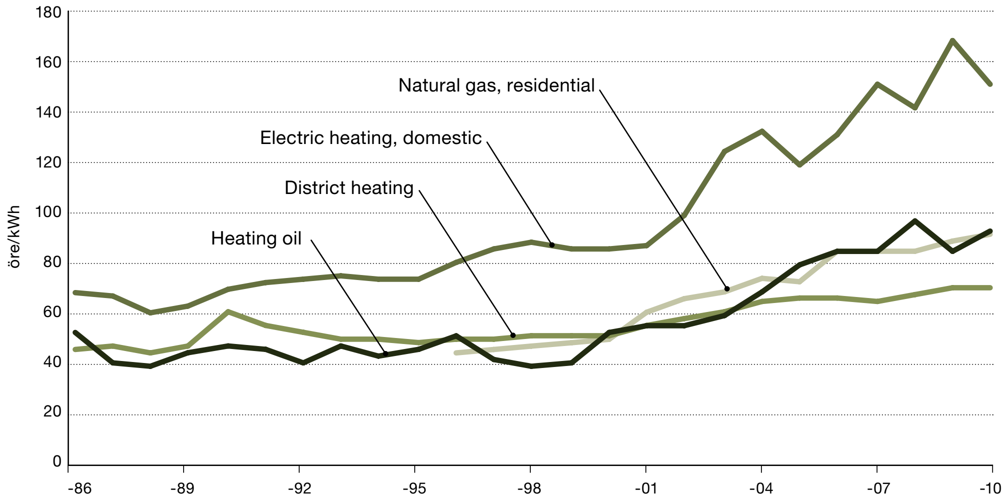


Source: FO Licht, World Ethanol Price Report, 3 May 2011.

5.8 Price developments for certain forms of energy and motor fuels

Energy and motor fuel prices have increased across the board over the last 20 years. The development of the real energy prices for households and for industry is shown in Figure 44 and Figure 45. These prices are reported at the 2010 price levels, with use of the Consumer Price Index (CPI) to convert nominal prices to real prices.

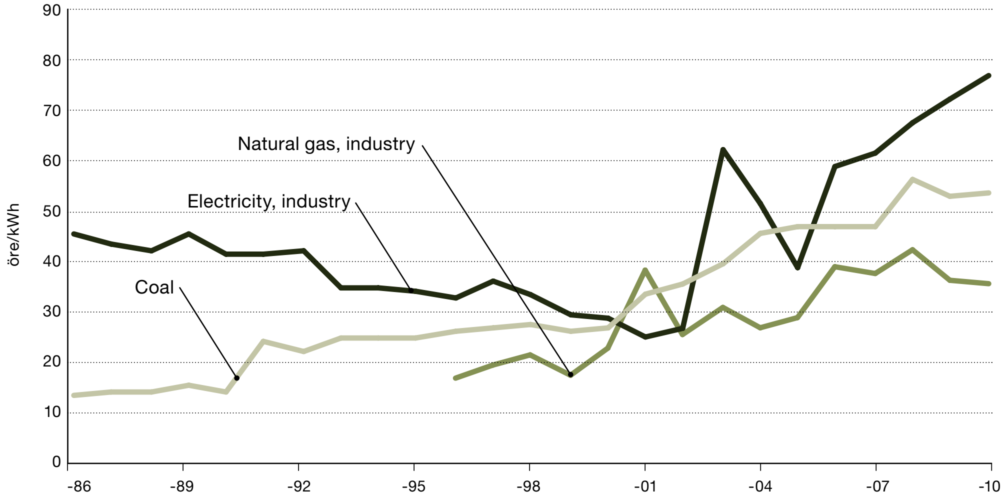
Figure 44 Real energy prices for households in Sweden including energy taxes and VAT, 1986–2010, in öre/kWh



Source: Swedish Energy Agency and Statistics Sweden.

All the reported forms of energy have seen a rise in real prices. Electricity prices especially have risen greatly over the last ten years, and the price of oil and natural gas has also risen. Electricity prices for houses with electric heating dropped between 2009 and 2010. A contributory reason for the increase in electricity prices is the introduction of the EU Emissions Trading System (EU ETS). This has led to carbon dioxide-based electricity production, which sometimes determines the prices in the Nordic electricity market, becoming more expensive.

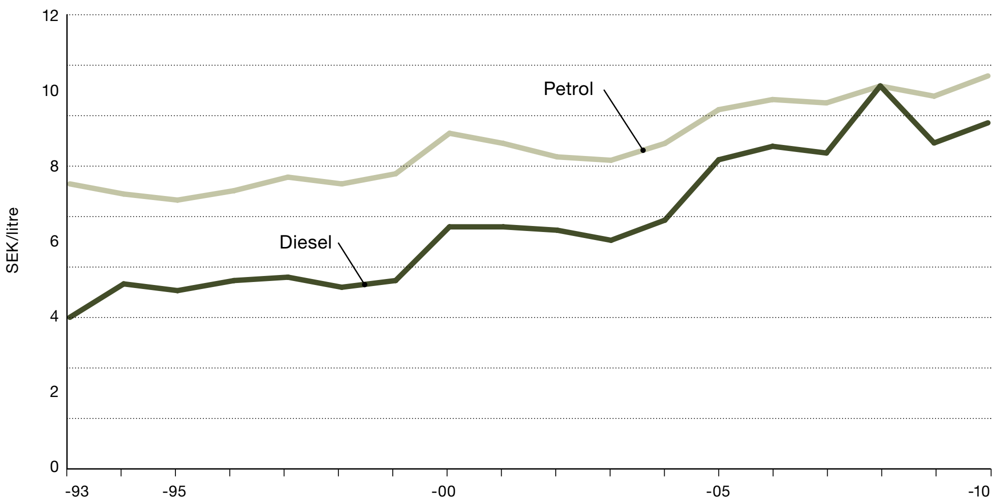
Figure 45 Real energy prices for the industry in Sweden including energy taxes, 1986–2010, in öre/kWh



Source: Swedish Energy Agency and Statistics Sweden.

The real motor fuel prices for 95 octane petrol and diesel is shown in Figure 46. The prices, including tax but excluding VAT, have risen during the reported period 1993–2010. Between 2008 and 2009, there was a relatively large fall in the prices. The reason for this price fall was that the price of oil had fallen sharply due to the financial crisis, which also led to lower motor fuel prices.

Figure 46 Real annual average energy prices for motor fuels in Sweden including energy taxes but excluding VAT, 1993–2010, in SEK/litre



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

Summary

Both the electricity and gas markets in Sweden have undergone great changes since deregulation. The electricity market was deregulated as early as 1996 and is becoming increasingly integrated into the other Nordic and EU markets.

In 1970, electricity was mainly produced with hydro power and oil-fired condensing power plants. In 2010, hydro power accounted for 46%, nuclear power for 38% and wind power for 2.4% of electricity production. The remaining proportion consisted of production based on fossil and biomass fuels. 2010 had the highest yearly average ever recorded for the electricity spot price in Sweden, which was due to improved economic conditions in that year leading to greater demand. The import of natural gas increased greatly in 2010, mainly as a result of gas-fired CHP.

Sweden has had district heating since the 1950s, and this has seen massive expansion in recent decades. Today, district heating is the most common heating method for multi-dwelling buildings and non-residential premises, and parallel to this, district cooling has seen an increase in projected deliveries. In the market for one- and two-dwelling buildings, district heating has a market share of 15%. One of the advantages of district heating is that it is flexible enough to be able to utilize different fuels. Since the 1970s, there has been a major transition towards the use of renewable fuels. In 1980, oil accounted for 90% of the energy used to produce district heating in Sweden. In 2010, biofuels, waste, peat and waste heat accounted for 73%. Significant market changes are forms of ownership as well as proposals for increased competition.

Since the 1980s, oil use in the Swedish energy system has almost halved, coal use has halved, while the use of biofuels, waste and peat has more than doubled. Biofuels are used primarily in the forest industry, in district heating plants, in electricity production and for heating residential buildings.

6 Security of energy supply

The energy system is complex, with a web of interdependencies between different parts of the system. There is also a great deal of interdependency between the energy system and other technical systems such as electronic communications and transport. But despite – or thanks to – its complexity, the energy system usually delivers the amount of energy expected of it by the user. The delivery of energy does experience disruptions from time to time. Short interruptions mainly pose problems for industry, while extensive and prolonged disruptions in the energy supply place the whole of society in serious difficulties. Different measures of various kinds can be used to bolster the security of energy supply, but these measures must be weighed against environmental considerations and cost effectiveness.

6.1 Disruptions to energy deliveries are an annual occurrence

Disruptions to energy deliveries occur to various degrees on a yearly basis. In theory, these disruptions can take on one of two forms: limited access to energy or an interruption in the delivery of energy.

Water shortage and cold weather caused problems in the energy supply

In a situation of limited access, energy prices usually rise, which normally leads to a reduced use of energy. This indicates that it is producers, suppliers and users of electricity who primarily deal with the shortage situation. If this turns out to be insufficient for the situation, national or international intervention in the market may become necessary. Examples of this at an initial stage might be extensive information campaigns to encourage energy conservation. In seriously difficult situations, various forms of restriction on energy use can be introduced. The worst-case scenario in times of electricity shortage is that users have to be subjected to temporary disconnection from the electricity system.

In the winter of 2010/11, reservoir water levels were the third lowest recorded since 1950, which led to an unusually vulnerable long-term capacity balance. This situation was aggravated when the most important river for electricity production, Luleälven, developed an ice jam, but conditions stabilized in April thanks to the snow melting unusually early. Despite a slow start in the autumn, electricity production at the nuclear power plants was relatively stable during the winter. The Swedish Energy Agency monitored developments closely during the whole period.

