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Two annexes

The Ministry of Infrastructure

Sweden's Integrated National Energy and Climate Plan

Reporting under Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

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1. OVERVIEW AND PROCESS FOR ESTABLISHING THE PLAN

1.1 Executive summary

1.1.1 Political, economic, environmental, and social context of the plan

In December 2015, the European Commission presented its communication on an Energy Union[1] for Europe. In practice the Energy Union involves the revision of all European energy and climate legislation. In November, the Commission presented *Clean Energy for all Europeans*[2], a package of measures to keep the EU competitive as the clean energy transition changes global energy markets. The package included legislative proposals for energy efficiency, renewable energy, electricity market design, security of electricity supply and rules for the governance of the Energy Union. The Governance Regulation[3] came into force on 24 December 2018. The Regulation states that, by 31 December 2019, and subsequently by 1 January 2029 and every ten years thereafter, each Member State must notify to the Commission an integrated national energy and climate plan, containing the elements set out in the Regulation. This document contains Sweden's Integrated National Energy and Climate Plan in accordance with the Governance Regulation and is structured according to the general framework set out in Annex I to the Regulation.

The Integrated Energy and Climate Plan elaborates on Sweden's existing energy and climate goals, policies and measures and on the associated scenarios. It is based primarily on the Climate Policy Framework, energy policy and the targets drawn from the Energy Policy Framework Agreement (see Section 1.3).

The long-term energy and climate targets and objectives described in the plan establish long-term conditions for the business community and society as a whole.

1.1.2 Strategy for the five dimensions of the Energy Union

Overall, Swedish energy and climate policy is compatible with the ambitions of the Energy Union's five dimensions. It is based on the same three pillars as energy cooperation in the EU and aims to combine ecological sustainability, competitiveness and security of supply. The energy policy must therefore create the conditions for effective and sustainable energy use

[1] COM/2015/080 final.

[2] IP/16/4009.

[3] Regulation 2018/1999 (EU) of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

and a cost-effective energy supply in Sweden, while minimising the damage to health, the environment and climate and facilitating the transition to a sustainable society. Sweden must lead the way on environmental and climate issues and become the world's first fossil fuel-free welfare state. Sweden aims to cut its net greenhouse gas emissions to zero by 2045, and reduce the emissions from activities on Swedish territory to 15% of their 1990 levels.

1.1.3 Table summarising important objectives, policies and measures in the plan

Table 1 Summary of targets for energy and climate policy.

Target	Target year	Base year
Sweden must cut its net greenhouse gas emissions to zero and then achieve negative emissions. A maximum of 15% of emission reductions should come from additional measures.	2045	1990
75% reduction in emissions from sectors outside the European Union's Emission Trading System (EU ETS). A maximum of 2% from additional measures.	2040	1990
63% reduction in emissions from sectors outside the EU ETS. A maximum of 8% from additional measures.	2030	1990
70% reduction in emissions in the transport sector	2030	2010
40% reduction in emissions from sectors outside the EU ETS. A maximum of 13% from additional measures[4]	2020	1990
50% of final consumption of energy to be covered by renewable sources	2020	
100% renewable electricity generation (this is a target not a deadline for nuclear energy)	2040	
50% improvement in energy efficiency	2030	2005

See Section 3 for information about policies and measures.

1.2 Overview of the current policy situation

1.2.1 National and Union energy system and policy context of the national plan

A coalition government of ministers from the Social Democratic Party and the Green Party took office on 21 January 2019. Although it is a minority government, there are broad-based agreements and frameworks in many policy areas.

The January Agreement

The January Agreement, signed in January 2019, is a sectoral policy agreement between the two ruling parties – the Social Democratic Party and the Green Party – and the Centre Party and the Liberals[5]. This agreement,

[4] The Government aims to achieve the target entirely with national measures.

[5] https://www.regeringen.se/regeringens-politik/regeringens-politik-bygger-pa-sakpolitisk-overenskommelse/.

which consists of 73 points in a number of areas, forms the basis for some of the Government's policies. Point 30 of the agreement states that the Government must pursue an active climate policy which upholds the Climate Policy Framework.

Sweden's Climate Policy Framework

The Riksdag adopted a climate policy framework for Sweden in June 2017[6]. The Framework was adopted with a broad majority and comprises national climate targets, a climate act and a climate policy council. The Climate Policy Framework provides order and stability for climate policy and establishes long-term conditions for the business community and society as a whole. It is a key component of Sweden's efforts to comply with the Paris Agreement. See Section 2.1.1 for details of Sweden's national climate targets.

The Climate Act

The Climate Act (2017:720) regulates the Government's climate policy; it sets out the aims of the policy and specifies how it should be conducted. The Act states that the Government's climate policy must be based on the long-term emission targets set by the Riksdag and must create conditions which allow the climate policy and budget policy targets to work together. The Act also determines when and how the Government should monitor climate policy and report planned measures to the Riksdag.

It must present a climate statement to the Riksdag every year in the draft budget and present a climate policy action plan the year after an ordinary general election.

The Climate Policy Council

As part of the Climate Policy Framework, the Government has set up the Climate Policy Council; the members of the council are experts on climate, climate policy, economics, social sciences and behavioural science. The Council is tasked with assessing whether the Government's overall policy is compatible with its, and the Riksdag's, climate targets.

The Energy Agreement

In March 2015, the Government decided to set up a parliamentary commission to oversee energy policy[7]. Under the directive, the Energy Commission was tasked with preparing the ground for a broad agreement[8] on energy policy, with a particular focus on electricity supply after 2025–2030. Five political parties (representing a majority in the Riksdag) came to an agreement on 10 June 2016. These were the Social Democrats, the

[6] Government bill 2016/17:146 Report 2016/17:MJU24, Riksdag communication 2016/17:320.

[7] Directive 2015:25.

[8] https://www.regeringen.se/artiklar/2016/06/overenskommelse-om-den-svenska-energipolitiken/.

Moderates, the Green Party, the Centre Party and the Christian Democrats. The Riksdag adopted energy policy targets based on the Energy Agreement. Sweden's energy policy is based on the same three pillars as energy cooperation in the EU; it therefore aims to combine sustainability, security of supply and competitiveness. The policy aims to combine security of supply, competitiveness and sustainability. The energy policy must therefore create the conditions for effective and sustainable energy use and a cost-effective energy supply in Sweden, while minimising the damage to health, the environment and climate and facilitating the transition to a sustainable society. The Riksdag has set the following targets as a result of the Energy Agreement.[9]:

- The 2040 target is 100% of electricity generated from renewable sources. This is a target, not a deadline for banning nuclear energy; nor is it a policy decision to stop generating nuclear energy.
- Consumption of energy in Sweden must be 50% more efficient in 2030 than it was in 2005. This target is expressed as energy supplied in relation to gross domestic product (GDP).

Progress on the Energy Agreement is monitored by regular reviews. The reviews must contain conclusions and suggestions for the evolution of the electricity market and the monitoring of energy policy targets. The first review report was submitted to the Riksdag in June 2019[10].

On 10 December 2019, the Moderates and the Christian Democrats announced that they are abandoning the agreement.

1.2.2 Current energy and climate policies and measures relating to the five dimensions of the Energy Union

See Section 3 for information about policies and measures.

1.2.3 Key issues of cross-border relevance

Sweden is part of the well-integrated and interconnected Nordic electricity market and is involved in matters related to further market integration A properly functioning, integrated cross-border energy market is extremely important.

1.2.4 Administrative structure of implementing national energy and climate policies

The role of the agencies

Each department is responsible for a number of Government agencies

[9] Government bill 2017/18:228, Report 2017/18:NU22, Riksdag communication 2017/18:411.

[10] Government communication 2018/19:153 *Första kontrollstationen för energiöverenskommelsen*.

which have to apply the laws and carry out the activities decided on by the Government and the Riksdag. The following agencies are mainly responsible for energy and climate matters[11]:

The Swedish Energy Agency works in various sectors of society to promote effective and sustainable energy consumption and to make the supply of energy in Sweden cost-effective.

The Swedish Environmental Protection Agency plays a key role in environmental work, driving, supporting and coordinating environmental policy.

It works towards meeting the Riksdag's environmental generation and quality targets and proposes measures for environmental work as required.

The Swedish Energy Markets Inspectorate supervises the electricity, natural gas and district heating markets.

The Swedish National Grid manages Sweden's national electricity network. It is also the system operator for electricity supply in Sweden, which involves balancing the system in the short term and ensuring that system installations work together reliably.

The Swedish Meteorological and Hydrological Institute (SMHI) provides supporting information for weather and water-related plans and decisions. It is the expert body for meteorology, hydrology, oceanography and climatology and a resource for environmental work.

The National Board of Housing, Building and Planning is the central agency for the built environment, land and water management, town and country planning, building and building management and finance for housing.

Formas (the Swedish research council for the environment, agricultural science and spatial planning) provides assistance and information about research in its field. It promotes sustainable growth and development.

County councils – Sweden is divided into 21 counties all of which have a county council led by a governor. The county council is a public coordinating authority, a service authority and an appeal body and has

[11] The descriptions of the agencies' activities have been taken from the Government's website unless otherwise specified: www.regeringen.se.

supervisory responsibility. The county councils are guarantors for the implementation of the Government's national goals and play an important part in drafting national energy and climate plans and allocating state aid for energy and climate purposes.

Many other agencies also play a large part in implementing energy and climate policy.

The role of municipalities and regions

Municipalities and regions are important for Sweden's climate work. Their closeness to the population, their role in town and country planning and the fact that they are major employers make them important operators in the work to meet climate targets. The municipalities work with companies, organisations, residents and other operators to drive local developments, thus helping to meet national and local targets. Many local initiatives are contributing towards the effort to meet Sweden's national climate targets.

The primary aim of the regional energy management agencies is to promote energy efficiency and renewable energy sources locally and regionally. They work with public and private operators on assignments and projects based on international and national energy and environment goals. Since they are not allowed to compete with private companies, they operate as independent, not-for-profit energy organisations. There are around 360 energy management agencies in Europe. The 15 agencies in Sweden have played an important part in the EU's energy policy since the 1990s.

1.3 Consultations and involvement of national and Union entities and their outcome

1.3.1 Involvement of the national parliament

Sweden's integrated energy and climate plan is based on goals and policies adopted by the Riksdag. On 14 November 2019, the Riksdag's Trade Committee held a consultation on guiding principles before Sweden's national energy and climate plan was finalised. It also held a consultation on the Commission's specific recommendations for Sweden's draft energy and climate plan on 17 December 2019.

1.3.2 Involvement of local and regional authorities

The Swedish Energy Agency and other relevant agencies started the preparatory work for the National Integrated Energy and Climate Plan in Spring 2019. An information meeting was held on 29 August 2019 for a wide range of operators, including the municipalities and regions. The meeting explained the process and the type of information the plan would contain. A written consultation on the Swedish Energy Agency's proposals

for the energy and climate plan was held on 1 September 2019,

in which the municipalities and regional operators expressed their opinions and provided input for the plan.

See Section 1.3.3 for more information about these consultations.

1.3.3 Consultations of stakeholders, including the social partners, and engagement of civil society and the general public

The political goals and policies described in this plan have been through the usual consultation process, which gives stakeholders and the general public the opportunity to express their views. The memorandum *Responding to the Consultation – How and Why*[12] issued by the Coordination Department of the Swedish Government Offices describes how and why the consultations are sent out and the mechanism for dealing with them in the subsequent stages of the procedure.

Much of the Integrated Energy and Climate Plan is based on the targets and goals developed as a result of the Energy Commission's work and the work on the Climate Policy Framework described in Section 1.2. The consultations held during this work are described separately below.

Consultation on the preparatory documents for the Integrated Energy and Climate Plan

The preparatory documents for the draft energy and climate plan were sent to 30 operators for consultation in spring 2018. Ten responses were received, mainly from trade associations. The views were taken into account in the draft, which was reported on 17 January 2019[13]. One of the views expressed was that Sweden's Integrated Energy and Climate Plan should be written in Swedish to make it more accessible to the general public; this was taken into account in the work on this plan.

Work began on the final energy and climate plan in spring 2019. An information meeting about the plan for a wide range of operators was held on 29 August 2019. Around 80 operators (trade associations, agencies, research institutes, universities, municipalities, regions and environmental organisations) were invited. The meeting explained the process for the energy and climate plan and the type of information the plan would contain. Sweden's contribution to the EU's renewable energy goals for 2030 and the proposals currently in the plan were also discussed.

[12] SB PM 2003:2.

[13] https://www.regeringen.se/rapporter/2019/01/sveriges-utkast-pa-integrerad-nationell-energi--och- klimatplan/.

A written consultation on the Swedish Energy Agency's proposals for the energy and climate plan was held on 1 September 2019. The Government has commissioned The Swedish Energy Agency to produce a proposal for the plan. However the proposal does not contain all of the parts of the template set out in the Governance Regulation. The parts related to ongoing work to implement the revised Energy Efficiency Directive and the Energy Performance of Buildings Directive are missing. The written consultations produced 36 responses containing views and comments on the plan. Detailed views have been incorporated into the plan. A summary of the views expressed is given in *Annex 1*.

Consultation on the Climate Policy Framework

The Government assigned the Environmental Objectives Committee, a cross-party policy committee, the task of developing the proposal for the Climate Policy Framework, along with a long-term goal for 2045. The Committee also prepared a proposal for a long-term climate and air pollution control strategy, including intermediate targets for 2030 and 2040.

The Environmental Objectives Committee was composed of representatives from seven of the eight parties in the Riksdag and a chair. It was assisted by 30 experts, who represented various categories of operator: agencies, representatives from industry, researchers, environmental organisations and trade unions. These experts were involved in some of the monthly meetings held by the Committee during this project, participating in discussions and contributing their expertise Key questions discussed were the level of ambition and the timing of the long-term goals. The research representatives and environmental organisations stressed that it was important to achieve net-zero within a short time frame to be in line with the IPCC's[14] conclusions. They also responded to assumptions about the potential of measures in the scenarios included in the preparatory documents for the intermediate targets for 2030 and 2040.

To explore the opportunities and challenges involved in reducing emissions and to discuss policy, ten seminars were held during the project for a broader range of experts and operators to examine how to implement the transition in various sectors of society. Separate round table discussions on possible measures and policies were also held with representatives from various sectors of industry (base materials, the bioeconomy and agriculture) and the academic world.

When the Committee had prepared its report, the proposal for a climate policy framework and a long-term goal for 2045 was sent for consultation to

[14] IPCC = Intergovernmental Panel on Climate Change.

around 200 stakeholders who were given three months to consider it[15]. Similar consultations were held for the long-term climate and air pollution control strategy[16]. The stakeholders selected represented all types of operator: voluntary organisations (NGOs), trade associations, think tanks, universities and colleges, authorities etc. The consultations showed that stakeholders broadly supported the climate policy framework and climate goals.

The Energy Commission

The Energy Commission arranged six major seminars in its areas of focus: consumption, supply, transmission and the market. Representatives from trade associations, trade unions, research institutes, environmental organisations, industry, departments and agencies were invited to the seminars along with many experts from Sweden and abroad. The seminars were open to the public, broadcast over the internet and documented on the Energy Commission's website[17], which also publishes the latest information about the Commission's work. The Commission also held two seminars for experts, one on the electricity and heating markets and one on energy storage facilities in cooperation with the Swedish Smartgrid Forum[18]. It also organised a round table discussion on the design of the future electricity market with Swedenergy. During Politician's Week in Almedalen in July 2016, the Energy Commission also arranged a seminar on the framework agreements concluded in June 2016.