The short-term capacity balance between expected electricity supply and electricity use was also strained on a number of occasions during the winter. At times, this led to high electricity prices, with some production cuts in certain electricity-intensive industries as a result. Some of the oil-fired power plants were started because electricity prices were still greater than the cost of producing electricity in these plants. But this still was not sufficient because electricity use was high as a result of unusually cold weather throughout the country. So on a number of occasions this winter, Svenska kraftnät was forced to make use of the peak load reserve to maintain the balance in the electricity system.

In Norway, which is almost completely dependent on hydro power for its electricity production, the situation was such that the authorities ran an information campaign in order to reduce electricity use.

FACTS THE PEAK LOAD RESERVE

Prior to deregulation of the electricity market in 1996, power companies were responsible for both the short-term and the long-term balance in the electricity market. After deregulation, Swedish National Grid has had responsibility for the short-term electricity balance. A part of this responsibility involves Svenska kraftnät acquiring a peak load reserve of, at the most, 2000 MW in time for winter. This peak load reserve is managed through contracts with electricity producers and major electricity users. The peak load reserve includes plants which would not otherwise be available on the electricity market. The peak load reserve will be phased out gradually by 15 March 2020..

Extreme weather conditions and systems failures led to disruptions in the electricity and heat supply

From 1 January 2011, unplanned electricity outages, with certain exceptions and reservations, may not last longer than 24 hours. This means that all electricity users must be able to manage electricity outages of at least 24 hours. The Swedish Energy Agency is currently formulating proposals for functional requirements even for other parts of the energy supply.

Most unplanned outages are short, even though they sometimes affect many people. Certain events are more serious, however, and affect the whole country or large parts of it. Examples of large outages during the period January 2010–June 2011:

- Large, but short, electricity outages affecting at least 10,000 electricity users as a result of technical faults or thunderstorms have occurred on at least one occasion in around fifteen places/areas throughout the country. In several cases, the electricity outages also led to disruptions in the district heating supply.
- Due technical failure or prolonged cold weather, several district heating plants had to utilize reserve plants in order to deliver sufficient heat.
- In the beginning of February 2011, southern Sweden was hit by the storm Berta. 120,000 customers lost electricity, of which 1,600 suffered outages lasting more than 24 hours. The Energy Markets Inspectorate is examining whether deficiencies in the electricity network operators' preventive measures played a part in their failure to meet the requirements of the Electricity Act. The Energy Markets Inspectorate has reported its initial findings in PM 2011:06. Further examination of the matter will follow.
- In March 2011, industrial areas and 900 households in Kiruna were affected by several days of disruptions with long outages in the district heating supply. This was a result of several major leakages in the pipeline network. The district heating company purchased and delivered 740 electric radiators to customers in houses.

6.2 World events affect Sweden

The earthquake and tsunami in Japan affect electricity prices

The very powerful earthquake in Japan and the subsequent tsunami which hit eastern Japan in the beginning of March 2011 has, in addition to the tragedies affecting the population and the extensive devastation, created great problems in Japan's energy supply. Many nuclear power plants were damaged or shut down for safety reasons. Other types of power plants were also damaged by the natural disaster. This has led to an increased use of natural gas and coal in Japan, which has also pushed up electricity prices in Europe. Japan's electricity shortage was initially managed through rotating power outages. Electricity rationing will, to one extent or another, be affecting 28 million people in the Tokyo area for at least a year.

As a result of the events in Japan, Germany has decided to phase out nuclear power by the year 2022. Switzerland too has decided to phase out nuclear power, and several other countries are talking about ending their nuclear power programmes. This stands in sharp contrast to the previous situation where many countries had an expansion of nuclear power on the agenda.

The supply of fossil fuels threatened by events outside Sweden

The greatest threats to the supply of oil-based fuels are associated with geopolitical events and other international factors, which makes them difficult to influence from a local or regional level. One example is the unrest in North Africa and the Middle East which has led to reduced production in the region, thus pushing up the price of oil. This played a role in the IEA's decision on 23 June 2011 to make oil available from the emergency stocks which member states had built up since the oil crisis in the early 1970s. This was the third time the IEA have decided to release such stocks.

Natural gas production in Denmark was wavering in January 2011. This disrupted deliveries to Sweden because the pressure in the gas pipeline was at times lower than normal. This poses a reminder that some of the greatest risks in the Swedish natural gas supply are related to events in Denmark and Germany.

6.3 A secure energy supply balances environmental and economic considerations

It is possible to increase the security of energy supply through investment and the groundwork laid by producers, distributors and users. But this work needs to be balanced with aspirations for an environmentally friendly and cost effective energy supply. In a corresponding way, environmental considerations and the desire for low prices must be weighed against the collective need for a secure delivery of energy. Everyone who works with energy issues, or uses energy in some form, must weigh up these considerations. To help with this, the Swedish Energy Agency has produced some concrete advice and good examples for various target groups on how to prevent and mitigate the consequences of electricity and heating outages. This information is found at www.energimyndigheten.se/tryggenergi.

FACTS PRIORITIZING OF ELECTRICITY USERS

Nowadays, it is possible to prioritize certain electricity users in exceptional situations which require electricity users to be disconnected from the grid. Such situations are considered to be when electricity production and reserve capacity are insufficient to create balance in the system. The process for the new planning system, Styrel, starts with each municipality identifying and prioritizing the activities which are important for society.

Swedish National Grid will continue to be the decision-maker with regard to when, where and how much electricity use needs to be disconnected from the grid.

6.4 Almost all energy supply is dependent on electricity

Electricity is a prerequisite for virtually all other forms of energy supply and therefore occupies a unique position in the energy system. The availability of electricity is, in many cases, also a prerequisite for the operation of other technical systems, such as electronic communications. These in turn are important for the operational function of the energy system.

A large part of the heating of non-residential premises and residential buildings is dependent on electricity to be fully operational. This is the case whether or not this heating is provided by electric heating, boilers fired by biofuels or oil, heat pumps or district heating. In cold weather, residential buildings quickly lose their heat after an outage in the heat supply. When the outdoor temperature is –5°C, it takes about 48 hours for the temperature in the average 1970s home to drop from 20°C to 5°C. A prolonged outage in the heat supply may require the occupants to move out.

An operational electricity supply is also necessary to be able to fill vehicles with petrol, diesel, E85 or vehicle gas.

6.5 The energy system is dependent on transport

Several parts of the energy system are dependent on road transport. This transport is in turn highly dependent primarily on the availability of diesel. Only in the long term will other motor fuels be able to replace – or noticeably supplement – oil-based fuels.

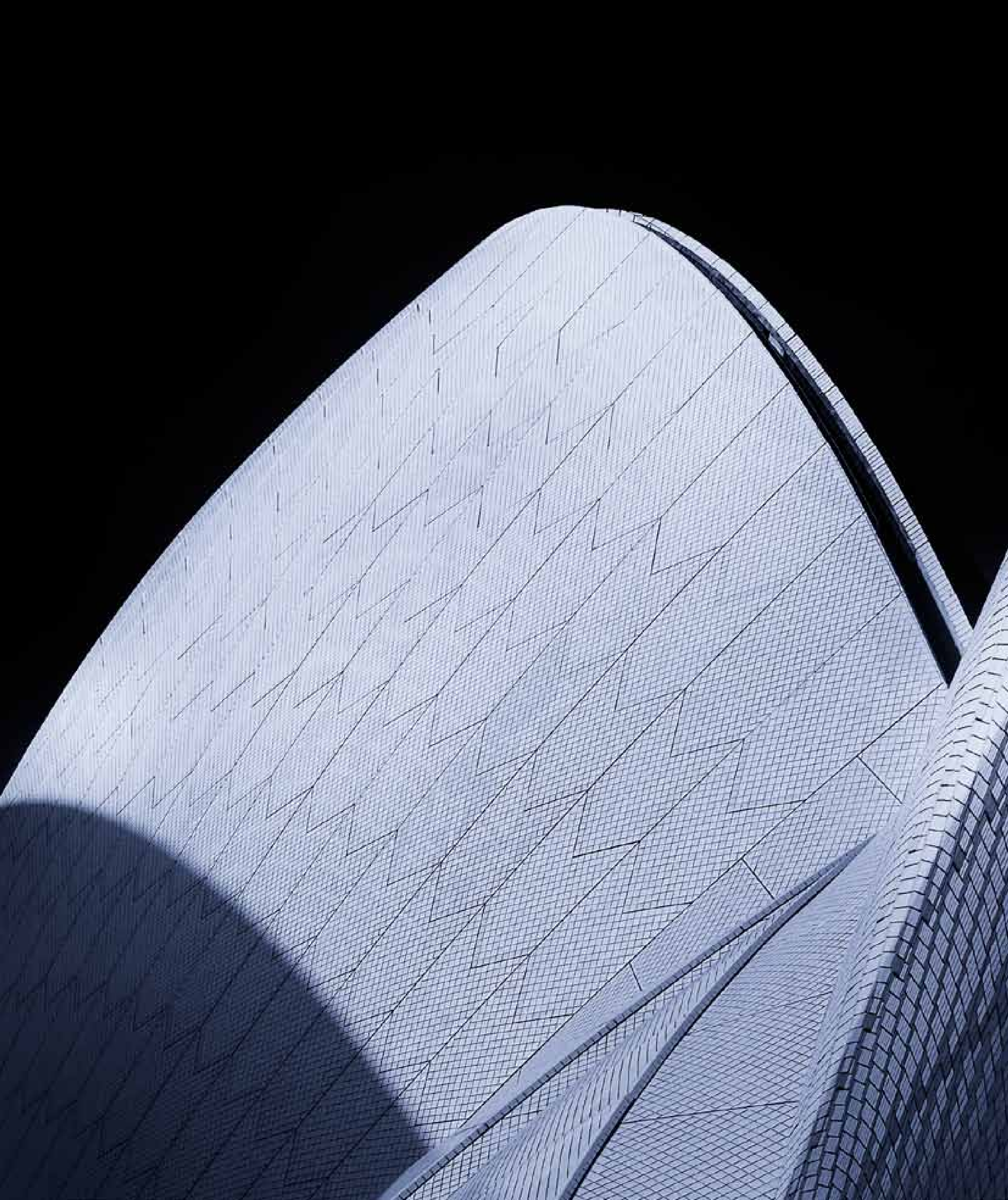
An acute shortage of diesel would affect opportunities to use other fuels. In addition to the distribution of petrol and diesel to filling stations, opportunities to use biofuels and heating oil in district heating plants would also be affected. Diesel is necessary, for example, for machinery in forestry and at district heating plants as well as for the transport of raw materials from forests to fuel factories and of biofuels to heating plants.

Summary

Disruptions to the energy supply can affect a large part of society and the population. It is technically and economically impossible for the overall energy system to meet the reliability requirements of every single user. Electricity occupies a unique position in the energy system, as it is a prerequisite for virtually all other forms of energy supply. Through Parliament, and with effect from 2011, society has established requirements for the electricity network operators to ensure that electricity outages not last more than 24 hours. In practice, this means that electricity users must be able to withstand the consequences of a power failure of this duration.
If there is urgent need to disconnect electricity users from the grid, there are now opportunities to prioritize certain activities.

7 An international perspective

The global demand for energy is growing continually, and the use of fossil fuels is becoming greater and greater even though alternative sources of energy are growing. A prolonged period of rising energy use was interrupted somewhat in 2008 and 2009 as a result of the financial crisis, but began to rise again in 2010. Energy use varies greatly from region to region throughout the world, both in terms of use per inhabitant and per form of energy.



7.1 Economic recovery led to increased energy use in the world

2010 was characterized by economic recovery after the financial crisis of 2008 and the subsequent recession in the global economy in 2009. The OECD countries were those hardest hit by the economic downturn, which meant a reduced energy supply in these countries. Many countries outside the OECD coped better during the recession and were able to increase their energy supply. This was the case for Asia in general, but China in particular. In 2010, all world regions saw an increased energy supply as a result of the global economic upturn[34].

Meeting the world's energy needs is of great importance for global economic growth and the development of countries. Fossil fuels are primarily used for the production and transport of goods. Any imbalances in the relationship between supply and demand somewhere in the world will to some extent affect energy markets in the rest of the world. Increasingly wide fluctuations in the price of energy raw materials have also led to an ever growing proportion of the energy market being affected by speculation within the financial system. Over the last few years, wild swings and price rises on the world's exchanges for raw materials have signalled that imbalances and high prices for energy raw materials are something we may have to become accustomed to.

Energy use increasing everywhere but not to the same extent

The economic disparities between the regions of the world are clearly reflected in the energy use per inhabitant. The average American uses by far the most energy, followed by the average European. As more and more countries are raising their standard of living, there will need to be a much greater energy output, not least in the form of fossil fuels, which still dominate the world's energy use.

The total energy use in the world was almost 100,000 TWh in 2008. This is a clear increase since 1990, but the distribution between the various sectors is generally the same. The industrial sector shows the greatest increase in use when compared with the other sectors, even though it is only a moderate increase. The transport sector, often described as the fastest growing sector, has during the 2000s remained relatively constant at around 27% of the use. Over the last few years the proportion of household energy use has had a declining trend, even though there was an upswing in 2008. Energy use for non-energy purposes is made up of raw materials for the chemical industry, lubricating oils and oils used for surface treatments in the building and civil engineering sectors, to name a few.

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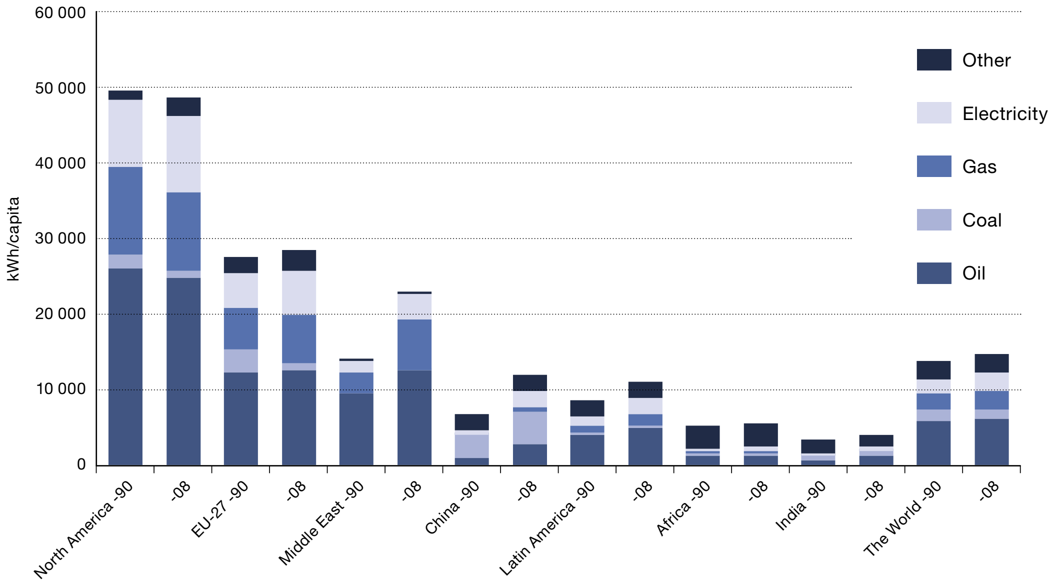
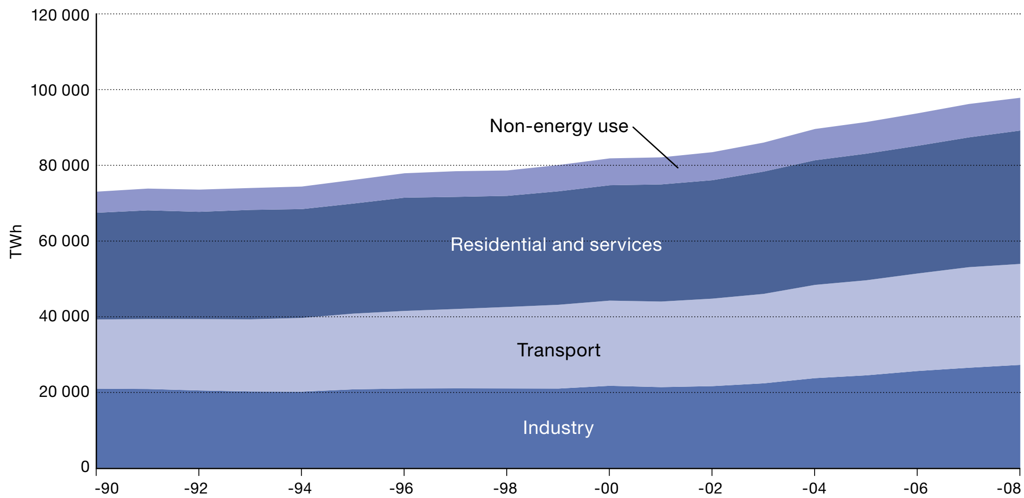
34 BP Statistical Review of World Energy, 2011

Figure 47 Regional energy use in the world by energy source, 1990 and 2008, in kWh/capita



Source: IEA Energy balances of Non-OECD Countries 2010, IEA Energy Balances of OECD Countries 2010.

Figure 48 The world's energy use by sector, 1990-2008, in TWh

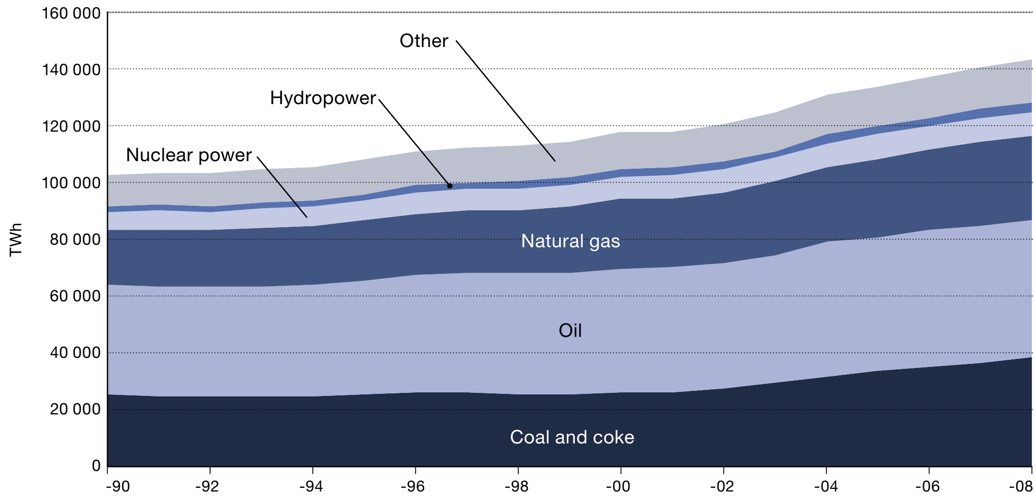


Source: IEA Energy Balances of Non-OECD Countries 2010.

7.2 The world is dependent on fossil fuels

The global energy supply in 2008 amounted to almost 144,000 TWh. Fossil fuels make up just over 81% of this supply. Oil dominates, with 33% of the supply, followed by coal with 27% and natural gas with 21%. Renewable energy, including hydro power, has risen in the last decade to a proportion of 13%. The remaining 6% of the energy supply comes from nuclear power.

Figure 49 Global energy supply, 1990–2008, in TWh



Source: IEA Energy Balances of Non-OECD Countries 2010.