During the course of this work, the Energy Commission held 14 ordinary meetings to which the Directors General of the Swedish National Grid, the Swedish Energy Markets Inspectorate and the Swedish Energy Authority were invited. These meetings were held in conjunction with external parties – The Confederation of Swedish Enterprise, Swedenergy, the Swedish Association of Local Authorities and County Councils (now the Swedish Association of Local Authorities and Regions) and the Swedish Society for Nature Conservation – to gain a deeper understanding of the views of the various operators[19].

1.3.4 Consultations of other Member States

A draft of Sweden's Integrated National Energy and Climate Plan was sent to Denmark, Finland and Norway for comment. There were no comments on the draft.

1.3.5 Iterative process with the Commission

[15] https://www.regeringen.se/remisser/2016/03/remiss-av-delbetankande-fran-miljomalsberedningen-med- forslag-om-ett-klimatpolitiskt-ramverk-inklusive-langsiktigt-klimatmal/.

[16] https://www.regeringen.se/remisser/2016/06/remiss-av-delbetankande-fran-miljomalsberedningen-med- forslag-om-en-klimat--och-luftvardsstrategi-for-sverige/.

[17] www.energikommissionen.se.

[18] Described in Section 2.4.3 and 3.4.3.

[19] The Energy Commission's Report *Kraftsamling för framtidens energi* (SOU 2017:2).

Sweden took part in the meetings held with the technical working group set up by the European Commission to assist Member States with the development of their integrated energy and climate plans. To start the iterative process with the Commission, Sweden uploaded an early draft of the Integrated National Energy and Climate Plan to the technical cooperation platform set up for the technical working group in June 2018. This early draft was discussed informally with the Commission during autumn 2018. Sweden formally reported its draft Integrated Energy and Climate Plan on 17 January 2019[20].

The Commission assessed the draft plans of all Member States and, on 18 June 2019, issued recommendations for each of the plans along with a general assessment of whether they are ambitious enough to meet the common EU goals. The specific recommendations for Sweden[21] were taken into account for the work on this Integrated Energy and Climate Plan and for the aim to implement it as far as possible within the framework of established targets and policies.

1.4 Regional cooperation in preparing the plan

1.4.1 Elements subject to joint or coordinated planning with other Member States

Cooperation, coordination and dialogue between the Nordic countries is conducted through the Nordic Council of Ministers. An ad-hoc network group has been set up within this cooperative framework to coordinate the national energy and climate plans in the Nordic region. The ad-hoc group has met to discuss matters of common interest and to share knowledge. It has also held discussions with Nordic Energy Research (NER) about ways of using its analytical work for the preparation of the integrated energy and climate plans of the Nordic countries.

The ad-hoc group was formed in 2018 to encourage the Nordic countries to cooperate on the preparation of their national integrated energy and climate plans. The first meeting was held in Stockholm in May 2018.

Sweden is a member of the North Seas Energy Cooperation (NSEC), a forum for regional cooperation founded in 2016. Ten countries and the European Commission belong to the NSEC. The member countries, besides Sweden are: Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway and the United Kingdom. Cooperation is voluntary; one of the aims is to produce joint strategies for cost-effective

[20] https://www.regeringen.se/rapporter/2019/01/sveriges-utkast-pa-integrerad-nationell-energi--och-klimatplan/.

[21] C (2019) 4427 final.

expansion of renewable energy, in particular offshore wind power in the North Sea region.

The work on the integrated energy and climate plans has also been discussed within the regional cooperation on the Baltic Energy Market Interconnection Plan (BEMIP).

1.4.2 Explanation of how regional cooperation is considered in the plan

The Nordic cooperation on energy and climate matters has benefited the work on many parts of the plan. The interconnected nature of the Nordic energy market is reflected in the scenarios used in this plan.

The analytical work of Nordic Energy Research was considered particularly in Section 5.

2. NATIONAL OBJECTIVES AND TARGETS

2.1 Dimension decarbonisation

2.1.1 GHG emissions and removals

2.1.1.1 The elements set out in point (a)(1) of Article 4

With respect to greenhouse gas emissions and removals and with a view to contributing to the achievement of the economy wide Union greenhouse gas emission reduction target:

The Member State's binding national target for greenhouse gas emissions and the annual binding national limits pursuant to Regulation (EU) 2018/842.

For the emission sectors[22] which do not belong to the EU's scheme for emission allowance trading. For the (EU ETS) or LULUCF[23] sector, each member country has a national target under the EU's Effort Sharing Decision/non-traded sector (ESD[24]/ESR[25]). Sweden's contribution to effort sharing is to reduce its emissions to 20% of their 2005 levels by 2030.

The Swedish national intermediate target for 2030 is to reduce emissions from the non-EU ETS or LULUCF sectors by 63% compared to their 1990

[22] Examples of sectors that do not belong to the EU ETS or LULUCF are heating of homes and commercial premises, agriculture and national transport (excluding national flights).

[23] LULUCF stands for Land Use, Land-Use Change and Forestry . In this sector, carbon storage changes are reported for each soil type and for harvested wood products. https://www.naturvardsverket.se/Sa-mar-miljon/Statistik-A-O/Vaxthusgaser-utslapp- och-upptag-fran-markanvandning/.

[24] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

[25] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013.

levels, equivalent to a 59% reduction of their 2005 levels. Sweden has Annual Emissions Allocations and intends to continue to cancel any scope for emissions created by overachievement of its target under the EU's Effort Sharing Decision. This is to ensure that the emission reductions achieved in Sweden cannot be used by other EU Member States and that the EU's total emission margin is reduced by the amount by which Sweden has overachieved its target. The Riksdag makes decisions on cancellation every year.

Sweden's annual emission path for 2021-2030 will be determined once the implementing act is clear at EU level.

Member State's commitments pursuant to Regulation (EU) 2018/841

Under the LULUCF Regulation[26] (period 2021–2030) each Member State undertakes to ensure that the removals and emissions from the LULUCF sector do not exceed those permitted under the Regulation's accounting rules. The Regulation aims to provide an incentive for additional actions within the LULUCF sector; it is up to the Member States to choose appropriate actions.

Sweden's 2021-2025 reference levels for its LULUCF forestry accounts have not yet been determined. At the beginning of 2020 the European Commission will determine the reference level for the accounts of Sweden's actions and their outcome. For other types of land Sweden follows the same LULUCF guidelines as other Member States.

2.1.1.2 Where applicable, other national objectives and targets consistent with the Paris Agreement and the existing long-term strategies. Where applicable for the contribution to the overall Union commitment of reducing the GHG emissions, other objectives and targets, including sector targets and adaptation goals, if available.

The Riksdag adopted a national climate policy framework for Sweden in June 2017. The framework consists of a climate act, national climate targets and a climate policy council. See Section 1.2 for more information about the Climate Policy Framework.

Sweden has four main climate policy targets.

- An overall environmental quality target, with no specific deadline, to help limit the rise in global average temperatures.
- A long-term Swedish emissions target for 2045.

[26] Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU.

- Intermediate targets for Swedish emissions outside the EU's emissions trading scheme for 2020, 2030 and 2040.
- A special intermediate target for greenhouse gas emissions from national transport (except for national aviation, which belongs to the EU ETS) for 2030.

Sweden's environmental quality goal: Limited Impact on the Climate

To provide a clear structure for environmental work in Sweden, the Riksdag has adopted 16 environmental quality goals. One of these, *Limited Impact on the Climate*, forms the basis for action on climate change. The target has been defined[27] as:

'Limiting the global average temperature rise to less than 2 ºC above its pre-industrial level and making efforts to achieve an increase of less than 1.5 ºC above the pre-industrial level. Sweden must work internationally to direct global efforts towards achieving this goal.'

A long-term emissions target

Sweden must reduce its net emissions of greenhouse gases to zero by 2045, and then achieve negative emissions. This means that greenhouse gases from Swedish territory must be at least 85% lower in 2045 than they were in 1990. Capture and storage of carbon dioxide of fossil origin must be included in the measures to achieve this target in the absence of reasonable alternatives. Additional measures will also have to be taken into account to achieve net zero emissions. The climate goal is illustrated in Figure 1.

Intermediate targets for greenhouse gas emissions in 2020, 2030 and 2040

- In 2020, the greenhouse gas emissions of the ESR sector in Sweden[28] must be 40% lower than they were in 1990. A maximum of 13% of emission reductions may be made by implementing additional measures in the form of credits[29].
- By 2030, the greenhouse gas emissions of the ESR sector in Sweden must be at least 63% lower than they were in 1990. A maximum of 8% of emission reductions may be made by implementing additional measures.
- By 2030 greenhouse gas emissions from national transport, excluding national flights, must be at least 70% lower than they were in 2010[30].
- By 2040, the greenhouse gas emissions of the ESR sector in Sweden must be at least 75% lower than they were in 1990. A maximum of 2% of emission reductions may be made by implementing additional measures.

[27] Government bill 2016/17:146, Report 2016/17:MJU24, Riksdag communication 2016/17:320.

[28] ESR stands for Effort Sharing Regulation. Emissions are regulated nationally on the basis of the EU's Effort Sharing Regulation. Between 2013 and 2020, this sector is called the ESD, Effort Sharing Decision.

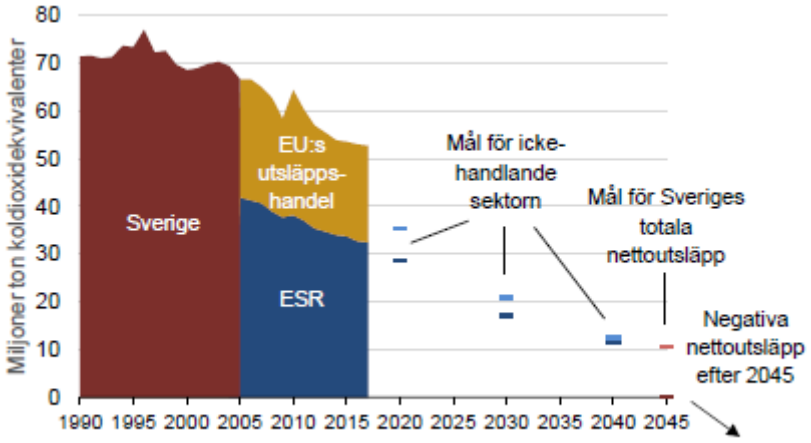
[29] Credits may include emission reductions in other EU Member States and credits from the Clean Development Mechanism under the Kyoto Protocol.

[30] National aviation is not included in the target as it belongs to the EU ETS.

Additional measures

Under international rules, additional measures may be taken into account to achieve the long-term goal for 2045 and the intermediate targets. However, no decision has yet been made about how to do this. Current additional measures include net removal by forests and land, verified emission reductions through investments in other countries and capture and storage of biogenic carbon dioxide (bio-CCS).

Figure 1. Sweden's climate targets (with and without additional measures) and historic emissions. The levels marked in a lighter colour are target levels making maximum use of additional measures, while the darker colours are target levels without using additional measures. From 2005, the historic emissions are split between the traded and the non-traded sector (ESR), as the EU's emissions trading system started in that year.



Source	Target
Sverige	Sweden
EU:s utsläpps-handel	EU emissions trading
Mål för icke-handlande sektorn	Target for the non-traded sector
Mål för Sveriges totala nettoutsläpp	Target for Sweden's total net emissions
Negativa nettoutsläpp efter 2045	Negative net emissions after 2045
Miljoner ton koldioxidekvivalenter	Million metric tonnes of carbon dioxide equivalents

Climate change adaptation

The Government's goal for climate change adaptation is to develop a long-term, sustainable and robust society which actively combats climate change by reducing vulnerabilities and grasping opportunities. The Government adopted the first National Climate Change Adaptation Strategy in March 2018[31]. The strategy establishes mechanisms for coordinating, monitoring, evaluating and reviewing climate change adaptation work. Seven particular areas have been highlighted for further work on the basis of the predicted consequences for society. The work should be informed by a number of guiding principles.

As climate change adaptation involves many different fields, the work is largely governed by existing national and international regulations, frameworks and objectives. These include the goals of the 2030 Agenda and the Planning and Building Act (2010:900).

[31] Government bill 2017/18:163. National Climate Change Adaptation Strategy

Air pollution control policy

The revised National Emission Ceilings Directive[32] (2016/2284/EU) on the reduction of atmospheric pollutants sets ceilings for Sweden's emission reduction commitments for sulphur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (NMVOC), particulate matter (PM2,5) and ammonia (NH_3). The emission ceiling must be complied with by 2020 and 2030 and there are also indicative targets for 2025, which must demonstrate a linear emission reduction between 2020 and 2030. Table 2 and Table 3 show Sweden's commitments for 2020 and 2030.

Table 2. Sweden's commitments for 2020 and 2030 under the new Ceilings Directive in per cent with 2005 as the base year.

Air pollution	Reduction by 2020 [%]	Reduction by 2030 [%]
NO_X	36	66
SO_2	22	22
NMVOC	25	36
NH_3	15	17
PM2,5	19	19

Table 3. Sweden's commitments for 2030 expressed in thousand metric tonnes (kt) and remaining target according to the emission inventory and forecast reported in February and March 2017.

Pollution	Emissions 2005 [kt]	Commitment 2030 [lt]	Forecast 2030 [kt]	Target 2030 [kt]
NO_X	172	58	70	-12
SO_2	36	28	17	-
NMVOC	179	115	107	-
NH_3	58	48	49	-1
PM2,5	26	22	17	-

A new Air Pollution Control Ordinance (218:740) implementing the provisions of the revised National Emission Ceilings Directive came into force on 1 July 2018. The Ordinance covers the work of the Swedish Environmental Protection Agency and other relevant agencies on the National Air Pollution Control Programme, emission statistics, scenarios, environmental monitoring and reporting to the EU under the provisions of the Directive.

2.1.2 Renewable energy

2.1.2.1 The elements set out in point (a)(2) of Article 4

With respect to renewable energy: With a view to achieving the Union's binding target of at least 32% renewable energy in 2030 as

[32] Directive (EU) 2016/35/EC of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.

referred to in Article 3 of Directive (EU) 2018/2001, a contribution to that target in terms of the Member State's share of energy from renewable sources in gross final consumption of energy in 2030, with an indicative trajectory for that contribution from 2021 onwards. By 2022, the indicative trajectory shall reach a reference point of at least 18% of the total increase in the share of energy from renewable sources between that Member State's binding 2020 national target, and its contribution to the 2030 target. By 2025, the indicative trajectory shall reach a reference point of at least 43% of the total increase in the share of energy from renewable sources between that Member State's binding 2020 national target, and its contribution to the 2030 target. By 2027, the indicative trajectory shall reach a reference point of at least 65% of the total increase in the share of energy from renewable sources between that Member State's binding 2020 national target, and its contribution to the 2030 target.

By 2030, the indicative trajectory shall reach at least the Member State's planned contribution. If a Member State expects to surpass its binding 2020 national target, its indicative trajectory may start at the level it is projected to achieve. The Member States' indicative trajectories, taken together, shall add up to the Union reference points in 2022, 2025 and 2027 and to the Union's binding target of at least 32% renewable energy in 2030. Separately from its contribution to the Union target and its indicative trajectory for the purposes of this Regulation, a Member State shall be free to indicate higher ambitions for national policy purposes.

Sweden has no national targets for the share of renewable energy in 2030. Sweden's draft Integrated Energy and Climate Plan[33] used the Swedish Energy Agency's long-term scenarios[34] from 2016 and the policies adopted at that time as the basis for a national contribution to the Union's common target for 2030. The Swedish Energy Agency's 2016 reference scenario with conditions recommended by the EU indicated that renewable energy would account for 65% of gross energy consumption in 2030. The Agency's latest long-term scenarios[35] show that this is still a reasonable contribution which should be achievable with the policies adopted (see Section 4).

Under the Renewable Energy Directive[36], Sweden's binding target for the share of renewable energy in gross energy consumption in 2020 is 49%. Figure 2 shows the indicative trajectory from the binding target for 2020 to a national contribution of a 65% share of renewable energy in gross energy consumption in 2030. The indicative trajectory does not place any limits on higher national ambitions and objectives or the development of national policies.

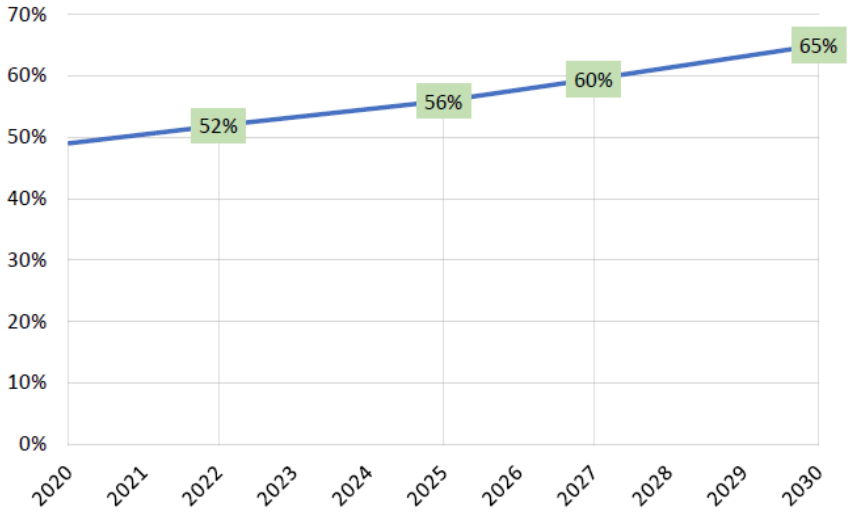
[33] https://www.regeringen.se/rapporter/2019/01/sveriges-utkast-pa-integrerad-nationell-energi--och-klimatplan/.

[34] The Swedish Energy Agency – *Scenarier över Sveriges energisystem 2016* (ER2017:6).

[35] The Swedish Energy Agency – *Scenarier över Sveriges energisystem 2018* (ER2019:7).

[36] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

Figure 2 Sweden's indicative trajectory for the share of renewable energy in final energy consumption between 2020 and 2030.



2.1.2.2 Estimated trajectories for the sectoral share of renewable energy in final energy consumption from 2021 to 2030 in the electricity, heating and cooling and transport sector.

The EU Reference Scenario is described in detail in Section 4.2.2 including trajectories for the share of renewable energy in the electricity, heating and cooling and transport sectors.

2.1.2.3 Estimated trajectories by renewable energy technology that the Member State projects to use to achieve the overall and sectoral trajectories for renewable energy from 2021 to 2030, including expected total gross final energy consumption per sector in Mtoe and total planned installed capacity (divided by new capacity and repowering) per technology and sector in MW.

The future profitability and competitiveness of different renewable energy sources will depend on developments on the market. The Government believes it is more cost-effective to leave it to the market to determine which technologies are used instead of setting specific targets.

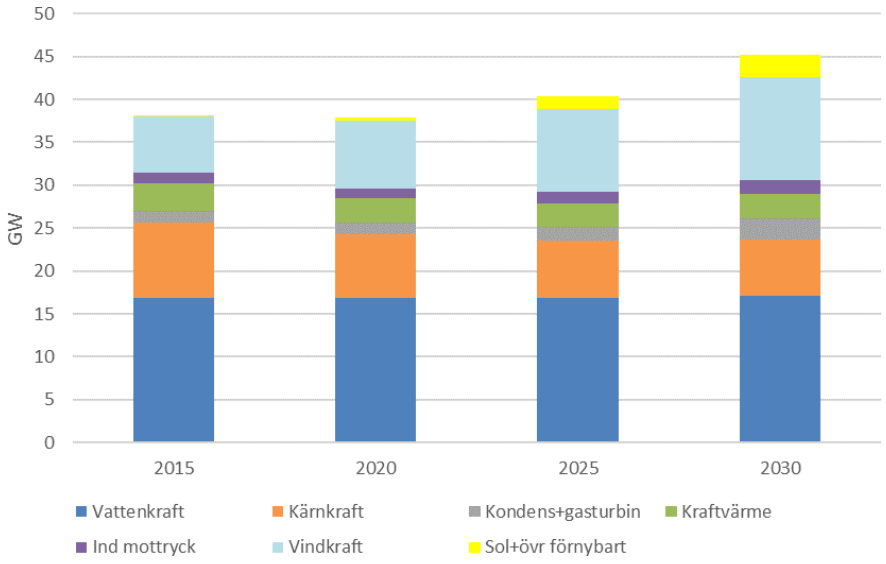
Section 4.2.2 describes the estimated distribution of renewable energy by technology and energy consumption in 2030 according to the EU Reference Scenario, in total and by sector.

The expected total gross final energy consumption[37] of 37 Mtoe given in the EU Reference Scenario does not change from 2020 to 2030. In the heating and cooling sector, the equivalent energy consumption increases by 1 Mtoe to 17 Mtoe in 2030. The energy consumption in the transport sector falls slightly from 2020 to 7 Mtoe in 2030; in the electricity sector it is unchanged at 13 Mtoe in 2030.

[37] The denominator in the calculations of renewable energy shares.

In the scenario, the total installed electricity generation capacity increases from around 39 GW in 2017 to nearly 45 GW in 2030 in spite of the fact that two nuclear reactors are expected to be decommissioned during this period (see the estimated distribution between different technologies in Figure 3). The installed capacity for wind power is expected to increase the most, by 5 GW between 2017 and 2030. Solar power is expected to increase by 2 GW in the same period. There is no information on the division between new capacity and repowering.

Figure 3 Installed capacity per type of power in the Swedish Energy Agency's EU Reference Scenario, 2020–2030, GW.



Source	Target
Vattenkraft	Hydropower
Kärnkraft	Nuclear power
Kondens+gasturbin	Steam + gas turbine
Kraftvärme	Cogeneration
Ind mottryck	Ind back-pressure
Vindkraft	Wind power
Sol+övr förnybart	Solar + other renewable
GW	GW

Note: The modelling result is based on normal operation which means that the need for back-up power is probably underestimated.

2.1.2.4 Estimated trajectories on bioenergy demand, disaggregated between heat, electricity and transport, and on biomass supply by feedstocks and origin (distinguishing between domestic production and imports). For forest biomass, an assessment of its source and impact on the LULUCF sink.

In the Swedish Energy Agency's EU Reference Scenario the total bioenergy consumption increases by 14 TWh between 2017 and 2020 to a total of 157 TWh. The estimated bioenergy consumption for 2030 is 161 TWh, as shown in Figure 4.

In the heating and cooling sector, bioenergy consumption increases by 10

TWh up to 2020 and then by 2 TWh to 121 TWh in 2030. Solid biofuels[38] account for 9 TWh of the increase and depend on increased use for heat generation in district heating plants and for heating in the housing and services sector.

In the transport sector, the consumption of bioenergy (but only liquid biofuels) increases by 3 TWh up to 2020 and then remains constant until 2030[39]. The increase is due primarily to increased consumption of biodiesel in the form of HVO (around 2 TWh) which is currently produced primarily from waste and residues.

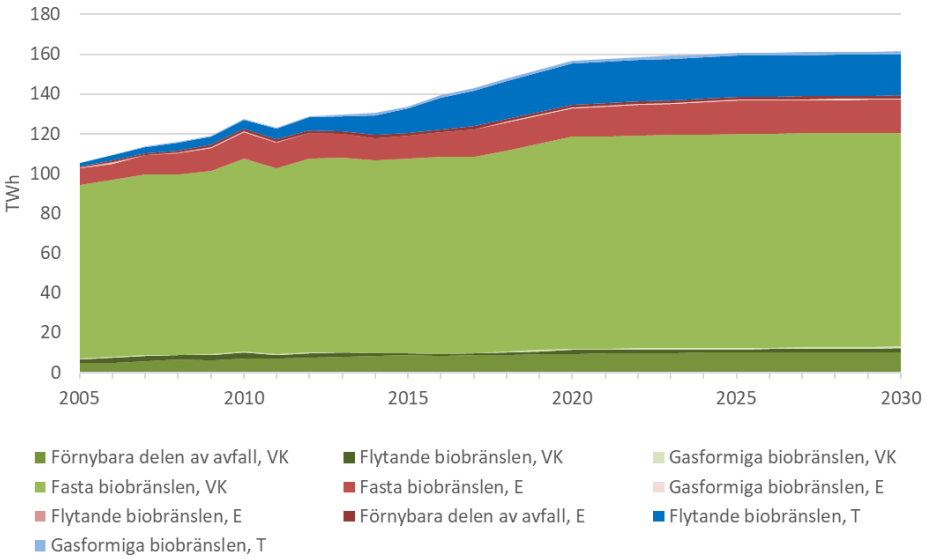
In the electricity sector, bioenergy consumption increases by only 1 TWh up to 2020 and then by 2 TWh up to 2030. Solid biofuels account for the largest proportion of this increase.

At present, Sweden imports a relatively large amount of biofuel feedstocks for all three consumer sectors, although there is significant national potential for most types of feedstock. However, there is no state policy for controlling the balance between domestic production and imports; it is controlled by market forces.

[38] Including lyes, a residual product of paper production.

[39] The scenario only contains the current levels for the reduction obligation.

Figure 4 Bioenergy consumption in the Heating and Cooling, Electricity and Transport sectors from 2005 to 2017 by type of biomass, and assessment in the EU Reference Scenario up to 2030, TWh.



Source	Target
Förnybara delen av avfall, VK	Renewable share of waste, HC
Fasta biobränslen, VK	Solid biofuels, HC
Flytande biobränslen, E	Liquid biofuels, E
Gasformiga biobränslen	Gaseous biofuels
Flytande biobränslen, VK	Liquid biofuels, HC
Fasta biobränslen E	Solid biofuels, E
Förnybara delen av avfall, E	Renewable share of waste, E
Gasformiga biobränslen, VK	Gaseous biofuels, HC
Gasformiga biobränslen, E	Gaseous biofuels, E
Flytande biobränslen, T	Liquid biofuels, T

Source: The Swedish Energy Agency.
Note: T = transport; E = electricity and HC = heating and cooling.

The model used in the EU Reference Scenario does not indicate which specific types of solid biofuel are used, in other words whether or not they are based on forestry feedstocks. However, the consumption of solid biofuels increases by nearly 8 TWh between 2017 and 2020 and then remains constant. If felling residues in the form of branches and tops account for most of this increase, it has little impact on the carbon sink; but the removal of more stumps can be detrimental. However, stores of carbon could be increased by growing trees for biomass on derelict land formerly used for annual crops.

2.1.2.5 Where applicable, other national trajectories and objectives, including those that are long-term and sectoral (such as share of renewable energy in district heating, renewable energy use in buildings, renewable energy produced by cities, renewable energy communities and renewables self-consumers, energy recovered from the sludge acquired through the treatment of wastewater)

The 2040 target is 100% of electricity generated from renewable sources.

That is a target, not a deadline for banning nuclear energy; nor is it a policy decision to stop generating nuclear energy.

Progress towards the target of 100% electricity generated from renewable sources was assessed during the first review[40] of the Energy Agreement in 2019. Electricity generated from renewable sources as a proportion of total electricity generation increased from 57.6% to 58.4% in 2017. In the Swedish Energy Agency's EU Reference Scenario, this share increases to 84% in 2040. Nuclear energy accounts for most of the remaining electricity generated from non-renewable sources, followed by electricity from burning residual fossil gases (coke and blast furnace gases) from the steel industry and the fossil content of waste.

Section 4 describes the trend in the generation of energy from renewable sources shown in the EU Reference Scenario using the calculation method from the Renewable Energy Directive.

2.2 Dimension energy efficiency

2.2.1 The elements set out in point (b) of Article 4

2.2.1.1 The indicative national energy efficiency contribution to achieving the Union's energy efficiency targets of at least 32.5% in 2030 as referred to in Article 1(1) and Article 3(5) of Directive 2012/27/EU, based on either primary or final energy consumption, primary or final energy savings, or energy intensity. Member States shall express their contribution in terms of absolute level of primary energy consumption and final energy consumption in 2020, and in terms of absolute level of primary energy consumption and final energy consumption in 2030, with an indicative trajectory for that contribution from 2021 onwards. They shall explain their underlying methodology and the conversion factors used.

Sweden has set a target for the reduction of energy intensity in terms of energy supplied in relation to GDP. This is a cross-sectoral target to reduce energy intensity by 20% between 2008 and 2020.

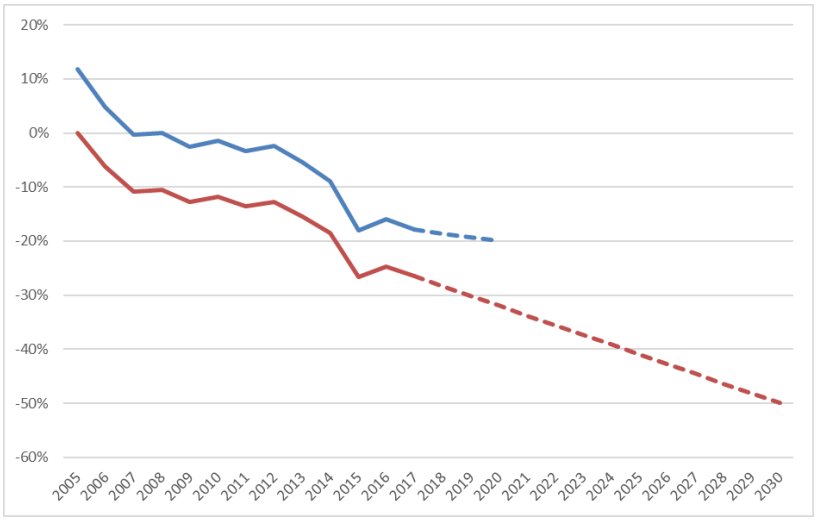
Energy consumption must be 50% more efficient by 2030 than it was in 2005. This target is also expressed as energy supplied (primary energy) in relation to real GDP and is part of the Energy Agreement (see Section 1.2).

Figure 5 shows the energy intensity targets, which are a 20% reduction in 2020 and a 50% reduction in 2030. Besides the difference in base and target

[40] Government communication 2018/19:153 *Första kontrollstationen för energiöverenskommelsen*.

years, the 20% target also includes fuels for non-energy purposes, which the 50% target does not.

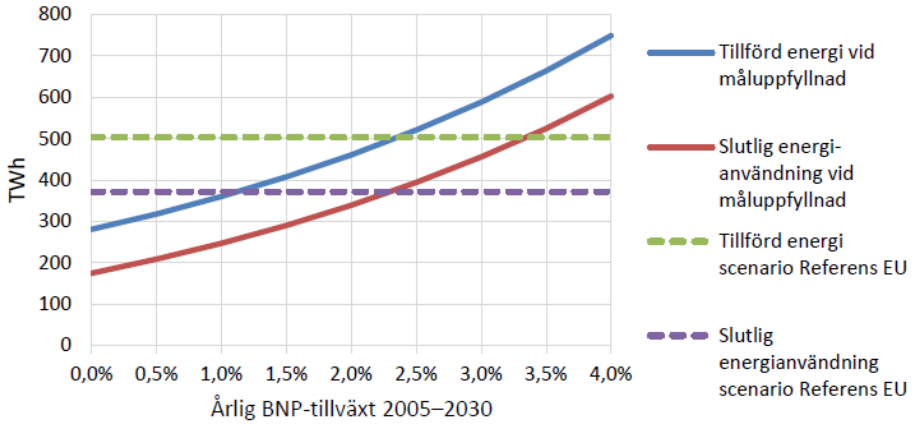
Figure 5 Energy intensity targets for 2020 and 2030. Statistics up to 2017 followed by the assumed linear progression to the respective target.