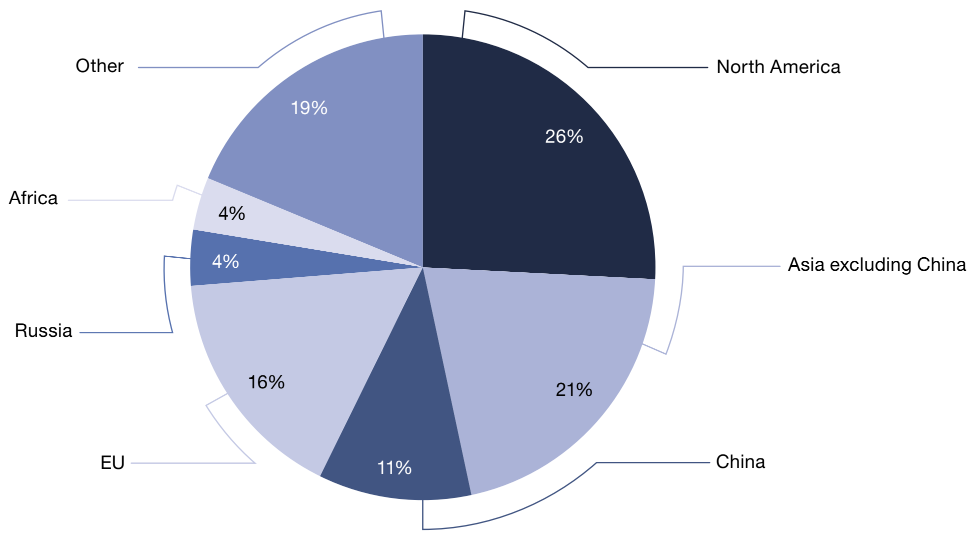
Oil is still the largest source of energy

The supply of oil grew steadily from 1990 until the financial crisis of 2008. In 2009, however, the supply of oil dropped by 3% compared with 2008. In 2010, the supply increased again by 3.1%, reaching the highest level ever. The sharp rise in the price of oil over the past few years, however, has caused a reduction of the total proportion of oil within energy use since 1999 in favour of cheaper fossil fuels. A large part of the world's oil production takes place in politically unstable regions, which makes the supply of oil uncertain. Within the oil segment, the proportion of petrol has remained virtually constant over the last ten years, accounting for around 32% of the production of oil refineries. The proportion of heavy fuel oils has declined steadily and is now at less than 11%. This decline is matched by the increase of middle distillates, primarily diesel, from 34% to 36% during a ten-year period.

FACTS THE STATISTICS IN CHAPTER 7

The statistics in this chapter are based primarily on data collected by the IEA. OECD countries make submissions with one year's delay while countries outside the OECD make submissions with two years' delay. This is why statistics for the whole world are only available up to the year 2008. Figures and statistics relating to 2009 and 2010 have been taken from BP's compilation of energy use, energy supply and world production of electricity and heating. Because the IEA and BP have different methods of data collection and sampling, the statistics for 2009 and 2010 are not directly comparable with historic data. The Swedish Energy Agency has, despite this, chosen to report statistics for 2009 and 2010 in order to provide a picture of the world energy situation for those years.

Figur 50 Global supply of oil in 2010, in total 46 847 TWh, by region in per cent

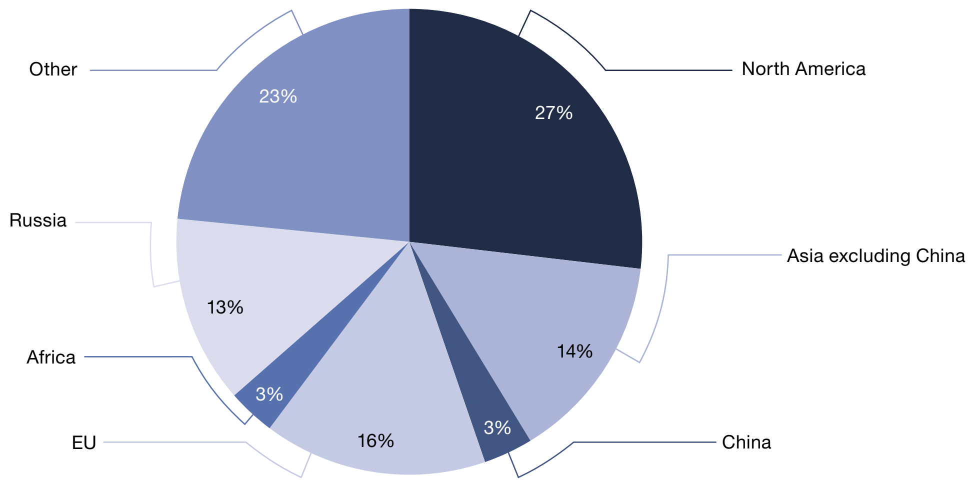


Source: BP Statistical Review of World Energy, 2011.

Coal and natural gas dominance varies in different regions

The supply of natural gas in the world has increased by 50% over the last twenty years, and increased greatly in 2010 compared with 2009. Most of the world's regions, except for the Middle East, saw the greatest increase since 1984, with the world supply growing by 7.4%. Natural gas accounts for about a quarter of the world's total energy use, and is abundant in nature. As in the case of oil, the availability of natural gas is unevenly distributed across the regions of the world, where the Middle East (41%) and the former Soviet Republics (31%) hold the bulk of the reserves.

Figure 51 Global supply of gas in 2010, in total 33 240 TWh, by region in per cent

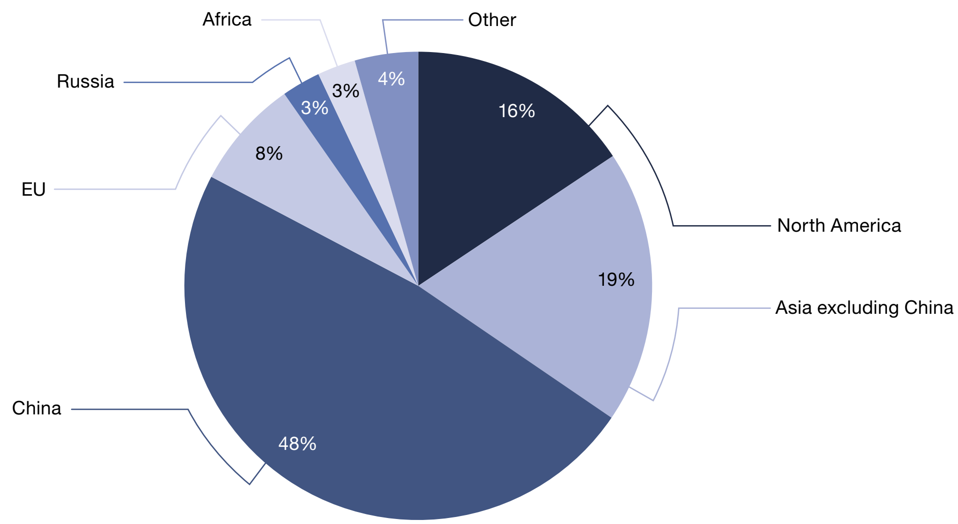


Source: BP Statistical Review of World Energy, 2011.

The dwindling reserves of natural gas in Europe and North America have led to an increased interest in unconventional gas such as shale gas. This gas is not as accessible as conventional gas and extraction has therefore been more expensive. However, the extraction of unconventional gas has a greater environmental impact than traditional extraction. Unconventional gas is already significant in North America, but extraction has also begun in Europe.

The proportion of coal in the total energy supply has increased steadily over the last ten years, accounting for around 30% of the total energy supply. This is the highest figure since 1970 and is largely due to China's rapid economic growth and increasing energy requirements. Just as is the case for other forms of energy, the supply decreased in 2009, to increase by 7.6% in 2010. In 2010, the use of coal increased in all regions except the EU. China accounts for almost half the total use. The prices of coal and natural gas vary from region to region in the world, and the markets may be considered to have a more local character than the oil market.

Figure 52 Global supply of coal in 2010, in total 41 354 TWh, by region in per cent

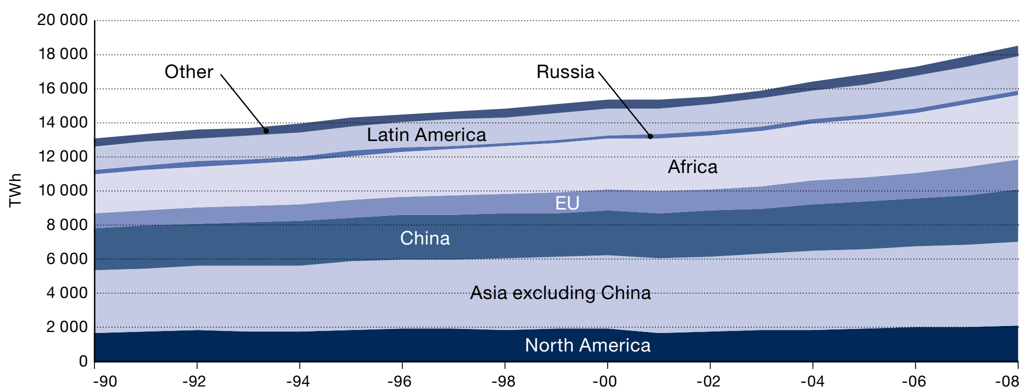


Source: BP Statistical Review of World Energy, 2011.

7.3 Renewable energy is increasing the most

The global supply of renewable energy is growing the most rapidly, in percentage terms, but this growth is not sufficiently strong to give any appreciable increase in the total proportion of renewable energy in the energy supply. In 2008, renewable energy accounted for 18,492 TWh or 7.8% of the world's energy supply. Aside from economic factors, political decisions also play a role in this increase, where targets for greenhouse gas reductions and a decreased dependence on fossil fuels are the greatest incentives.