Source: The Swedish Energy Agency.

As Sweden's 2030 target is an energy intensity target there is no fixed level for consumption of energy supplied (primary) and final energy to meet the target. Figure 6 shows the different energy consumption levels calculated for different assumptions about the development of GDP. Assuming the economy grows at 2% a year, the primary energy consumption on meeting the target in 2030 will be 461 TWh and the final energy consumption will be 339 TWh. These are not target levels. Energy consumption may be different if the GDP develops differently.

Figure 6. Calculated levels for consumption of supplied (primary) and final energy to meet Sweden's target for a 50% fall in energy intensity in 2030.



Source	Target
Tillförd energi vid måluppfyllnad	Energy supplied on meeting the target
Slutlig energi- användning vid måluppfyllnad	Final energy consumption on meeting the target
Tillförd energi scenario Referens EU	Energy supplied, EU Reference Scenario
Slutlig energianvändning scenario Referens EU	Final energy consumption, EU Reference Scenario

The EU Reference Scenario (see Section 4) estimates Sweden's primary energy consumption – in practice, the same as energy supplied – in 2020 at 533 TWh and its final energy consumption at 391 TWh. The corresponding figures for 2030 are 516 TWh and 384 TWh without further policy measures. Besides the growth in GDP, the development of energy intensity depends on primary energy consumption which, in turn, is dependent on measures for renewable energy, energy efficiency, structural changes in the industry, the future of nuclear energy and general economic growth. See Section 2.4.4 for information about sectoral energy-efficiency strategies.

Scenarios are mainly prepared in energy terms, rather than in terms of physical units, with base year statistics from the national energy balances (official statistics). Since they are prepared both for energy supplied and for final energy consumption, conversion factors for electricity and district heating, for example, are not needed for the calculations.

2.2.1.2 The cumulative amount of end-use energy savings to be achieved over the period 2021-2030 under point (b) of Article 7(1) on the energy saving obligations pursuant to Directive 2012/27/EU.

For the whole of the period 2021–2030, Member States must achieve a cumulative end-use energy saving equivalent to an annual saving of at least 0.8% of the annual final energy consumption in 2016–2018. According to Eurostat data, Sweden's average final energy consumption in 2015–2017 was 371 TWh; this means that the provisional total savings obligation is 163 TWh. The final energy savings obligation will be determined when the 2018 energy statistics are available.

2.2.1.3 The indicative milestones of the long-term strategy for the renovation of the national stock of residential and non-residential buildings, both public and private, the roadmap with domestically established measurable progress indicators, an evidence-based estimate of expected energy savings and wider benefits, and the contributions to the Union's energy efficiency targets pursuant to Directive 2012/27/EU in accordance with Article 2a of Directive 2010/31/EU.

Sweden will report its long-term renovation strategy, including indicative milestones, to the Commission by 10 March 2020. The Government has commissioned the National Board of Housing, Building and Planning and the Swedish Energy Agency to prepare proposals for Sweden's long-term renovation strategy.

2.2.1.4 The total floor area to be renovated or equivalent annual energy savings to be achieved from 2021 to 2030

under Article 5 of Directive 2012/27/EU on the exemplary role of public bodies' buildings.

Sweden intends to use the alternative strategy permitted under Article 5(6) of the Energy Efficiency Directive. The cumulative energy savings obligation for 2014–2030 is 47.6 GWh. This is shared between the Fortifications Agency, which must save 26.7 GWh and the National Property Board of Sweden, which must save 20.9 GWh. The cumulative savings obligation for 2021–2030 is 28.6 GWh. This is shared between the Fortifications Agency, which must save 15.8 GWh and the National Property Board of Sweden, which must save 12.8 GWh. In its decision of 11 December 2019, the Government tasked the Fortifications Agency and the National Property Board of Sweden with taking action to achieve these energy savings.

Under Article 5(2)(a) of the Energy Efficiency Directive[41] buildings officially protected as part of a designated environment, or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance, do not count as part of the building stock. Since Sweden uses this exemption these buildings are not included in the building stock.

Under Article 5(2)(b) of the Energy Efficiency Directive buildings serving national defence purposes, apart from single living quarters or office buildings for the armed forces and other staff employed by national defence authorities, do not count as part of the building stock. Since Sweden uses this exemption only the Fortifications Agency's public stock is included.

2.2.2 The indicative milestones for 2030, 2040 and 2050, the domestically established measurable progress indicators, an evidence-based estimate of expected energy savings and wider benefits, and their contributions to the Union's energy efficiency targets as included in the roadmaps set out in the long-term renovation strategies for the national stock of residential and non-residential buildings, both public and private, in accordance with Article 2a of Directive 2010/31/EU.

See point 3 of Section 2.2 i).

2.2.3 Where applicable, other national objectives, including long-term targets or strategies and sectoral targets, and national objectives in areas such as energy efficiency in the transport sector and with regard to heating and cooling.

On 6 July 2017 the Government commissioned the Swedish Energy Agency

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

to prepare sectoral energy efficiency strategies with various sectors in consultation with the relevant agencies. This is a task under the Energy Agreement and will continue until 2030.

It will take the form of a discussion of suitable indicative targets and measures for the sector's contribution to at 50% increase in energy efficiency by 2030, taking account of other energy and climate policy targets. The Swedish Energy Agency has identified five sectors and has defined the following strategic areas with the relevant operators:

1. Fossil-free transport.
2. World-class production.
3. A flexible and robust energy system.
4. Future trade and consumption.
5. Resource-efficient building.

The Swedish Energy Agency intends to focus on cooperation and to proceed iteratively so that strategic areas can be added or removed during the process.

The sectoral strategies must make use of the drive and ambitions of Swedish operators. It is important that their actions and activities genuinely improve the resource-efficiency of energy consumption.

The Government's national goods transport strategy *Effective, high-capacity, sustainable goods transport — a national goods transport strategy*, contains five key areas for the transition to fossil-free transport. The Government has issued a number of assignments under the goods transport strategy.

2.3 Dimension energy security

2.3.1 The elements set out in point (c) of Article 4

2.3.1.1 National objectives with regard to

- **increasing the diversification of energy sources and supply from third countries, the purpose of which may be to reduce energy import dependency**
- **increasing the flexibility of the national energy system, and**
- **addressing constrained or interrupted supply of an energy source, for the purpose of improving the resilience of regional and national energy systems, including a timeframe for when the objectives should be met.**

Besides the requirements and criteria in European Union legislation, there are no national targets for reducing dependence on importing energy from third countries.

Instead, the energy supply is secured by properly functioning energy

markets, where energy is traded freely as far as possible, both within Sweden and between Sweden and other countries.

See Section 2.3.4 for national objectives for increasing the flexibility of the national energy system.

Responsibility for a secure energy supply, and hence for objectives to address constrained or interrupted supply, is shared among many different operators. A secure energy supply, together with sustainability and competitiveness, is the overall objective of Swedish energy policy. It is also an integral part of the general guidelines for crisis management and civil defence. The energy markets, which are largely international, provide a means of preventing interruptions and shortages or reducing their severity. The energy supply can be adapted to new requirements on market conditions. The public authorities have an important role in designing frameworks and monitoring the energy markets to ensure that they are functioning well.

Electricity supply

There is currently no specific target for the security of the electricity supply. The revised Electricity Market Regulation[42] requires all Member States that have a capacity mechanism to define a supply security target in the form of a reliability standard. An action plan to identify remaining market failures and distortions as a result of legislation to improve the operation of the market was drawn up during the preparation of this standard. In its 2020 appropriation directive, the Government commissioned the Swedish Energy Markets Inspectorate to submit proposals for a reliability standard. Sweden has had a capacity mechanism in the form of a power reserve since 2003 to manage winter peaks in electricity consumption (see Section 3.3 for more information). In a notice to the Government in May 2019, the Riksdag asked it to develop an electricity supply security target for Sweden[43]. The Government intends to develop an accounting method for electricity supply security in future draft budgets.

A rapid rise in electricity consumption in some metropolitan areas, mainly as a result of increased urbanisation and new industry, combined with the length of time needed to increase the capacity of the grid, can increase the risk of regional capacity shortages, particularly if the scarcity is not reflected in the price. The Government has therefore commissioned the Swedish Energy Markets Inspectorate to investigate the extent of the capacity shortage in the grid, investigate the history of the problem and analyse conditions and measures linked to the problems identified. It must submit

[42] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity.

[43] Report 2018/19:NU12, Riksdag communication 2018/19:210.

its final report to the Swedish Government Offices (Infrastructure Department) by 1 October 2020 and an interim report by 30 April 2020.

Under Article 10 of the Risk-Preparedness Regulation[44] the competent authority of each Member State must establish a risk-preparedness plan for electricity. A risk-preparedness plan must be adopted by 5 January 2022 and must be updated every four years. As Sweden does not have a competent authority for electricity, there is currently no Swedish risk-preparedness plan for electricity.

The national grid is planned and operated according to the (n-1) principle, which means that a fault in a single component should not affect the electricity supply. In the event of a fault, the effects must be remedied within 15 minutes and the electricity system must then be prepared for any new fault. This requires rapid access to an active fault reserve[45]. If the grid is damaged, the necessary repairs must be started without delay.

The objective for power cuts is expressed as an obligation for network owners to ensure that they do not last for more than 24 hours, unless the causes are beyond the grid operator's control.

Section 3.3 discusses shortages of electricity and capacity in more detail. Section 4.4 analyses the adequacy of future capacity.

Oil supply

Under the IEP Agreement[46] and the Oil Stocks Directive[47], Sweden is obliged to hold emergency supplies equivalent to 90 days' net imports of oil. Section 3.3 provides more information about this.

Gas supply

The EU's Security of Gas Supply Regulation[48] requires protected customers to have access to gas for at least 30 days if the gas supply is disrupted. Sweden has decided that only households connected to the Western Swedish gas network should be defined as protected customers; they account for 2% of Sweden's gas consumption. Under the Security of Gas Supply Regulation, solidarity protected customers may include, under specific conditions, certain essential social services and district heating installations.

[44] Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC.

[45] A generation failure or a fault in the grid disrupts the operation of the electricity system. If the balancing power market does not have the capacity to deal with the problem, the state-owned enterprise Svenska kraftnät activates the reserve capacity to restore the balance in the system. The reserve capacity is currently provided primarily by gas turbines located in the southern bidding zones (SE3 and SE4).

[46] The International Energy Agency's Agreement on an International Energy Programme.

[47] Council Directive 2009/119/EG of 14 September 2009 imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products.

[48] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010.

2.3.2 National objectives with regard to increasing the diversification of energy sources and supply from third countries for the purpose of increasing the resilience of regional and national energy systems.

See Section 2.3.1.

2.3.3 Where applicable, national objectives with regard to reducing energy import dependency from third countries, for the purpose of increasing the resilience of regional and national energy systems.

See Section 2.3.1.

2.3.4 National objectives with regard to increasing the flexibility of the national energy system, in particular by means of deploying domestic energy sources, demand response and energy storage.

The Government's draft budget for 2020 (Government bill 2019/20:1 expenditure area 21) confirms that a future electricity system containing a larger proportion of variable wind and solar energy will require more flexibility in planned generation, better demand response in consumer sectors and more energy storage and systems services to support and stabilise the electricity system. To achieve this, we must continue to promote demand response, for example by removing regulatory obstacles to new business models.

In its bill *The Focus of Energy Policy* [49] the Government states that the role of the network operator may have to be broadened to take full advantage of the benefits of smart grids, energy storage and demand response for the electricity system.

Emergency oil stocks are based on the target for minimum stocks in the Oil Stocks Directive[50] and the Agreement on an International Energy Program, which requires members of the International Energy Agency to hold oil stocks equivalent to at least 90 days' net imports.

For demand response, see Section 2.4.3.

2.4 Dimension internal energy market

[49] Government bill 2017/18:228 *Energipolitikens inriktning*.

[50] Council Directive 2009/119/EG of 14 September 2009 imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products.

2.4.1 Electricity interconnectivity

The level of electricity interconnectivity that the Member State aims for in 2030 in consideration of the electricity interconnection target for 2030 of at least 15%, with a strategy with the level from 2021 onwards defined in close cooperation with affected Member States, taking into account the 2020 interconnection target of 10% and the following indicators of the urgency of action:

1. Price differential in the wholesale market exceeding an indicative threshold of EUR 2/MWh between Member States, regions or bidding zones.

2. Nominal transmission capacity of interconnectors below 30% of peak load

3. Nominal transmission capacity of interconnectors below 30% of installed renewable generation.

Sweden has not set a target for interconnection in 2030. However, the Energy Agreement includes an ambition to increase Sweden's network connections with other countries. At the beginning of 2019, Sweden's interconnectivity level was[51] 27%, which already exceeds the EU's target for 2030. Current and future levels are discussed in Section 4.5.

Table 4 shows the annual average prices in the Swedish and neighbouring bidding zones in 2018 and the price differences between the zones. The differences vary from year to year and are highly dependent on the weather, in other words the flow of water for hydroelectric power, the generation of wind power and the demand for heating which varies with the temperature.

Table 4 shows that the following zones could benefit from increased Net Transfer Capacity (NTC): SE3-SE4, SE1-FI, SE3- FI, SE4-LT, SE4-PL and SE4-DE. Some of these have already been identified and are the subject of existing or planned projects. The SouthWest Link (SE3-SE4), 3:e AC to Finland (SE1-F1) and the Hansa Powerbridge (SE4-DE).

However any analysis of potential new or improved connections must include an assessment of the socio-economic benefits in the expected future market situation. The current price may give an indication of the potential demand, but the analysis should be based on the market situation in 10–30 years' time.

Table 4. Annual average prices in 2018 in EUR/MWh and price differences between neighbouring bidding zones.

[51] Interconnectivity level = installed capacity for transmission abroad / installed electricity generation capacity.

Bidding zone		Electricity price (EUR/MWh)		Difference
Zone 1	Zone 2	Zone 1	Zone 2	
SE1	SE2	44.2	44.2	0.0
SE2	SE3	44.2	44.5	-0.3
SE3	SE4	44.5	46.3	-1.8
SE1	FI	44.2	46.8	-2.6
SE3	FI	44.5	46.8	-2.3
SE3	DK1	44.5	44.0	0.5
SE4	DK2	46.3	46.2	0.2
SE3	NO1	44.5	43.6	0.9
SE2	NO3	44.2	44.1	0.1
SE1	NO4	44.2	43.7	0.5
SE4	LT	46.3	50.0	-3.6
SE4	PL	46.3	52.2	-5.8
SE4	DE	46.3	44.7	1.7

Source: NordPool, Montel.

Table 5 shows the relationship between the NTC and the peak load. In all cases the level exceeds the target level of 30%.

Table 5. NTC (Net Transfer Capacity) Import & Export, Peak Load, [MW].

	NTC Import [MW]	NTC Export [MW]	Peak load [MW]	Import / top load	Export / top load
SE1	5 100	5 400	1 600	319%	338%
SE2	11 450	11 900	3 200	358%	372%
SE3	13 385	16 675	17 100	78%	98%
SE4	9 015	5 215	4 800	188%	109%
SE	10 350	10 590	26 700	39%	40%

Source: Svenska kraftnät – *Kraftbalansrapporten 2019*.

A socio-economic and environmental cost-benefit analysis must be carried out for every new interconnectivity project; the project should only go ahead if the potential benefits outweigh the costs.

Table 6 shows the relationship between the Net Transfer Capacity and the renewable capacity. In all cases the level exceeds the target level of 30%.

Table 6. NTC (Net Transfer Capacity), RES (Renewable Energy Sources), [MW].

	NTC Import [MW]	NTC Export [MW]	RES [MW]	Import / RES	Export / RES
SE1	5 100	5 400	6 650	77%	81%
SE2	11 450	11 900	12 220	94%	97%
SE3	13 385	16 675	8 014	167%	208%
SE4	9 015	5 215	3 220	280%	162%
SE	10 350	10 590	30 103	34%	35%

Source: Svenska kraftnät. *Kraftbalansrapporten 2019*.

2.4.2 Energy transmission infrastructure

2.4.2.1 Key electricity and gas transmission infrastructure projects, and, where relevant, modernisation projects, that are necessary for the achievement of objectives and targets under the five dimensions of the Energy Union Strategy.

Electricity transmission

Svenska kraftnät is a state-owned enterprise which owns the Swedish national grid. It is responsible for maintaining the instantaneous energy balance and the operational security of Sweden's grid and is certified as the system operator by the Swedish Energy Markets Inspectorate. The current system development plan[52] covers the period up to 2027 and includes Svenska kraftnät's grid development plan; the full text of the plan can be found on Svenska kraftnät's website. The following are some of the largest grid development projects.

- The SouthWest Link project[53], which increases Net Transfer Capacity between bidding zones 3 and 4 (see Figure 32 on bidding zones in Section 4.5), is currently in the test phase and is expected to increase capacity by 1 200 MW.

- The West Coast Programme comprises several projects to eliminate bottlenecks in this area.

- The expected phase-out of nuclear energy in bidding zone 3 and expansion of wind energy in bidding zones 1 and 2, will increase the need for transmission between bidding zones 2 and 3. The NordSyd Programme[54] comprises around 50 different projects to increase capacity between bidding zones 2 and 3 by 2040.

Gas transmission

The western Swedish natural gas system extends from Trelleborg in the south to Stenungssund in the north and slightly eastwards towards Jönköping. Gas is transported to Sweden through a pipeline from Dragør in Denmark. The Swedish transmission network is owned by Swedgas AB, which is also responsible for balancing the system. A few very large consumers are connected directly to the transmission network.

[52] Svenska kraftnät – *Systemutvecklingsplan 2018– 2027*.

[53] https://www.svk.se/natutveckling/stamnatsprojekt/sydvastlanken/.

[54] https://www.svk.se/natutveckling/stamnatsprojekt/nordsyd/.

The LNG[55] terminal at the Port of Gothenburg opened in autumn 2018 and will initially supply gas for shipping, industry and road haulage. It will eventually have a total capacity of around 30 000 m_3. The Government has decided to reject an application for a concession to build a natural gas pipeline between the LNG terminal and the natural gas transmission network.[56]

2.4.2.2 Where applicable, main infrastructure projects envisaged other than Projects of Common Interest.

There are plans for a third AC line[57] between Sweden (SE1) and Finland. There are also plans for a new 700-MW HVDC link[58] between Sweden (SE4) and Germany.

One of the Öresund cables from SE4 to DK2 will be replaced in 2020. Some of the other connections to Denmark, and Fennoskan 1 (SE3-FI) are likely to need replacing before 2030.

A new Nordic grid development plan[59] was published in August 2019. The report from the four Nordic Transmission System Operators (Energinet, Fingrid, Statnett and Svenska kraftnät) describes the driving forces behind the major changes which the Nordic power system is undergoing and the planned and existing projects designed to meet the challenges these changes present.

2.4.3 Market integration

2.4.3.1 National objectives related to other aspects of the internal energy market such as: increasing system flexibility, in particular through policies and measures related to market-based price formation in compliance with applicable law; market integration and coupling, aiming to increase the tradeable capacity of existing interconnectors, smart grids, aggregation, demand response, storage, distributed generation, mechanisms for dispatching, re-dispatching and curtailment and real-time price signals, including a timeframe for when the objectives should be met.

Sweden has no specific national objectives for market integration, but is continuously developing measures and taking part in Nordic cooperation in this field.

To ensure the optimum use of resources and a cost-effective transition to a sustainable energy system, the Nordic Council of Ministers has set up a new

[55] LNG = liquefied natural gas.

[56] Government decision II:1 at the cabinet meeting of 10 October 2019, ref. I2019/00911/E.

[57] AC = alternating current.

[58] HVDC = high-voltage direct current.

[59] Nordic Grid Development Plan 2019, June 2019, Stanett, Fingrid, Energinet, Svenska kraftnät.

Nordic electricity market forum for closer dialogue between political and non-political stakeholders, and between different types of stakeholder on the Nordic electricity market. The forum has produced a new vision for the Nordic electricity market which was adopted by the Nordic Council of Ministers at its last meeting in Reykjavik in 2019[60]. The vision is accompanied by a roadmap for action up to 2030, which was drawn up by the electricity market operators[61].

The Nordic countries have decided to intensify their cooperation on the Nordic balancing process and have developed a model for the balancing of the Nordic power system in the future — the Nordic Balancing Model (NBM)[62]. A considerable amount of work will be required over the next few years to finalise the design of the new model, develop the IT systems and implement it. The intention is to implement it gradually so that the whole system is operational by 2023.

Important elements and milestones are:

- Single price model
- 15-minute settlement period
- Nordic capacity market for aFRR[63]
- Nordic capacity market for mFRR[64]

Until now balancing has been planned and handled on an hourly basis and the system operator's balancing reserves have been used to cover any changes within the operating hours. A 15-minute settlement period will enable all parties on the power market to plan their own balance more precisely and allow more efficient use of power resources and the grid.

2.4.3.2 Where applicable, national objectives related to the non-discriminatory participation of renewable energy, demand response and storage, including via aggregation, in all energy markets, including a timeframe for when the objectives are to be met.

Sweden has no specific targets for this. However, it has introduced a provision in Chapter 3, Section 16 of the Electricity Act (1997:857) prohibiting grid operators from establishing technical requirements or other conditions which make it more difficult to provide services in the form of changed electricity consumption, unless the condition is justified in the interests of the secure, reliable and efficient operation of the grid.

Another provision (Chapter 5, Section 11 of the Electricity Act) states that, when determining how much the grid operators may charge customers,

[60] https://nordicelforum.org/wordpress/wp-content/uploads/2019/06/Vision-for-the-nordic-electricity-market-EN_2.pdf.

[61] https://nordicelforum.org/wordpress/wp-content/uploads/2019/06/Handlingsplan-for-at-opnå-2030-visionen-FINAL.pdf.

[62] http://nordicbalancingmodel.net/.

[63] automatic Frequency Restoration Reserves.

[64] manual Frequency Restoration Reserves.

account must be taken of the extent to which their operations are compatible with or contribute to the efficient use of the grid. This provision is intended to encourage grid operators to make it easier for customers to provide services which allow better demand response, for example by using new technical solutions.

The Smartgrid Forum, a joint enterprise to promote smarter energy use set up in spring 2016 by a Government decision, has developed a strategy for using smart grids to increase the flexibility of the electricity system[65]. The strategy is described in more detail in Section 3.4.3.

2.4.3.3 Where applicable, national objectives with regard to ensuring that consumers participate in the energy system and benefit from self-generation and new technologies, including smart meters.

Sweden has no specific targets for this.

On 1 November 2018, new requirements were introduced in the Ordinance (1999:716) on the Measurement, Calculation and Reporting of Transmitted Electricity (the Measurement Ordinance) which will apply from 2025. The new requirements apply to functions of electricity meters, measuring systems and measuring equipment. Under the new Measurement Ordinance, the grid operator must meet the functional requirements by the start of the 2025 measurement year; the requirements cover the measuring systems and equipment for all consumers of low-voltage electricity.

The functional requirements for measuring systems and measuring equipment

- allow electricity consumers to obtain information, such as capacity used, which make it easier for them to save energy and play an active part in the electricity market; and
- promote reliable and effective grid operation and make it easier and cheaper to integrate electricity from microgeneration, such as solar electricity.

2.4.3.4 National objectives with regard to ensuring electricity system adequacy, as well as for the flexibility of the energy system with regard to renewable energy production, including a timeframe for when the objectives are to be met.

Sweden has no national objectives for ensuring electricity system adequacy.

The new regulation[66] for cross-border exchanges in electricity includes

[65] http://swedishsmartgrid.se/projekt-och-resultat/strategier-for-smarta-elnat/okad-flexibilitet-i-elsystemet/.

[66] Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in

articles which require Member States to monitor system adequacy continuously.

The Swedish Energy Markets Inspectorate was given the task of producing proposals for a reliability standard in its 2020 spending authorisations. Member States with adequacy problems must take a number of measures to improve the operation of the market. If these measures prove insufficient, they can introduce a mechanism to conserve capacity (the Swedish capacity reserve counts as such a mechanism) which must be backed up by a reliability standard based on the value of the lost load. The European Network of Transmission System Operators for Electricity (ENTSO-E) must produce European methods for calculating the value of the lost load and reliability standards for system adequacy.

2.4.3.5 Where applicable, national objectives to protect energy consumers and improve the competitiveness of the retail energy sector.

The Government is working to give customers more active choice and to increase competitiveness by introducing a system in which suppliers are the key party in the market. This means that customers will mostly have contact with the electricity supplier and the supplier will bill them both for electricity and grid costs. To increase active customer engagement and provide new services, the Government and the authorities have also started work on launching an electricity market hub for centralised management of measurement data, where the stakeholders can obtain and provide information.

The electricity market hub is a central IT system which will manage the exchange of information between electricity market operators.

2.4.4 Energy poverty

2.4.4.1 Where applicable, national objectives with regard to energy poverty, including a timeframe for when the objectives are to be met.

Sweden makes no distinction between energy poverty and poverty in general. As a result, the term energy poverty is not used, and there are no targeted policies to deal with it. The issue is addressed within social policy.

2.5 Dimension research, innovation and competitiveness

2.5.1 National objectives and funding targets for public and, where available, private research and innovation relating to the Energy Union, including, where appropriate, a timeframe for when the objectives are to be met.

electricity and repealing Regulation (EC) No 1228/2003.

Answers given in Section 2.5.2.

2.5.2 Where available, national 2050 objectives related to the promotion of clean energy technologies and, where appropriate, national objectives, including long-term targets (2050) for deployment of low-carbon technologies, including for decarbonising energy and carbon-intensive industrial sectors and, where applicable, for related carbon transport and storage infrastructure.

The overall objective for energy research and innovation is to contribute to meeting energy and climate targets, the long-term energy and climate policy and the energy-related environmental policy objectives described in Section 2.

Energy research and innovation must[67]:

- develop the scientific and technical knowledge and competence required to use new technologies and new services to make the transition to a sustainable energy system in Sweden in the long term, combining sustainability, competitiveness and security of supply;

- develop technologies and services which can be commercialised by Swedish businesses, hence contributing to sustainable growth and the transition and development of the energy system both in Sweden and on other markets, and contribute to and make use of international cooperation on energy.

Energy research and cooperation must also contribute to achieving the general research policy objective[68] to make Sweden a world leader in research and innovation and a leading centre of knowledge, where high-quality research, higher education and innovation contribute to social development, welfare, competitive businesses and respond to the challenges facing society, both in Sweden and worldwide.

The public funding available for the National Energy Research and Innovation Programme for the next four years was announced in the 2017 draft budget; the funding increased from 1.3 billion krona in 2017 to 1.6 billion krona in 2020[69]. The areas covered are described in Section 3.5. Beneficiaries in the private sector are expected to contribute private funding equivalent to at least half of the public funding they receive.

[67] Government bill 2016/17:66 *Forskning och innovation på energiområdet för ekologisk hållbarhet, konkurrenskraft och försörjningstrygghet.*

[68] Government bill 2016/17:50 *Kunskap i samverkan – för samhällets utmaningar och stärkt konkurrenskraft.*

[69] Government bill 2016/17:1 expenditure area 21 and prop. 2016/17:66 *Forskning och innovation på energiområdet för ekologisk hållbarhet, konkurrenskraft och försörjningstrygghet.*

Sweden is actively engaged in international negotiations and discussions to spread the message about its transition to a fossil-free welfare state, in which climate work creates innovations, increases competitiveness and improves health. Sweden must become a permanent global showcase for sustainable innovation in transport.

2.5.3 Where applicable, national objectives with regard to competitiveness

The commercial policy is designed to create jobs and encourage companies to grow, by fostering entrepreneurship and innovation and ensuring effective competition[70].

In its climate policy framework[71] the Riksdag states that Sweden must show that climate transition is compatible with welfare and good competition.

3. POLICIES AND MEASURES

3.1 Dimension decarbonisation

3.1.1 GHG emissions and removals

3.1.1.1 Policies and measures to achieve the target set under Regulation (EU) 2018/842 as referred in point 2.1.1 and policies and measures to comply with Regulation (EU) 2018/841, covering all key emitting sectors and sectors for the enhancement of removals, with an outlook to the long-term vision and goal to become a low emission economy and achieving a balance between emissions and removals in accordance with the Paris Agreement.

The above climate goals are affected by many European Union policy areas and measures, such as the EU ETS, the Fuel Quality Directive, emission requirements for new vehicles, the Fluorinated Greenhouse Gases Regulations, the Landfill Directive and the Common Agricultural Policy. These will not be discussed here.

They are also affected by many policy areas and measures for renewable energy and energy efficiency (see Section 3.1.2 and 3.2) and the reduction of greenhouse gas emissions in Sweden. Table 7 summarises the key policies for achieving climate goals.

Table 7. Summary of key policies and measures for achieving the 2030 climate goals (EU policies are in bold type).

[70] https://www.regeringen.se/regeringens-politik/naringspolitik/.

[71] Government bill 2016/17:146 Report 2016/17:MJU24, Riksdag communication 2016/17:320.

Cross-sectoral	Energy supply	Housing and services	Industry	Transport	Waste	Agriculture	Forestry
Energy and Carbon Tax	Energy and Carbon Tax	Energy and Carbon Tax	Energy and Carbon Tax	Energy and Carbon Tax	Ban on dumping flammable and organic waste	**CAP**	The Forestry Act
EU ETS	Waste Incineration Tax	**Ecodesign Directive**	**EU ETS**	**Emission requirements for new vehicles**	Collection of measurement data from dumps	Rural Development Programme	Land drainage rules under the Environmental Code
Klimatkliv (Climate Stride) funding initiative	**EU ETS**	**Energy Labelling Regulation**	*Industrikliv* (Industrial Stride) funding initiative *Energisteg* (Energy Step) funding programme	Reduction obligation	Waste tax	The Rural Development Network	Forest and land protection under the Environmental Code and nature conservation agreements
Environmental Code	Electricity certificates system	Building regulations		Bonus-malus system	Producer responsibility	Advice	
Planning and Building Act	Wind power initiative	Energy and Climate Advisory Service		CO_2-based vehicle tax	Municipal waste planning	Support for biogas from manure	National Forest Programme
Fossil-Free Sweden	Support for solar energy	Energy declarations	Requirements and support for energy mapping	Lower taxable value for vehicles with environmental technology	**EU waste package**	Biogas support	Advice and education
Communication		Education programme for low-energy buildings	Energy and climate coaches	Pump Act			**CAP**
Energy and Climate Advisory Service		Client groups and networks	Energy-efficiency network	Environmental information about fuels			
Regional energy and climate plans			Environmental Code	Climate incentive payment			
The European Regional Development Fund			**F-Gas Regulation and BREF**	Urban Environment Agreement			
Research and demonstration				Infrastructure planning			
Procurement rules				Eco-bonus system for shipping			
				Procurement rules			
				Tax on air travel			
				EU ETS (flights)			

Cross-sectoral policies and measures

Energy Tax and Carbon Tax

The Swedish energy taxation system combines a carbon tax with a fuel tax and an electricity tax. The main taxes affecting greenhouse gas emissions in Sweden are the carbon tax and the fuel tax. These are described in general terms below; a more detailed description is given for each sector.