Figure 53 Global supply of renewable energy, 1990-2008, in TWh



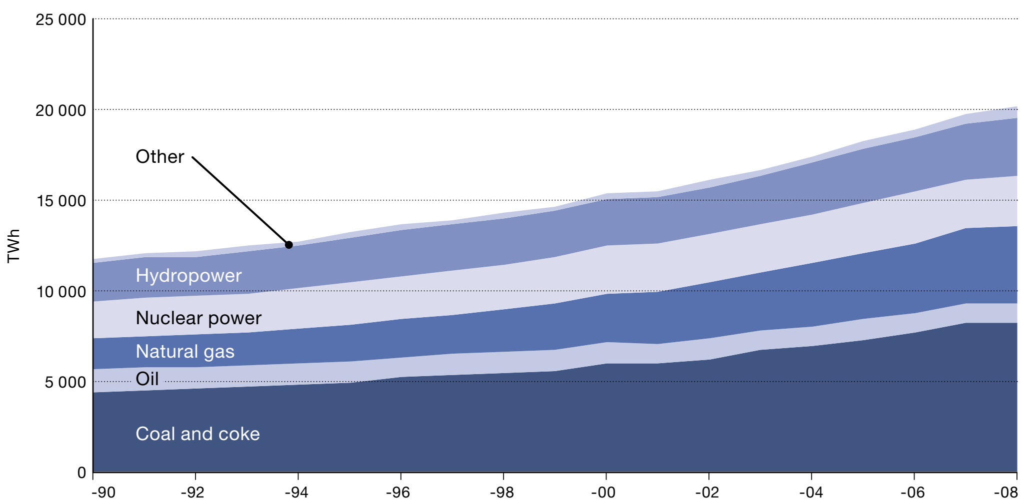
Source: IEA Energy Balances of Non-OECD Countries 2010. IEA Energy Balances of OECD Countries 2010.
Note: Includes energy from hydro, solar, wind and geothermal power as well as biofuels.

7.4 Electricity production is affected by many factors

Electricity production has undergone great changes since the beginning of the 1990s. Apart from the increase in the world's total electricity use by more than 60% to 17,000 TWh in 2008, the relationship between the regions of the world has also changed. The most widespread trend is that Asia, and China especially, has greatly increased its proportion of the world's electricity use. North America and the EU still account for a large proportion of the total electricity use. The electricity use of Africa and Latin America, though increasing since 1990, is still low compared with the rest of the world due to the low level of growth in these two regions combined with greater growth in other parts of the world.

The world's electricity production amounted to just over 20,000 TWh in 2008, distributed across different production methods. The combustion of fossil fuels is still the most common method of producing electricity, followed by hydro power and nuclear power. Electricity produced with biofuels and wind power, for example, is on the increase, but still accounts for just a small part of the electricity mix.

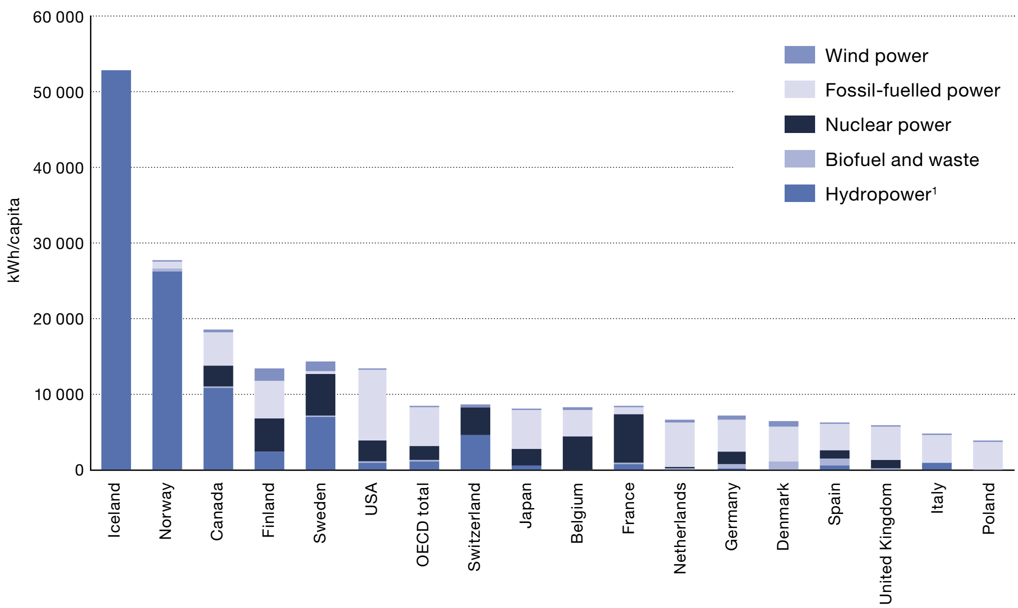
Figur 54 Electricity production in the world by energy resource, 1990-2008, in TWh



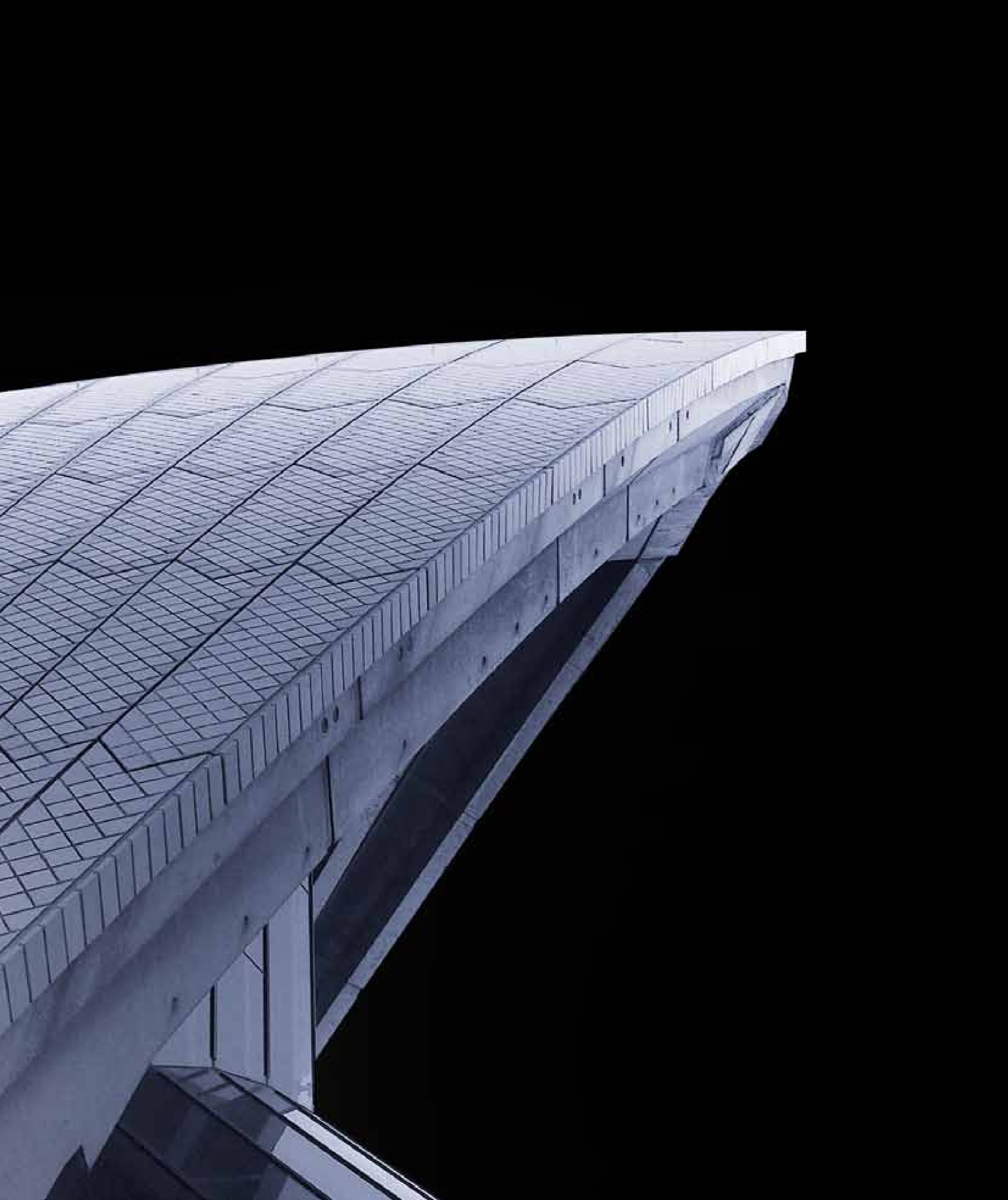
Source: IEA Energy Balances of Non-OECD Countries 2010.

There are many different factors influencing the mix of a country's electricity production. Some of the important factors include its degree of economic development, population size, climatic conditions and its infrastructure. The methods of production vary from country to country and are an outcome of the country's natural resources as well as a result of political decisions. Countries rich with watercourses generally make use of these to produce electricity with hydro power. The type of fossil fuel used for electricity production generally depends on resources in the region. The existence of nuclear power is very much dependent on political decisions, political and geographical stability as well as economic development.

Figure 55 Electricity production by power source 2009, in kWh/capita



Source: Electricity Information 2010 IEA/OECD.
Note: 1. The figures for hydropower include solar electricity and geothermal electricity.



Summary

2010 was dominated by global economic recovery after the financial crisis of 2008/2009. The Western world still has a great use of energy, and for each year that goes by, Asia increases its share of the total use. During the financial crisis, China increased its energy use, in contrast to many other countries. Even though the global supply of renewable energy is growing most in terms of percentage, the fossil fuels still dominate the world's energy supply. The importance of political stability in the regions where oil is produced continues to be great as regards meeting demand and maintaining steady prices. The use of coal, oil and natural gas increased in 2010.

8 The environmental situation

All extraction, conversion and use of energy results in some form of environmental impact. The most significant environmental effects are related to emissions from the combustion of fuels. The use of fossil fuels generally leads to an increase in atmospheric greenhouse gases, the precipitation of acidifying substances and emissions of unhealthy or environmentally harmful compounds in flue gases and vehicle exhaust gases. The use of renewable forms of energy may well lead to its own set of environmental problems. For example, hydro power production generates no atmospheric emissions, but may prevent the free migration of fish in watercourses.

8.1 Active environmental work in Sweden

Sweden has a long history of active and successful work for the environment. It has, for example, succeeded in reducing its greenhouse gas emissions while at the same time increasing its economic growth. Since 1990, emissions have declined by over 12% while the gross domestic product, GDP, has increased by over 50% between 1990 and 2008.[35] Climate change as a result of emissions from human activities is a global environmental problem which calls for an international response. Apart from international collaboration, Sweden is also affected by joint decisions made within the EU.

8.2 Swedish environmental policy for sustainable development

The overall aim of Swedish environmental policy is what has come to be known as the generation goal, which is also the overarching goal of the Swedish national system of environmental objectives. The ambition of the generation goal, as stated by Government Bill 2009/10:155, is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems outside Sweden's borders. The generational goal means that environmental policy should be directed towards ensuring that:

- Ecosystems have recovered, or are on the way to recovery, and their long-term capacity to generate ecosystem services is assured
- Biodiversity and the natural and cultural environment are conserved, promoted and used sustainably
- Human health is exposed to a minimum of negative environmental impact, while promoting the beneficial effects of the environment on human health
- Material cycles are resource-efficient and as far as possible free from dangerous substances
- Natural resources are managed responsibly
- The share of renewable energy increases and energy use is efficient, with minimal impact on the environment
- Patterns of consumption of goods and services cause the least possible problems for the environment and human health.

The national system of environmental objectives also includes sixteen environmental quality objectives which are to be met within one generation, by 2020.[36] Consideration of these environmental quality objectives is to be taken at all levels of decision making: national, regional and local. Through these environmental quality objectives, current

35 Ett grönare Sverige – Miljöpolitiken 2006–2010 (A greener Sweden – Environmental policy 2006–2010), the Swedish Government Offices, Article no 2010.16
36 The Environmental Objectives Portal: www.miljomal.se

legislation, the implementation of EU directives and international agreements, Sweden can attain sustainable development.

Work with these environmental objectives means that central government agencies, county administrative boards, municipalities and other actors combine forces to achieve the objectives. The Environmental Protection Agency is responsible for coordinating the work and the All Party Committee on Environmental Objectives for proposing measures and strategies to achieve the environmental quality objectives and the generation goal. The Swedish Energy Agency is one of 25 agencies with an environmental objective mandate. The role of the Swedish Energy Agency is chiefly to promote a holistic perspective on energy within the system of environmental objectives.

8.3 Assessing the environmental work

In 2011, many of the interim targets of the environmental objectives system underwent an expanded annual follow-up and final reporting[37]. In July 2012, the Environmental Protection Agency will, in collaboration with other agencies, submit an in-depth evaluation of the environmental objectives system. The evaluation will include an overall assessment of how the condition of the environment is developing and a prognosis on the prospects of achieving the generational goal, the environmental quality objectives and established interim targets, as well as information for assessing which areas require further efforts to achieve the objectives.

The 2011 expanded follow-up of the environmental quality objectives is for the first time using the new assessment basis outlined in the Government Bill 2009/10:155 Svenska miljömål – för ett effektivare miljöarbete (Swedish environmental objectives – for more effective environmental work). This means an assessment is being made as to whether or not it is possible to create the conditions to achieve the environmental quality objectives within a generation, by 2020. It will be sufficient, therefore, if the appropriate prerequisites in the form of decisions and projected implementation are in place by 2020; and not that the environmental objective is actually achieved.

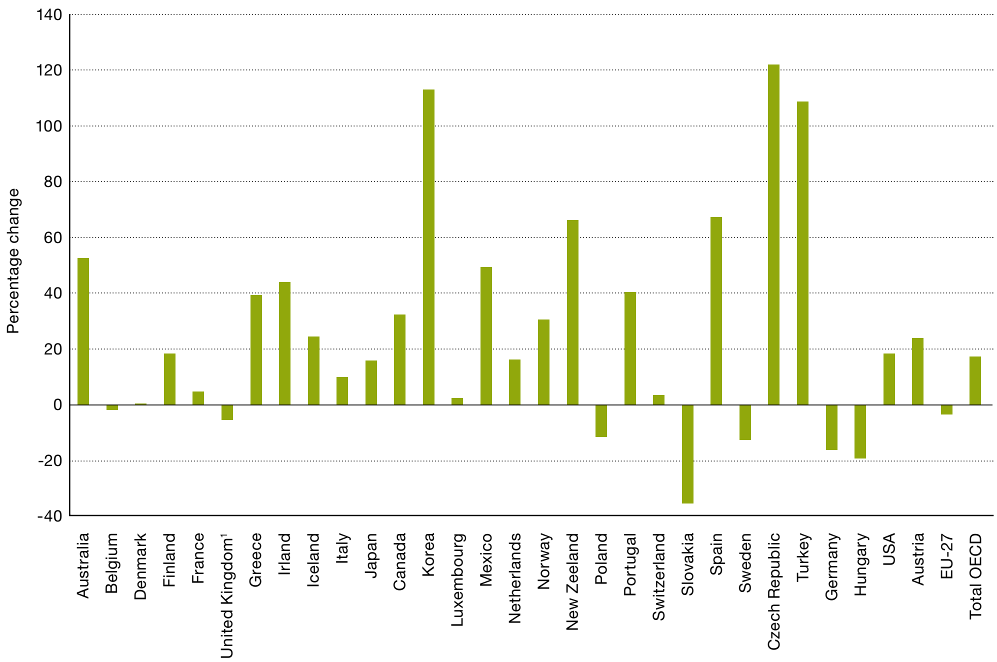
According to the current prognosis, A Protective Ozone Layer is the only environmental quality objective which is possible to achieve through measures already taken or planned. Ten of the environmental quality objectives have been assessed as possible to achieve by 2020, or as having by then the required conditions for achievement if further measures are taken. For five of the environmental quality objectives, it has been assessed as very difficult to have in place the conditions required to achieve in the long-term the environment condition depicted in the objectives by 2020. These are *Reduced Climate Impact, A Non-Toxic Environment, A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos, A Rich Diversity of Plant and Animal Life and A Good Built Environment.*[38]

37 Miljömålen på ny grund (Environmental objectives on a new basis). The Swedish Environmental Protection Agency Report 6433
38 Miljömålen på ny grund (Environmental objectives on a new basis). The Swedish Environmental Protection Agency Report 6433

Reduced Climate Impact difficult to achieve even with international collaboration

Sweden has low emissions of greenhouse gases per inhabitant and per unit of GDP compared with most other industrial countries. Sweden has also reduced its carbon dioxide emissions more than most other countries during the period 1990–2007.

Figure 56 Changes in carbon dioxide emissions in 2007 compared to the levels in 1990, in EU and OECD countries, in percentage change



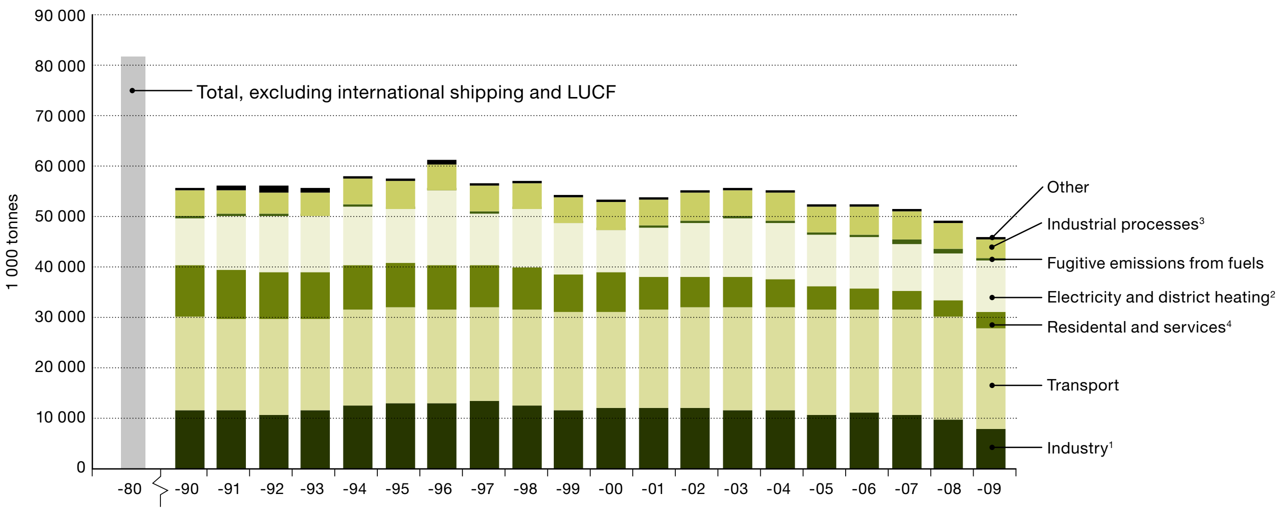
Source: OECD in Figures 2009
Note: 1. Great Britain and Northern Ireland

The Kyoto Protocol states that the industrial countries' combined greenhouse gas emissions must be reduced by at least 5% from levels in 1990. The EU countries have agreed on internal burden-sharing which spreads the burden of reductions across the member states. In 2001, as a part of Swedish climate strategy, Parliament established a national interim target for reducing greenhouse gas emissions which goes further than the agreed burden-sharing agreement within the EU. EU's burden-sharing agreement, which is legally binding, stipulates that emissions for the years 2008 to 2012 may not exceed 104% of emissions in 1990. The Swedish interim target instead states that greenhouse gas emissions shall not exceed 96% of emissions in 1990. Every year since 1999, greenhouse gas emissions have been lower than levels in 1990. Emissions in 2009 were 17% lower than those in 1990. The economic downturn in 2009, which affected both industry and transport, is one reason why emissions that year also were much lower than in 2007 and 2008.