A carbon tax, based on the fossil content of fuel, was introduced in Sweden in 1991 to reduce carbon dioxide emissions. The tax has been increased in stages since it was first introduced. Overall, it has increased from SEK 0.25/kg CO_2 (1991) to SEK 1.18/kg CO_2 (2019). Besides specific tax increases introduced by the Riksdag in response to proposals in Government bills, the tax rates are indexed annually on the basis of earlier legislation. Carbon tax is not deducted on biofuels, which are not covered by the reduction obligation for petrol and diesel.

Some sectors are taxed at a reduced rate, or are exempt from tax, because of the risk of carbon leakage, in other words a business or its emissions moving outside the country's borders.

Energy has been taxed for many years in Sweden[72]. Energy taxes on petrol and diesel were introduced in 1924 and 1937 respectively. An energy tax was first imposed on heating fuel and electricity in the 1950s. The purpose of energy taxes was initially purely fiscal, but for a long time they have also been used to bring energy consumption into line with Sweden's energy efficiency and renewable energy goals[73]. The energy tax on motor fuels is also designed to absorb external traffic-related costs, such as wear to road surfaces and noise. The energy tax on fuel varies depending on whether it applies to motor fuel or heating fuel. The level of taxation on heating fuels also varies between the domestic, industrial and energy supply sectors (see Section 3.2 for current levels of taxation).

Both energy and carbon tax are charged on petrol and diesel for road vehicles, machinery, private vehicles and aircraft. To take account of inflation and economic developments, energy and carbon taxes on fuel are also adjusted to reflect changes in the Consumer Prices Index (CPI) and Gross Domestic Product (GDP)[74].

In some cases, Sweden applies a tax reduction for sustainable biofuels. All high-blend sustainable biofuels are exempt from both energy tax and carbon tax. Sweden has state aid approval for current tax relief on high-blend liquid biofuels and biogas until the end of 2020[75]. Biofuels blended into gasoline or diesel are covered by the reduction obligation (see the section on the transport sector below) and therefore subject to the same tax per litre as the fossil fuels they are blended with. The carbon tax on the finished fuel has been determined on the basis of the average fossil carbon content, taking account of the target for the average content of blended biofuel (see Section 3.2 for the current levels of taxation).

There is no energy or carbon tax on fossil fuel for national and international commercial shipping and aviation.

Both energy and carbon tax is applied to fuel used for heating. Biofuel is exempt from both taxes. Other fuels used to generate heat in combined heat and power (CHP) and other heat generation plants within the EU ETS are subject to 91% carbon tax and the full rate of energy tax. The rate for CHP plants has increased significantly since 1 August 2019, when the fuel was subject to an 11% carbon tax and 30% energy tax. CHP plants outside the

[72] Energy tax is a collective term for excise duties on fuel and electricity and is governed by the Energy Tax Act, see (1994:1776).

[73] The energy efficiency goal and the renewable energy goal for 2020 are set out in Government bill 2008/09: 162 and 163.

[74] The annual adjustment of tax rates for petrol and diesel takes account of changes in GDP by applying a flat-rate of 2% in addition to the CPI adjustment. This additional adjustment is applied both to energy and carbon tax but is expressed as an increase in energy tax. This additional indexation was neutralised in the petrol and diesel tax adjustment in 2020. 2019/20:1 expenditure area 22).

[75] C(2015) 9344 final, C(2015) 9345 final.

EU ETS pay the full rate of energy and carbon tax on the fuel used to generate heat. This is also an increase, as only 30% energy tax was paid on this fuel until 1 August 2019 (see Section 3.2 for current levels of taxation).

The fuel used to generate electricity is exempt from both energy and carbon tax, but electricity consumption is generally subject to the energy tax on electricity (see Section 3.2 for current levels of taxation).

Some energy and carbon tax exemptions and reduction are applied to industry, mainly because most of the manufacturing sector is already covered by the EU ETS. These parts of the manufacturing sector pay 30% of the general energy tax on heating fuel and are completely exempt from carbon tax. The parts of the manufacturing sector outside the EU ETS also pay 30% of the energy tax on the heating fuel used in the manufacturing process. These sectors previously paid significantly less carbon tax, but this has gradually increased in recent years. The tax reduction was removed entirely in 2018 and carbon tax is now applied in full.

Until 31 July 2019, energy and carbon tax on diesel for on-track machines (OTMs) in the mining industry ('mining diesel') was charged at 11% and 60% of the general levels of taxation respectively. This energy and carbon tax reduction was abolished on 1 August 2019 (see Section 3.2 for current levels of taxation).

The agriculture, forestry and aquaculture sectors pay 30% of the general energy tax on heating fuel. Carbon tax reductions were also applied to these sectors, but they have been reduced gradually and the full carbon tax has applied since 2018.

A special reduction of the carbon tax on diesel for machinery in the agriculture, forestry and aquaculture sectors has been reduced gradually from SEK 2.10 a litre (2011) to SEK 1.43 a litre (up to 30 June 2019). From 1 July 2019 to 31 December 2019 the tax reduction was increased again to SEK 2.24 a litre. Energy tax on this fuel was reduced to SEK 0.19 a litre in the same period.

The Klimatkliv

Since 2015, all types of organisation, except for those belonging to the EU ETS, have been able to apply for local climate investment.[76] The candidates compete for this investment on the basis of the estimated reduction in greenhouse gas emissions per krona. Examples of eligible investments are

[76] Investments in sectors within the EU ETS may still be eligible if they increase the utilisation of waste heat.

charging infrastructure for electric vehicles, biogas plants, switching from fossil oil to biofuel or district heating, the expansion of smaller district heating networks, destruction of nitrous oxide in the healthcare sector, cycle paths and cycling infrastructure. In 2019, the Government budgeted SEK 1.5 billion for the *Klimakliv* initiative.

The Environmental Code and the Planning and Building Act

The horizontal environmental legislation is collected in the Environmental Code, which has the overall purpose of promoting sustainable development. The code is applied with reference to Sweden's environmental quality goals, including Limited Impact on the Climate (see Section 2.1.1 for this goal). The Environmental Code includes general rules to be followed by all operations and measures. It also contains a requirement to use the best available technology. Large environmentally hazardous operations require a permit. The process for granting a permit includes an assessment of direct and indirect environmental impact and energy management and, for installations that are not part of the EU ETS, an assessment of greenhouse gas emissions. However, requirements for greenhouse gas emissions may not be imposed on operations that are part of the EU ETS.

Land-use planning is governed mainly by the Planning and Building Act (2010:900), which requires environmental and climate aspects to be taken into account in planning. Some infrastructure projects are assessed under the Environmental Code instead, either directly or by reference from other legislation.

Communication about climate matters

The Swedish authorities have many years of experience with using communication as a policy for the public sector, business and the general population. Examples include the following:

- the Swedish Environmental Protection Agency's website www.naturvardsverket.se is a hub for facts and statistics about emissions and is widely used by politicians, the media, companies, organisations and researchers;
- the Swedish Meteorological and Hydrological Institute (SMIH) develops and distributes information about weather, water and climate change; the Swedish National Knowledge Centre for Climate Change Adaptation, part of the SMHI, has launched a Swedish climate change portal, providing information and guidance on adaptation to a warmer climate;
- the Swedish Energy Agency is responsible for giving energy efficiency information and advice to companies and the general population and for providing a reliable and

sustainable energy supply; it also runs an informative website and assists with local energy advice (for more information, see Energy and climate advisory services below);

- the Swedish Forest Agency and the Swedish Board of Agriculture focus on e-services and digital information for land and forest owners, forestry workers and farmers about reducing the impact of climate on forestry and agriculture; and
- The Swedish Transport Administration is tasked by the Government with providing information and raising awareness to help meet the domestic transport milestone and creating the conditions for Sweden to meet its net zero emissions target by 2045.

Fossil-Free Sweden

The Government's Fossil-Free Sweden initiative was launched in 2016 to improve dialogue between the Government and business, municipalities, other public operators and civil society[77].

The Government has appointed a national coordinator for Fossil-Free Sweden who acts as a link between the operators and the Government to remove obstacles and accelerate the reduction in greenhouse gas emissions. The initiative is an important platform for dialogue and cooperation between major operators for a competitive climate transition.

It currently involves around 400 operators and is open to anyone who supports the declaration. The operators involved in the initiative share the belief that the world must be fossil-free and that Sweden must take a lead on this. The declaration also commits operators to take certain specific actions to reduce emissions.

The initiative includes sectoral roadmaps which highlight the commercial possibilities for companies and sectors to become fossil free. Fourteen of these roadmaps were presented to different sectors in 2018–2019. They are a good basis for constructive cooperation between the Government and business on the path to the joint climate goals.

The work includes giving advice and publicising the vision for a fossil-free society, highlighting the opportunities presented by the transition.

Energy and climate advisory services

[77] http://fossilfritt-sverige.se/.

The Swedish Energy Agency provides municipalities with Government funds so that they can give local climate and energy advice to private individuals and small businesses. Almost every Swedish municipality has a local climate and energy advisor, who provides objective information tailored to the locality and advises on energy efficiency measures, energy consumption and climate-related issues in buildings and households.

The Swedish Energy Agency also gives financial assistance to the 15 regional energy offices which coordinate the energy and climate advisors. The energy offices initiate and participate in many energy efficiency and renewable energy projects funded by the EU, the county councils, regional associations and other organisations. The offices work regionally with companies, county councils, municipalities and others bodies, for example on producing plans and strategies.

Regional climate and energy strategies

The county councils coordinate regional climate and energy initiatives and support regional operators, for example by gathering and disseminating information. The county councils have worked with other regional and local operators on regional climate and energy strategies based on the long-term energy and climate policy targets adopted by the Riksdag, with the aim of producing effective measures and synergies. The county councils also contribute to environmental assessments and environmental monitoring, local and regional town and country planning, regional development and growth policy and infrastructure planning.

Public procurement

There is great potential for using public procurement to reduce emissions and promote innovative and climate-smart solutions.

In its national procurement strategy, the Government stated that Sweden must lead the way and continue to set the standard for green public procurement, and that the life-cycle should be considered in every phase of procurement. The new procurement legislation, including the Public Procurement Act (2016:1145), explains how environmental and climate aspects can be taken into account.

The transport sector

Reduction obligation – switching fuels

An obligation to reduce petrol and diesel consumption was introduced on 1 July 2018 to promote the use of biofuels[78]. All fuel suppliers must therefore reduce the greenhouse gas emissions of petrol and diesel over their entire

[78] Act (2017:1201) on Reducing Greenhouse Gas Emissions by Adding Biofuels to Petrol and Diesel.

life-cycle by a certain percentage every year by gradually increasing the amount of added biofuel (see Table 8). The reduction obligation makes an important contribution to phasing out fossil fuels in transport.

Table 8. 2018–2020 reduction levels under the Reduction Obligation Act[79].

Year	2018	2019	2020
Diesel	19.3%	20%	21%
Petrol	2.6%	2.6%	4.2%

The Government has asked the Swedish Energy Agency to suggest reduction levels for 2021–2030. It has also examined whether the same reduction should apply to petrol and diesel and whether or not high-blend biofuels should be included in the reduction obligation. The report on this task was submitted in June 2019[80] and it was completed on 25 October 2019. The process for successively increasing the reductions after 2020 is continuing.

Bonus-malus system for new light-duty vehicles

A bonus-malus system has been in force in Sweden since 1 July 2018. The system means that purchases of low carbon vehicles qualify for a bonus, while high carbon vehicles are subject to a higher rate of vehicle tax for the first three years. A carbon-based vehicle tax is applied from year four onwards (see below). The system covers purchases of new cars, light-duty buses and light-duty trucks. From 1 January 2020, vehicle tax and the bonus for new vehicles will be based on the Worldwide Harmonised Light Vehicle Test Procedure (WLTP), a new, more accurate method for measuring a vehicle's fuel consumption. Since the new method generally produces higher emission measurements, the changeover will lead to tougher environmental governance.

Carbon-based vehicle tax

To give buyers an incentive to choose cars, light-duty trucks, light-duty buses and mobile homes with low greenhouse gas emissions, Sweden applies different annual tax rates based on the vehicle's carbon emissions per kilometre, which means that vehicles with low carbon emissions are taxed at a lower rate than those with high emissions. This tax applies to vehicles purchased before the bonus-malus system was implemented in July 2018 and will continue to apply to vehicles that 'leave' the bonus-malus system three years after purchase.

Lower taxable value for vehicles with environmental technology

Company cars account for 50% of new vehicle registrations in Sweden and employees can use a large proportion of them privately. The benefit of using

[79] Act (2017:1201) on Reducing Greenhouse Gas Emissions by Adding Biofuels to Petrol and Diesel.

[80] The Swedish Energy Agency – *Kontrollstation 2019 för reduktionsplikten* (ER 2019:27).

an employer's car for private travel is generally taxable and the value is calculated on the basis of a separate rate. Under a rule introduced to support the introduction of environmentally friendly cars to the market, the value of environmentally friendly company cars is reduced to the price of the closest comparable new car without that technology. The taxable value of electric cars, plug-in hybrids and cars that run on gas (excluding gasoil) can be reduced even further.

Requirements for biofuels at filling stations – The Pump Act

To improve the availability of renewable fuels, Sweden has passed a law[81] requiring filling stations with sales of over 1 500 m3 of petrol or diesel to offer at least one type of renewable fuel.

Environmental information about fuels

The Government has amended the Fuels Ordinance (2011:346) to enable consumers to obtain information about the origin and environmental impact of fuels at the pump. The Ordinance obliges fuel suppliers to provide consumers with information based on their annual reports to the Swedish Energy Agency under the Fuels Act (2011:319).

The environmental information must be available at the pump and must provide a summary of a fuel's greenhouse gas emissions over its entire life-cycle, its raw materials and their country of origin. More details can be found on the fuel supplier's websites. Small fuel suppliers are exempt from the requirement to provide information to avoid the excessive administrative costs they would incur. The information requirement will therefore be voluntary for companies supplying less than 1 500 m3 of liquid or 1 000 000 m3 of gaseous fuels a year.

The Swedish Energy Agency is currently developing detailed requirements for the environmental information. The information requirement will come into force in May 2020.

Electric bus incentive payment becomes a climate incentive payment

The regional public transport authorities (municipalities and companies which the regional public transport authorities have authorised to enter into public transport contracts) and private operators of public transport services can apply for an electric bus incentive payment. This payment applies to electric buses, plug-in hybrid buses, trams and fuel cell buses for public transport.[82] The amount of the payment depends on the number of passengers and whether the buses are electric only or hybrid. It is designed to support the introduction of electric buses to the market. The budget for

[81] Act (2005:1248) on the obligation to provide renewable fuels.

[82] Ordinance (2016:836) on Electric Bus Incentive Payments.

the electric bus incentive payment in 2019 is SEK 80 million.

From 2020, the electric bus incentive payment will become a climate incentive payment. This will make it possible to apply for support for electric trucks and other environmentally friendly trucks and electric machinery as well as electric buses; in combination with the continuing support for electric buses this will promote the introduction of these vehicles to the market. The budget for this will be increased to SEK 120 million in 2020.

Urban Environment Agreement

In 2015, the Government introduced a special grant for sustainable urban environments, the Urban Environment Agreement. The grant is intended for municipalities and county councils and amounts to SEK 1 billion a year for 2018–2029, or SEK 12 billion in total. The Urban Environment agreement is financed via the economic framework of the 2018– 2029 National Transport Infrastructure Plan. The measures are intended to produce energy-efficient solutions with low greenhouse gas emissions and contribute to achieving the environmental quality goal *High Quality Built Environment*. The grant provides municipalities and county councils with up to 50% Government funding for infrastructure for public transport and, since 2017, for cycling. In April 2019, the Government decided to amend the Ordinance (2015:579) on Support for Sustainable Urban Environments to include goods transport measures in the Urban Environment Agreement. The amendments came into force on 22 May 2019. Municipalities and county councils which have been given grants must use them to increase the proportion of sustainable transport or build more houses.