The environmental objective Reduced Climate Impact has the year 2050 in mind, in contrast to the other objectives, which are geared to the year 2020. This objective states that the concentrations of greenhouse gases in the atmosphere are to be stabilized at levels which ensure that human activities do not have a harmful impact on the climate system. This objective is very difficult to achieve and is completely dependent on global initiatives. Global greenhouse gas emissions must be reduced by 50–70% by 2050 compared with 1990 and be close to zero by the end of the century if the environmental quality objectives are to be achieved. But instead of seeing a reduction, emissions have increased over the last few years, partly due to emissions from the use of fossil fuels in electricity and heat production and in transport, which makes it necessary to see both a transition to an energy supply low in fossil fuels and a more efficient energy use.

This international collaboration is crucial if the concentrations of greenhouse gases in the atmosphere are to be stabilized. This is why a natural part of Swedish strategy is to work with the EU to pursue climate issues internationally. Global negotiations have yet to reach agreement on sufficient emissions reductions.

Figure 57 Emissions of carbon dioxide in Sweden in 1980, 1990–2009, in 1000 tonnes



Source 1980: Statistics Sweden. Source 1990–2009: Sweden's National Inventory to UNFCCC year 2010.
Note: Revised figures for all years compared with previous editions.

1. Including industrial back-pressure production.
2. Including coking plants, refineries and hazardous waste incineration.
3. Including the use of solvents and products.
4. Including agriculture, forestry and fisheries.

FACTS MILESTONES IN CLIMATE COLLABORATION

In 1992, the countries of the world join in an agreement in which they will together tackle the global threat of climate change. The countries sign the UN Framework Convention on Climate Change, also known as the Climate Convention. Among other things, the Climate Convention, ratified by Sweden in 1993, states that all industrial countries are to take measures to reduce greenhouse gas emissions and increase the removal and storage of these gases.

The Climate Convention entered into force in 1994 after ratification by 166 countries, including Russia. Following this, the Kyoto Protocol is established, and a number of agreements linked to this enter into force. In 2001, detailed regulations and guidelines are established for the implementation of the Kyoto Protocol through the Marrakech Accords. In 2005, the Kyoto Protocol enters into force, with first commitment period running from 2008 to 2012.

Negotiations on climate collaboration for the period after 2012 commence in Montreal in 2005, the first combined meeting of the Convention and of the Parties to the Kyoto Protocol. The Kyoto Protocol receives its finalized form in Montreal as regards regulations to be observed. Subsequent meetings are held in Nairobi, Bali, Poznan, Copenhagen and Cancún. The outcomes from Bali are presented in an action plan containing the Road Map to an agreement for the period after 2012. The ambition is to see the working programme initiated in Bali culminate in a global climate regime at the meeting in Copenhagen in 2009. This would include the USA and the large developing countries, such as China, India and Brazil.

The outcome in Copenhagen is not the legally binding agreement many of the parties were hoping for. Instead, the climate negotiations in Copenhagen resulted in a political agreement without legal status, the Copenhagen Accord. However, the meeting of the parties in Cancún, Mexico consolidates important components from the Copenhagen Accord which are now incorporated in the UN process, such as the objective to limit the temperature increase to a maximum of two degrees.

The parties are currently discussing the possibilities of bringing about a legally binding agreement at the next meeting of the Convention and of the Parties to the Kyoto Protocol in Durban, South Africa in 2011. The components of such a framework encompass long-term global objectives for emissions reductions and greater national and international efforts to reduce climate impact. A key issue in the negotiations is what a future climate regime after 2012 should be based on, as some parties have indicated that they only wish to see a second commitment period to the Kyoto Protocol. At the same time, the optional emissions restrictions proposed by the parties are not sufficiently ambitious to counteract a temperature increase of two degrees. A large question mark is therefore posed by whether developed countries, such as the USA, and large developing countries, such as China, India and Brazil, will commit to ambitious reductions which are legally binding.

Apart from these emissions commitments, negotiations are also being held on climate funding and a new fund, the Copenhagen Green Climate Fund. The fund is intended to manage financial aid for developing countries' work with alignment, emissions reductions and technology transfer. The parties also continue to negotiate on the establishment of a mechanism to reduce emissions from deforestation in developing countries as well as the possible establishment of new market-based mechanisms.

Work with the Clean Air objective moves forward

There is a range of air pollutants which have adverse effects on human health. Especially in urban areas, high concentrations of air pollutants lead to airway inflammation and allergies as well as cancer in the longer term. Acidifying air pollutants also affect buildings, for example, by accelerating the process of material degradation. In addition, pollutants such as nitrogen dioxide and sulphur dioxide contribute to eutrophication and acidification.

The latest prognosis indicates, however, that it is possible to create the conditions to achieve the environmental quality objective within a generation, but to achieve this objective, measures must be taken, including emissions reduction measures for traffic, wood combustion, electricity and heat production as well as in the industrial sector. It is also important to make full use of existing measures. With regard to the opportunities of municipalities to limit wood combustion in individual cases, the Swedish Energy Agency established in a report in 2010 that a further tightening of current legislation was not necessary. Instead, the emphasis was placed on a tightening of the Swedish National Board of Housing, Building and Planning's building regulations so that the requirements for new buildings also apply to renovations.[39]

International collaboration is a prerequisite for Natural Acidification Only

The results of acidification include metals, such as aluminium, being released so that they are absorbed by soil and water. This has a negative effect on forest growth, which is harmful for many vulnerable species of animal and plant, both on land and in the water.

The main cause of acidification is sulphur emissions in the form of sulphur dioxide. The greatest sources of sulphur dioxide emissions are transport, electricity and heat production, industry and agriculture. Apart from sulphur dioxide, ammonia and nitrogen oxide emissions contribute to acidification. Sulphur dioxide emissions arise from fuels containing sulphur, while nitrogen oxides are mainly formed from nitrogen in the air during combustion.

39 Småskalig förbränning av fasta biobränslen (The small-scale combustion of solid biofuels), the Swedish Energy Agency, ER 2010:44

Figure 58 Emissions of sulphur dioxide in Sweden, 1990–2009, in 1 000 tonnes

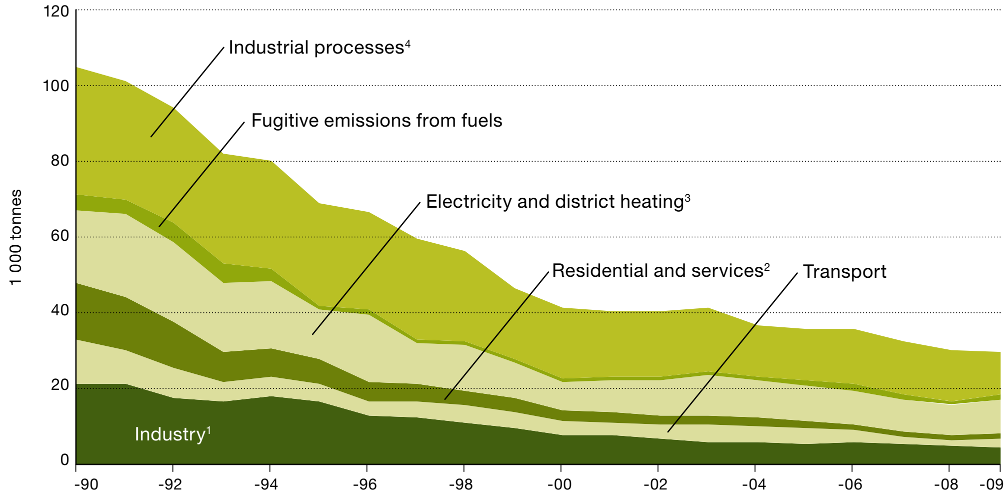
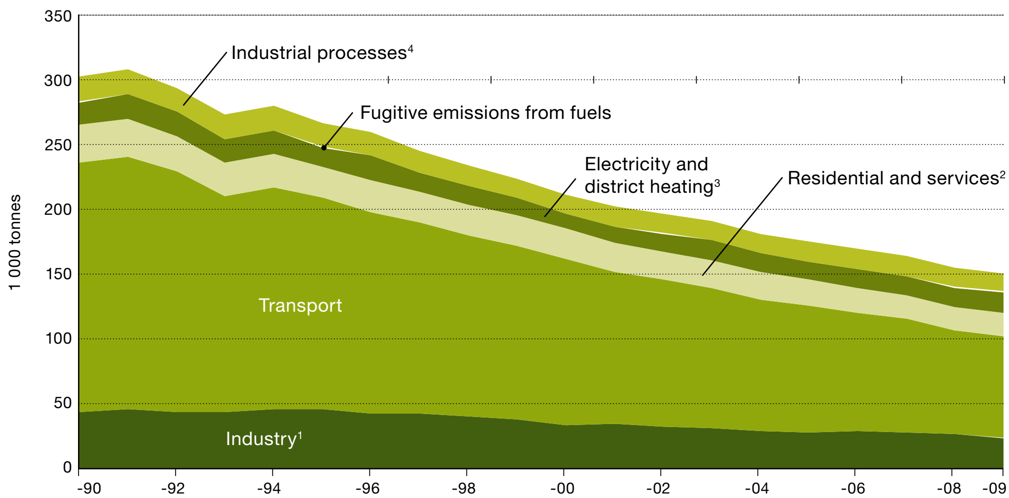


Figure 59 Emissions of nitrogen oxides (calculated as NO2) in Sweden, 1990–2009, in 1 000 tonnes



Source: Sweden's submission in accordance with the UN Convention on Long-range Transboundary Air Pollution (CLRTAP), the Swedish Environmental Protection Agency, additional processing by the Swedish Energy Agency.

Note: Revised figures for all years compared with previous editions.

1. Including industrial back-pressure production and hazardous waste incineration.
2. Including agriculture, forestry and fisheries.
3. Including coking plants and oil refineries.
4. Including use of solvents and other products.

The latest prognosis points to it being possible to create the conditions to achieve the environmental objective within a generation if further measures are taken. In Sweden, the increased use of forest fuels, for example, increases the risk of acidification.

An important measure to counteract this is ash replacement. Much of the precipitation over Sweden today comes mainly from foreign sources, which makes international collaboration important.

A Non-Toxic Environment requires more measures to be achieved

The Swedish Energy Agency's work for a non-toxic environment relates primarily to the implementation of various EU directives, including the Ecodesign Directive and the Energy Labelling Directive. It is estimated that the requirements of these directives can save up to 1,116 TWh a year in the EU in 2020. It may be the case that energy efficiency improvements, such as LEDs in televisions, also lead to reductions in the release of toxic substances. However, environmental objectives can clash. One example is if an energy-saving product contains more toxic substances, for example mercury in energy-saving bulbs, which would mean a conflict between A Non-Toxic Environment and energy efficiency improvements for Reduced Climate Impact.

A Non-Toxic Environment is very difficult to achieve. It takes time to reduce the concentrations of dangerous substances in the environment as well as the risks in society. The production of and trade in chemical substances is increasing globally, and is often operated with insufficient regulations and chemical safety. Additional, more stringent policy instruments are needed at all levels.

Environmentally compatible hydro power important for Flourishing Lakes and Streams

A large part of the Swedish electricity production is derived from hydro power production. At the same time, hydro power production does have an impact on the ecosystems surrounding the rivers and the power station, where it can prevent the free migration of fish. This difficulty is one example of possible conflicts between two environmental objectives. To arrive at the best solution, it is important to evaluate the benefits and the cost, so that the objective with the greatest net benefit is prioritized. This is often difficult because local natural values and global climate problems are in opposition to each other.

The latest prognosis points to it being possible to create the conditions to achieve the environmental objective within a generation if further measures are taken. This is due, in part, to work starting on the Swedish River Basin District Authorities' programme of measures. Achieving the objective requires that the problems of eutrophication and acidification in lakes and watercourses need to be tackled, that the intensity of the work to restore watercourses increase and that more lakes and watercourses of great natural and cultural value receive long-term protection.

Sustainable Forests

Forests are important, not least in terms of bioenergy, but they must also be protected in order to conserve biodiversity and the cultural environment. The latest prognosis points to it being possible to create the conditions to achieve the environmental objective within a generation if further measures are taken. It is however difficult to determine which trend that has the greatest effect on forests at present. More forest areas are coming under protection, but there is also an intense use of forests. There is a need for greater environmental consideration and more resources for the long-term conservation of forests worthy of protection.

A Magnificent Mountain Landscape demands adapted wind power

Interest from municipalities and energy companies regarding the establishment of wind farms in mountain areas has increased in recent years. Some Sami villages too have investigated the possibilities of building wind power turbines. These should be established in areas which can be considered appropriate with regard to opposing interests of land use.

It is possible to create the conditions to achieve the environmental objective within a generation if further measures are taken. It is unclear whether the condition of the environment is developing in any particular direction. Permits for wind power, mining and other operations in untouched mountain areas should be granted very restrictively.

A Good Built Environment is difficult to achieve

The objective A Good Built Environment is complex. The parts primarily relating to the energy sector are those which are geared towards reducing the environmental impact of energy use in residential and non-residential premises. This is to be brought about through energy efficiency improvements which reduce the need for supplied energy and through a transition towards a greater proportion of renewable energy sources.

Attaining a good built environment demands a number of measures, and many actors need to be involved in their implementation. The prognosis points to it being very difficult to create the conditions to achieve the environmental objective within a generation. As regards energy use in built-up areas, developments are going in the right direction. Heating is more efficient, the proportion of renewable energy is increasing and the proportion of fossil fuels is decreasing.

Summary

Environmental impact takes place at many different levels: local, regional and global. There are no clear boundaries between the levels, as this depends on the type of impact and how the pollutants are spread.
The overall aim of Swedish environmental policy is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems outside Sweden's borders. The generation goal is also the overarching goal of the Swedish national system of environmental objectives, introduced in 1999. This environmental objectives system also encompasses sixteen national environmental objectives, and follow-ups indicate that measures are leading to an improvement, but that further measures are required in order to achieve these objectives.

9 Energy facts

9.1 Energy statistics

The government has given a total of 26 government authorities the responsibility for the official statistics in various areas. Since 1998, the Swedish Energy Agency has been the statistical authority responsible for all official statistics on energy in Sweden, which means that the Swedish Energy Agency has the power to collect statistics in order to shed light on the area of energy. The Swedish Energy Agency decides on the content and scope of statistics, but must also take into consideration the requests and needs of various users. The task of serving as an authority responsible for statistics also involves deciding, through public procurement, which organization will produce the statistics.

The area of energy covers three statistical areas: energy balances, price development in the area of energy as well as the supply and use of energy. These statistical areas have a total of 22 statistical products linked to them, the majority of which fall under the category of supply and use of energy.

As the agency responsible for statistics, the Swedish Energy Agency must follow the laws, ordinances and regulations in this area, both at national level and EU level. In addition, there are a number of guidelines and policies, which have been produced by the Council for Official Statistics, ROS[40]. It is not a requirement to follow these, but the Swedish Energy Agency follows them as far as is possible. The Swedish Energy Agency plans to be able to follow ROS guidelines on sufficient quality, 2006:1 in 2014.

The Government has commissioned an investigation into statistics with the purpose of reviewing the statistical system based on several perspectives. These are quality, accessibility, confidentiality and clarity. The investigation will be completed by 10 December 2012.[41]

40 Sufficient quality and criteria for official statistics, Statistics Sweden
41 Utredningen om översyn av Statistiska centralbyrån och statistiksystemet (Investigation reviewing Statistics Sweden and the statistical system), Dir. 2011:32, Fi 2011:05

The statistics in Energy in Sweden

The statistics in Energy in Sweden are largely taken from the Official Statistics of Sweden, SOS. Statistics come from the Swedish Energy Agency and from other agencies, such as Svenska kraftnät, the Swedish Tax Agency and Transport Analysis. Sources are always given under each figure. If comments are required with regard to individual statistical sources or documents, these are also placed under the figure. The most recent statistics available have been used throughout. The most recent energy balance available is for 2010. Where more recent statistics are available, which is the case for electricity prices, for example, these have been used.

As far as energy statistics are concerned, there are short-term statistics and yearly statistics. At the time of writing, only short-term statistics are available for 2010. For the yearly statistics, 2009 is the most recent year of publication. This edition of Energy in Sweden therefore presents yearly statistics up to and including 2009, complemented by short-term statistics for 2010. There are differences in level between these two, as they are based on different investigations and because the methods of allocating energy between different energy carriers and sectors differ to some extent. There are also differences for individual energy carriers, as well as for the total energy use per sector.

The statistics in Chapter 7, An international perspective, are mainly based on statistics collected by the IEA. OECD countries make submissions with one year's delay while countries outside the OECD make submissions with two years' delay. This is why statistics for the whole world are only available up to the year 2008. Figures and statistics relating to 2009 and 2010 have been taken from BP's compilation of energy use, energy supply and world production of electricity and heating. Because the IEA and BP utilize different methods of data collection and sampling, the statistics for 2009 and 2010 are not directly comparable with historic data. The Swedish Energy Agency has, despite this, chosen to report statistics for 2009 and 2010 in order to provide a picture of the world energy situation for those years.

9.2 Energy units and conversion factors

Here follows a presentation of units and conversion factors. To be able to make comparisons with other international statistics, the relationships between some different units of energy are also presented.

It should be noted that the conversion factors constitute averages for different fuels and that there are variations between different forms. This is not least the case for various wood fuels and coal.

The international standard unit for measuring energy is the joule, J. In Sweden, however, the watt hour, Wh, is often used. In making international comparisons, the unit tonne of oil equivalent, toe, is often used and in certain areas of application, also calories, cal. When measuring amounts of energy greater than a joule, watt hour or calorie, small units become impractical. Instead, larger units are formed through the use of prefixes, for example, petajoule, PJ, and terawatt hour, TWh.

Table 7 Prefixes used with energy units in Energy in Sweden

Prefix		Factor	
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

Table 8 Conversion factors for energy units used in Energy in Sweden

	GJ	MWh	toe	Mcal
GJ	1	0,28	0,02	239
MWh	3.6	1	0.086	860
toe	41.9	11.63	1	10 000
Mcal	0.0419	0.00116	0.0001	1

Table 9 Calorific values in MWh and GJ per physical quantity

Fuel	Physical quantity	MWh	GJ
Wood chips	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	10.1	36.3
Topped crude oil	1 m^3	11.1	40.1
Petroleum coke	1 tonne	9.67	34.8
Asphalt, road dressing oil	1 tonne	11.6	41.9
Lubricating oils	1 tonne	11.5	41.4
Road fuel petrol	1 m^3	9.10	32.7
Aviation gasoline	1 m^3	9.08	32.7
Light virgin naphtha	1 tonne	8.74	31.5
White spirit	1 m^3	9.34	33.6
Aviation kerosene and intermediate distillates	1 tonne	9.58	34.5
Other kerosene	1 m^3	9.54	34.3
Diesel and domestic heating oil	1 m^3	9.80	35.3
Heavy fuel oils	1 m^3	10.6	38.1
Liquefied petroleum gas	1 tonne	12.8	46.0
Gasworks gas and coke oven gas	1 000 m^3	4.64	16.7
Natural gas[1]	1 000 m^3	11.0	39.6
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

Note: Conversion factors are given with three significant digits. In the calculations more significant digits is used.
1. Natural gas is in effective calorific value or net calorific value.

Our target – better use of energy

The Swedish Energy Agency's work is aimed at the establishment of a reliable, low-environmental-impact and efficient energy system. Energy and climate are closely linked: through international cooperation and engagement, we can help to achieve climate targets. The Agency finances research and development of new energy technologies. We provide pro-active support for commercial ideas and innovations that can lead to the establishment of new companies.

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Swedish Energy Agency

Swedish Energy Agency, Box 310, SE-631 04 Eskilstuna
Telephone +46 16-544 20 00, Fax +46 16-544 20 99
E-mail registrator@energimyndigheten.se
www.swedishenergyagency.com