Sustainable cities with a focus on climate-smart mobility

The Government has appointed the Swedish Energy Agency as main project manager and administrator of the Nordic Council of Ministers' Sustainable Nordic Cities project, focusing on climate-smart mobility. The project will consist of five sub-projects:

1. the launch and the concluding conference on sustainable cities, focusing on climate-smart travel and transport;
2. the presentation of good examples and recommendations for ways of increasing the number of zero-emission vehicles in cities;
3. discussions, exchanges of experience and recommendations for promoting attractive and climate-smart transport in cities;
4. exchanges of experience and attempts to find solutions for charging electric vehicles in cities; and
5. development of a database of electric vehicle charging

stations.

The Government has commissioned the Swedish Transport Administration to lead the sub-project on attractive and climate-smart transport in cities. It must submit a report on its work to the Infrastructure Department by 15 March 2021.

Long-term infrastructure planning

In May 2018 the Government decided to introduce a new national transport infrastructure plan for all modes of transport for 2018–2029. The Swedish Transport Administration is responsible for long-term planning for all modes of transport and for implementing the plan. The plan will be prepared in consultation with municipal and regional authorities and other stakeholders.

Eco-bonus system for shipping

Since 2018 the Government has allocated funding to an eco-bonus system to encourage the transfer of goods transport from roads to shipping. The aim is to reduce the greenhouse gas emissions from the transport of goods. In its draft budget for 2020, the Government proposed extending the system until 2022 with an allocation of SEK 50 million a year.

National goods transport strategy

In June 2018 the Government decided to introduce a national goods transport strategy[83]. The strategy highlights three priorities for further work. There are action areas for each priority, subdivided into six action areas for Competitive and Sustainable Goods Transport, five for Transition to Fossil-Free Transport and three for Innovation Competence and Knowledge. The Government has issued a number of assignments under the goods transport strategy. It has also set up a national goods transport council.

Electrification commission

The Government will commit SEK 5 million a year until 2022 for an electrification commission to accelerate work on the electrification of the transport sector[84]. The electrification commission will help to accelerate investments in electric roads, charging infrastructure for electric trucks and other effective applications. The commission will also shed light on matters related to funding, how quickly roads can be electrified, and the effects of converting goods transport on the electricity supply. It will work with the business community and relevant stakeholders, as a matter of urgency, to produce an action plan for electrification of Sweden's busiest roads and will investigate other electrification options.

[83] https://www.regeringen.se/regeringens-politik/nationell-godstransportstrategi/.

[84] https://www.regeringen.se/artiklar/2019/09/sarskilda-satsningar-i-hostbudgeten-inom- infrastrukturdepartementets-politikomraden/.

Electric roads

Electric roads are infrastructure for dynamic charging, in other words charging en route. Depending on the technology chosen, they can be used by trucks, buses and cars. A demonstration project is being carried out on the E16 outside Sandviken (heavy goods vehicles) and at Arlanda airport (heavy goods vehicles and cars). In April 2019, the Swedish Transport Administration decided to launch two more demonstration projects, which are currently being carried out in Lund (public transport) and on Gotland (heavy goods vehicles and public transport). The demonstration project on Gotland uses induction, so there is no need for a fixed connection with the vehicle, while the other projects use conduction, so the vehicle has to be physically connected to the electricity supply. The Swedish Transport Administration is currently preparing to build the first permanent electric road. The Government believes that electric roads will increase the efficiency of goods transport and reduce greenhouse gas emissions. It therefore intends to develop a long-term plan to construct and expand electric roads. Major goods routes and links to ports should be prioritised. The need for complementary technologies to allow vehicles to run on electricity outside the electric road network, for example rapid charging points for heavy goods traffic, should be addressed in future work.

Public procurement of transport

Since 2009 the cars purchased or leased by public authorities have had to be environmentally friendly[85]. Many municipalities and companies voluntarily apply the same requirements when purchasing or leasing vehicles.

The Vehicle and Public Transport Service Procurement (Environmental Requirements) Act (2011:846) sets out the criteria to be met for the public procurement of cars and public transport services. These criteria aim to reduce environmental impact by setting requirements for aspects such as energy consumption and emissions.

According to FRIDA, the Swedish Environment and Vehicle Database for Public Transport[86] around 85%[87] of public transport ran on renewable fuels in 2018. Statistics from the Swedish Confederation of Transport Enterprises[88] show that 63% of busses ran on fuels other than conventional diesel in 2017.

Procurement authorities apply criteria for public procurement of passenger transport, goods transport, fuel, tyres, public transport and vehicles[89] which help those procuring transport to set requirements.

[85] The Ordinance (2009:1) on Environmental and Road Safety Requirements for Cars and Car Journeys by Public Authorities.

[86] https://www.svenskkollektivtrafik.se/verktyg-och-system/frida-miljo-och-fordonsdatabas/.

[87] Percentage of vehicle kilometres with renewable fuels.

[88] Statistics for the bus sector, Swedish Confederation of Transport Enterprises.

[89] https://www.upphandlingsmyndigheten.se/hallbarhet/stall-hallbarhetskrav/fordon-och-transport/.

Coordination of charging infrastructure and renewable fuels which require specific infrastructure

The Swedish Energy Agency is tasked with coordinating support for the vehicle charging and renewable fuels infrastructure and providing information about the location of charging stations and filling stations for biodiesel, E85 and ED95, vehicle gas and hydrogen. This includes support for the Swedish Environmental Protection Agency under the *Klimakliv* initiative along with expertise and advice on setting priorities, information about the geographical distribution and assessment of support granted. As part of its coordination work, the Swedish Energy Agency has held discussions with the county councils about developing regional plans for the renewable fuels infrastructure.

It has focused its work on the charging infrastructure on increasing the capacity of society operators, by involving relevant operators in the development of a suitable charging infrastructure. In its work on the renewable fuels infrastructure it has focused on collecting knowledge and experience of renewable fuels which require specific infrastructure by increasing access to relevant and reliable information about the infrastructure for various operators.

Rapid charging along major roads

In response to the Government's proposal in the draft budget for 2020, the Riksdag has introduced support for rapid charging infrastructure along major roads to cover the large areas which do not have this infrastructure yet[90]. The Government proposes spending SEK 50 million over three years on this expansion.

The county councils' task to prepare regional plans for infrastructure for electric vehicles and renewable fuels

In its 2018 spending authorisation, the Government tasked county councils with preparing regional plans for infrastructure for electric vehicles and renewable fuels. This is part of the county councils' long-term leadership and coordination of regional work in all areas relevant to the energy transition and reduced climate impact. A report on the regional plans must be submitted by 31 January 2020.

Measures to improve information and raise awareness of the transition to a fossil-free transport system

In April 2019, the Government tasked the Swedish Transport Administration with taking measures to improve information and raise awareness of the transition to a fossil-free transport system. These measures

[90] Government bill 2019/2020:1 expenditure area 21, Report 2019/20:NU3, Riksdag communication 2019/20:110.

are intended to contribute to meeting the Riksdag's climate target of reducing the 2010 levels of greenhouse gas emissions from domestic transport, excluding aviation, by at least 70% by 2030, and to enable Sweden to achieve net zero emissions by 2045.

This project will continue until 31 December 2022, but the Swedish Transport Administration must submit a report by 30 June 2021 outlining the measures that should be taken to improve information and raise awareness of the transition to a fossil-free transport system during the rest of the planning period (2023–2029). The Swedish Transport Administration's main tasks for this project are:

- to hold an annual conference to discuss progress towards meeting the Riksdag's climate target for transport;
- to prepare an annual summary of ongoing work, concentrating on measures which may produce significant climate benefits, which are to be used by the relevant authorities and operators when planning and implementing their work on the climate target for transport; and
- to create an arena for access to fossil-free fuels and efficient transport in cities, provide more information about owning and driving electric vehicles to encourage electrification of the transport system, and take measures to improve information and raise awareness to help the municipalities and county councils to develop their climate requirements for procurement of transport infrastructure.

Tax on air travel

On 1 April 2018 a tax on air travel was introduced in Sweden to reduce its impact on the climate[91]. The tax is levied on commercial air travel and must be paid for passengers travelling from an airport in Sweden by the air carrier with which they are travelling.

The amount of the tax depends on the passenger's final destination (in 2020: SEK 62, 260 or 416).

Night trains abroad

The Government wants to give people a better choice of public transport with a low climate impact. On 11 July 2019 it tasked the Swedish Transport Administration with investigating the possibility of providing daily night train services to several European cities. It must submit proposals for the transport to be procured, prepare a timetable for implementation and assess the cost to the state. It must also investigate other options for providing night train services abroad and for the state to contribute to replacing the

[91] Air Travel (Tax) Act (2017:1200).

transport procured with a commercially operated service as soon as possible. The Swedish Transport Administration must submit an interim report of its findings by 15 January 2020 and a final report by 20 April 2020.

The waste sector

Ban on dumping combustible and organic material and methane collection

The dumping of combustible and organic waste is banned under the Ordinance (2001:512) on the Dumping of Waste. The Ordinance also governs the collection and disposal of methane from landfill sites.

Waste Tax Act

A tax on waste disposed of in landfill sites was introduced in 2000[92]. The tax has increased gradually and has been indexed at 2% above CPI a year since 2019. In 2019 the tax is SEK 520 per tonne of waste taken to a landfill site.

Producer responsibility

The producer responsibility legislation contains national recycling targets; eight product groups are covered by a number of ordinances[93]. Producer responsibility promotes the sorting, collection and recycling of waste streams. It also aims to reduce the amount of waste and to give producers an incentive to develop more resource-efficient products, which are easier to recycle and do not contain substances that are harmful to the environment.

Municipal waste plans

Under the Environmental Code, municipalities must have a waste plan which covers all types of waste and sets out the measures required to manage waste in an appropriate way to protect the environment and conserve resources. The waste plan must also include measures to reduce the amount and hazardousness of waste[94].

The forestry sector

The 2014–2020 Rural Development Programme

The Rural Development Programme for 2014–2020, which is part of the EU's Common Agricultural Policy (CAP), includes investments for young entrepreneurs, capacity building, cooperation and innovation, and support for organic farming, environmental and climate measures, and animal welfare. Measures specifically intended to reduce greenhouse gas emissions are those designed to increase energy efficiency, the product and use of

[92] Waste Tax Act (1999:673).

[93] The Ordinance (2018:1462) on Producer Responsibility for Packaging, the Ordinance (2018:1463) on Producer Responsibility for Recovered Paper, the Ordinance (2007:185) on Producer Responsibility for Cars, the Ordinance (1994:1236) on Producer Responsibility for Tyres, the Ordinance (2014:1075) on Producer Responsibility for Electrical Equipment, the Ordinance (2008:834) on Producer Responsibility for Batteries, the Ordinance (2009:1031) on Producer Responsibility for Medicinal Products and the Ordinance (2007:193) on Producer Responsibility for Certain Radioactive Products and Orphan Sources.

[94] The Swedish Environmental Protection Agency's Regulations (2006:6) for Municipal Waste Prevention and Management Plans.

renewable energy (including the production of biogas and the planting of perennial energy crops), conversion from fossil to renewable energy sources, improved manure management, more efficient nitrogen use, climate and energy advice, measures to prevent nitrogen leaks, restoration and establishment of wetlands, promotion of forage and catch crops on agricultural land, the conservation of natural pastures and other separate climate and energy projects. The budget for the whole duration of the programme is SEK 36 billion, 59% of which is funded by Sweden and the remaining 41% by the EU.

The Rural Development Network

The Rural Development Network completes Sweden's Rural Development Programme. The Network brings together local, regional and central operators to exchange information and experience, with the aim of improving the implementation of its EU-related programme. The Government has given the Swedish Board of Agriculture the task of ensuring that the Rural Development Network operates effectively.

Advice on plant nutrients – 'Keeping Hold of Nutrients'

The Swedish Board of Agriculture offers an advisory service called 'Keeping Hold of Nutrients' together with the Federation of Swedish Farmers and the county councils. The service is funded by the Regional Development Programme and has been giving advice on increasing the efficiency of nutrients to reduce leaching since the beginning of 2001. It also gives advice specifically on reducing greenhouse gas emissions, which is one of its main objectives, and on energy efficiency.

Support for biogas from manure

Since 2015 there has been a support system for production of biogas from anaerobic digestion of manure[95]. The support aims to increase the production of biogas from manure, obtaining twice the environmental and climate benefits by reducing methane emissions from manure and replacing fossil energy. Many environmental benefits can be obtained by digesting more manure. It reduces greenhouse gas emissions and eutrophication of fresh and marine water and produces biogas which can be used as energy. The biogas obtained can be used to generate electricity or heat and as a fuel for vehicles. The maximum support is SEK 0.40 per kWh of biogas produced. The Rural Development Programme can also provide support for investment in new biogas plants.

Biogas support

In 2018, temporary support was introduced for production of biogas upgraded to vehicle gas (biofuel) which was not produced from sewage

[95] The Ordinance (2014:1528) on State Support for the Production of Biogas.

sludge or landfill gas[96]. To improve competition in the sector, and in response to the Government's proposal in the revised budget in autumn 2019, the Riksdag decided that a total of SEK 100 million in support should also be paid out for this type of biogas production in 2019[97].

Land Use, Land-Use Change and Forestry (LULUCF)

The Forestry Act

The Forestry Act (1979:429) has two overall objectives of equal importance: to support production and to protect the environment The production objective is to use forests and woodlands efficiently and responsibly so that they provide a sustainable yield. Forestry production must focus on flexible use of forestry products. The environmental objective is to preserve the natural productive capacity of woodlands. The bio- and genetic diversity of forests must be secured. Forests must be managed in a way that allows viable populations of naturally occurring plant and animal species to survive under natural conditions. Endangered species and habitats and heritage forests and their aesthetic and societal value must be protected.

Rules for land drainage

The Environmental Code contains rules for land drainage which can also be used to reduce emissions from this land. Land drainage is carried out to remove water from the land or to protect it from water. For measures to be classified as land draining as defined in the Environmental Code, they must be intended to make the land more suitable for a particular long-term purpose, such as cultivation, development, peat cutting, road construction, landscaping or golf courses.

Since 1986, a permit has been required for land drainage under the Environmental Code. Land drainage is forbidden in large areas of Southern Sweden, where it is particularly important to preserve wetlands. This means that conservation measures are stricter and there is a two-stage process for land drainage permits. Applicants must first obtain an exemption from the land drainage ban and then permission for drainage. Land drainage is prohibited in the rest of the country and on sites protected under the Ramsar convention[98].

Provisions for nature reserves and protection of natural habitats in the Environmental Code and conservation agreements

In Sweden forests and land are set aside for the conservation of biodiversity, the care and conservation of valuable natural habitats, the protection,

[96] See the Ordinance (2018:1501) on State Support for the Production of Biogas for Use as Biofuel.

[97] Government bill 2019/20:2, Report 2019/20:FiU11, Riksdag communication 2019/20:60.

[98] The Ramsar convention is a global convention for the conservation of wetlands and aquatic environments and uses them sustainable: https://www.naturvardsverket.se/Miljoarbete -i-samhallet/EU-och- internationellt/Internationellt-miljoarbete/miljokonventioner/Vatmarkskonventionen/.

restoration or creation of valuable natural habitats and for open-air recreation. These measures in the form of nature reserves, conservation agreements and voluntary setting aside of land also benefit carbon storage in forest biomass and land carbon, by maintaining or increasing it.

In Sweden and many other countries, nature reserves[99] are one of the most common ways of protecting valuable natural environments in the long term. At the moment there are nearly 5 000 nature reserves in Sweden. Chapter 7 of the Environmental Code contains provisions for the establishment of nature reserves. The Swedish Environmental Protection Agency is in charge of this work.

Conservation agreements

Conservation agreements[100] are civil-law agreements under which the state or a municipality agrees to pay property owners a certain amount of money not to use land for forestry, for example. The Swedish Forest Agency and the Swedish Environmental Protection Agency provide joint guidance on setting up these agreements. It should not make any difference which authority a landowner makes an agreement with.

Sweden's National Forest Programme

The Government adopted the strategy for Sweden's National Forest Programme[101] on 17 May 2018. The strategy is governed by the Programme's vision: 'Forests – green gold – must provide jobs and sustainable growth for the whole country and contribute to the development of a growing bioeconomy.' An action plan, containing specific measures based on the Forest Programme's vision and objectives, has been developed[102] for the strategy. The availability of sustainable biomass from Swedish forests has an important part to play in the transition to a fossil-free society. The action plan contributes to Sweden's climate work by establishing targets and measures to increase the national supply of bio-based alternatives.

Advice, education and training on forest management

The Swedish Forest Agency provides forest owners with information about how climate change will affect their forests. It also issues guidance on how owners can best use and manage their forests to achieve their specific aims.

The energy supply sector

[99] http://www.naturvardsverket.se/Var-natur/Skyddad-natur/Naturreservat/.

[100] http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Skyddad-natur/Naturvardsavtal/.

[101] https://www.regeringen.se/49bad6/contentassets/34817820f e074cb9aeff084815bd3a9f/20180524_hela.pdf.

[102] https://www.regeringen.se/4a095b/contentassets/7cbc4c534fb3457385ff1d7f32e3e512/handlingsplan-for-sveriges-nationella-skogsprogram-2018.pdf.

Policies and measures for this sector are described in Section 3.1.2.

The housing and services sector

Policies and measures for this sector are described under the dimension Energy Efficiency in Section 3.2.

The industry sector

The '*Industrikliv*' is a state initiative which assists Swedish industry with the development of technologies and processes for reducing process-related greenhouse gas emissions. It is described under Research, innovation and competitiveness in Section 4.6.

Other policies and measures for the sector are described in the dimension for energy efficiency in Section 3.2.

3.1.1.2 Where relevant, regional cooperation in this area.

On 1 January 2019, the prime ministers of the Nordic states adopted a declaration undertaking to make their countries carbon neutral. The declaration highlights many areas for increased Nordic cooperation and work has started on identifying potential new areas. In August 2019, the prime ministers adopted a new vision for Nordic cooperation which aims to make the Nordic region the world's most sustainable and integrated region by 2030. Action on the climate is also at the heart of this vision. Nordic companies and sustainability solutions have great potential to play a key role in the green conversion of the global economy.

Nordic experience and know-how can help to promote higher ambitions under the Paris Agreement and encourage dialogue with other countries in international negotiations. The objective of the Nordic Environmental and Climate Cooperation Programme for 2019–2024, which was negotiated under Sweden's leadership, is therefore that the Nordic countries should contribute to the ambitious implementation of the Paris Agreement and continue to take a leading role in the necessary climate transition.

During its presidency of the Nordic Council of Ministers in 2018, Sweden took the initiative to promote closer cooperation on sustainable Nordic cities. The presidency project to promote the transition to climate-smart mobility in cities and sustainable solutions for the Nordic region with a focus on building in wood and sustainable architecture and design runs from 2018–2020 and will increase the exchange of information and joint actions.

The Nordic Environment Finance Corporation (NEFCO) plays an important part in the green transition. NEFCO's focus on climate, green

growth, the Baltic Sea and the Arctic and Barents Sea are entirely in line with the Government's priorities. It is also the only Nordic institution with Green Climate Fund (GCF) accreditation, which enables Nordic operators to carry out climate measures in cooperation with the fund.

Nordic cooperation as a priority for the Government, which is working to intensify it.

3.1.1.3 Without prejudice to the applicability of State aid rules, financing measures, including Union support and the use of Union funds, in this area at national level, where applicable

3.1.2 Renewable energy

3.1.2.1 Policies and measures to achieve the national contribution to the binding 2030 Union target for renewable energy and trajectories as referred to in point (a)(2) Article 4, and, where applicable or available, the elements referred to in point 2.1.2 of this Annex, including sector- and technology-specific measures.

The electricity certificates system

The aim of the electricity certificates system[103] is to stimulate the growth of renewable electricity. The system was introduced in Sweden in 2003 and has been operated jointly with the other Nordic countries since 2012. The countries have a common goal to use the system to increase renewable electricity generation to 28.4 TWh by the end of 2020. Sweden has undertaken to fund 15.6 TWh and Norway 13.2 TWh, but it is up to the market to determine when and where the new electricity will be generated.

In June 2017 the Swedish Government decided to extend the electricity certificate system until 2045 and to increase it by 18 TWh by 2030. Norway's target for 2020 is the same and no new target will be introduced in Norway after 2020.

Sweden is funding the higher target of 18 TWh, which will be achieved by applying a linear increase of 2 TWh a year from 2022 until 2030.

The electricity generators that fulfil the requirements of the Electricity Certificates Act (2011:1200) receive an electricity certificate for each megawatt hour (MWh) of electricity they generate, which they can then sell on the open market. There is a demand for electricity certificates because all electricity suppliers and some consumers are obliged to buy them for a

[103] http://www.energimyndigheten.se/fornybart/elcertifikatsystemet/.

certain amount (quota) of the electricity they sell or consume. The number of electricity certificates a supplier can buy increases every year in line with the quota, which increases the demand.

Tax on waste incineration

The Riksdag has decided to introduce a new excise duty on incinerated waste in response to the Government's proposal[104]. Biofuels, hazardous waste, animal by-products and the production of some materials which contain waste or waste residues will be exempted from the duty. The tax will be charged at SEK 125 per tonne of waste, although the rate will be SEK 75 per tonne of waste in 2020 and SEK 100 per tonne in 2021. The rate will be increased annually in line with general price increases from 2023 onwards. A deduction for tax purposes can be applied to waste from an incineration plant. The new tax comes into force on 1 April 2020.

Tax reduction for microgeneration of renewable electricity

To make it easier for private individuals and companies to invest in generating renewable electricity for their own use, microgenerators have been compensated for the surplus they feed into the grid since 2015[105].

The tax reduction is SEK 0.60 per kWh for the surplus fed in to a connection point with fuse of up to 100 amps in a calendar year. The ceiling for reductions is SEK 18 000 a year.

Reduced energy tax for microgenerators of renewable energy

Electrical power generated in a plant with an installed generation capacity of less than 50 kW by a generator with a combined installed generation capacity of less than 50 kW, which not been transferred to a network and which is covered by the grid concession and notified under Chapter 2 of the Electricity Act (1997:857) is tax-exempt.

50 kW of installed generation capacity is equivalent to 125 kW of installed generation capacity for electrical power generated by wind or waves, 255 kW installed peak power for solar power and 50 KW installed capacity for other energy sources without a generator. The installed capacities of electrical power generated from different sources must be combined.

If the generator's total generation capacity exceeds 50 kW or the equivalent, but not the capacity of a single plant, the energy tax can be reduced to SEK 0.5 per kWh for electricity not transferred to a licensed network.

[104] Government bill 2019/20:32, Report 2019/20:SkU12, Riksdag communication 2019/20:91.

[105] Chapter 67, Section 27–33, Income Tax Act (1999:1229).

Changes to investment support for photovoltaic cells connected to the grid

Since 2009 state support has been given for the installation of photovoltaic cells. It is directed at all kinds of operator – companies, public organisations and private individuals. There is a lot of interest in the support and county councils received around 52 000 applications up to April 2019, 29 000 of which were granted.

Since 8 May 2019, the maximum support has been 20%. The amount of support is calculated on the basis of the eligible installation costs. The maximum support for each photovoltaic cell system is SEK 1.2 million and the maximum eligible costs are SEK 37 000 plus VAT per installed kilowatt of rated electrical capacity. The support covers installation of all types of photovoltaic cell systems and hybrid solar electricity/heat systems. The county councils deal with applications in the order received. The support is limited and can only be given while the money set aside lasts. Systems eligible for energy certificates can also obtain photovoltaic cell support.

The budget for photovoltaic cell support was SEK 585.6 million in 2017 and SEK 1 085 million in 2018. The budget for the support in 2019 was SEK 736 million. The scheme expires on 31 December 2020 and the budget for 2020 has been set at SEK 835 million[106].

Renovation, conversion and extension deduction for photovoltaic cells or solar heat

The tax deduction for renovation, conversion and extension applies to the labour costs for house repairs, maintenance, conversions and extensions[107]. It was introduced in 2008 to increase the supply of labour and reduce undeclared work[108]. Private individuals can obtain a deduction of around 9% of the investment costs for installing photovoltaic cells or solar heating systems[109] .

Support for storage for self-generated electrical energy

Storing energy can increase the efficiency of the energy system. A grant for storage of self-generated electrical energy was introduced in November 2016 to enable customers to store more of their self-generated energy. It provides financial support for private individuals installing storage systems[110]. The grant has an annual budget of SEK 60 million and will end in 2020. Up to 60% of the cost of a storage system can be covered by the grant, however the maximum payment is SEK 50 000.

[106] Government bill 2019/20:1, Report 2019/20:NU3, Riksdag communication 2019/20:110.

[107] The renovation, conversion and extension deduction is also described in Section 3.2.

[108] Government bill 2006/07:94, Report 2006/07:SkU15, Riksdag communication 2006/07:181 and Government bill 2008/09:97, Report 2008/09:FiU18, Riksdag communication 2008/09:183.

[109] http://www.energimyndigheten.se/fornybart/solelportalen/vilka-stod-och-intakter-kan-jag-fa/stod-vid-investering/.

[110] The Ordinance (2016:899) on Grants for the Storage of Self-Generated Electrical Energy.

By April 2019, the Swedish Energy Agency had paid around SEK 36 million to the county councils, which administer the support.

Refunding of energy tax on electricity after battery storage

Under Chapter 11, Section 13 of the Energy Tax Act (1994:1776), consumers have been able to apply for an energy tax refund on electricity drawn from a licensed grid, stored and then fed back into the same licensed grid, since 1 January 2019. This is to avoid unintentional double taxation.

Exemptions from network charges

Electricity consumers who have their own small[111] generation plants and who consume self-generated electricity in addition to electricity purchased from the grid, are exempt from electricity feed-in charges. However the exemption applies only to consumers who have withdrawn more electricity from the grid in a calendar year than they have fed into it. Examples of consumers covered by this support include farms with small wind power plants and buildings with photovoltaic installations on the roof.

Smart and renewable energy systems on Gotland

The Government has commissioned the Swedish Energy Authority to conduct a pilot project for the transition to a sustainable energy system on Gotland; the project will be based on the three basic pillars of energy policy: security of supply, competitiveness and sustainability. The first stage was to produce a roadmap for the project, which was submitted to the Government on 20 March 2019.[112] The next stage is to implement the roadmap. The measures in the roadmap cover the whole of the energy system and, in principle, all sectors. They affect many major operators (public, private, not-for-profit organisations and individual members of the public) not least because they are responsible for implementing them. The project is expected to take several years to complete.

3.1.2.2 Where relevant, specific measures for regional cooperation, as well as, as an option, the estimated excess production of energy from renewable sources which could be transferred to other Member States in order to achieve the national contribution and trajectories referred to in point 2.1.2.

Since 2011, Sweden and Norway have had a joint electricity certificates market governed by a bilateral agreement. The aim of this joint electricity certificates market is to increase renewable electricity generation by 28.4 TWh between 2012 and 2020. Sweden will finance 15.2 TWh and Norway 13.2 TWh; it is up to the market to determine when and where the new electricity will be generated. Sweden also aims to increase renewable energy

[111] Exemption from network charges applies to electricity consumers with a contract for a power rating of up to 63 amps who generate electricity or are able to supply electricity at an output of up to 43.5 kilowatts.

[112] The Swedish Energy Agency – Gotland Energy Pilot Project. *Färdplan för att möjliggöra att Gotland blir pilot för ett hållbart energisystem* (ER2019:09).

generation by a further 18 TWh by 2030. This increase will be financed by Sweden alone.

Reporting under the agreement between Sweden and Norway will be based on a 50-50 distribution of electricity generation between the two countries until each has reached 13.2 TWh and then on 100% generation by Sweden (Article 14(2)).

3.1.2.3 Specific measures on financial support, where applicable, including Union support and the use of Union funds, for the promotion of the production and use of energy from renewable sources in electricity, heating and cooling, and transport.

Information about specific financial support, including Union support, is given in Section 3.1. The Regional Funds Programme is described in Section 3.2. The Connecting Europe Facility (CEF) aims to bridge gaps in the European transport, energy and telecommunications networks, focusing particularly on the cross-border parts of those networks. The facility aims to improve competitiveness within the EU and to foster economic, social and territorial cohesion, and has provided funding for Swedish projects over the years.

3.1.2.4 Where applicable, the assessment of the support for electricity from renewable sources that Member States are to carry out pursuant to Article 6(4) of Directive (EU) 2018/2001.

Sweden has not prepared specific assessments of the effectiveness of support schemes for the generation of renewable electricity and their major distributive effects on different consumer groups, and on investments. Under Article 6.4 of the revised Renewable Energy Directive[113] Member States must, at least every five years, assess the effectiveness of their support schemes for electricity from renewable sources and their major distributive effects on different consumer groups, and on investments. The Member States must include the assessment in the relevant updates of their integrated national energy and climate plans and progress reports in accordance with the Energy Governance Regulation[114].

3.1.2.5 Specific measures to introduce one or more contact points, streamline administrative procedures, provide information and training, and facilitate the uptake of power purchase agreements. Summary of the policies and measures under the enabling framework Member States have to put in place pursuant to Article 21(6) and Article 22(5) of Directive (EU) 2018/2001 to promote and facilitate the development of self-consumption and renewable energy communities.

[113] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

[114] Regulation 2018/1999 (EU) of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

The introduction of one or more contact points

In May 2019, the Government commissioned the Swedish Environmental Protection Agency to analyse the measures required to implement Article 16 of Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (the revised Renewable Energy Directive). This includes investigating which agency or agencies should be designated as contact points. It must submit a report to the Swedish Government Offices (Infrastructure Department) by 31 January 2020.

Strategy for sustainable expansion of wind power

The Swedish Energy Agency and the Swedish Environmental Protection Agency are working together to develop a strategy for sustainable expansion of wind power. The strategy is based on the target of 100% renewable electricity generation in 2040 under the Energy Agreement. A substantial, sustainable expansion of wind power will be required to achieve this transition. The Directors General of the two agencies have therefore begun to develop a joint strategy for sustainable expansion of wind power which takes account of factors such as resource-efficiency, human health and the environmental impact. This is an Environmental Objectives Council initiative[115].

The council coordinates the approach of state operators to wind power and produces guidelines for balancing various interests; it is also drafting a wind power plan, which breaks down the national wind power requirement to regional and municipal level. It began the work in 2018 and is due to report on it in spring 2020.

Maritime spatial plans

On 17 June 2015, the Government decided to introduce a maritime spatial planning regulation (2015:400) to govern maritime spatial planning in Sweden. Under this regulation, the Swedish Agency for Marine and Water Management must produce proposals for maritime spatial planning for the Gulf of Bothnia, the Baltic Sea and the North Sea. The maritime spatial plans must ensure sustainable use of marine resources and development of industry, while improving the marine environment. The Swedish Agency for Marine and Water Management must work with the Swedish Energy Agency to develop ways of harnessing offshore wind power and wave energy. The Agency prepared the first draft of its maritime spatial plans in autumn 2016. The plans were sent out for consultation in spring 2017. This was followed by further consultation in 2018 and a review in 2019. The Agency submitted draft maritime spatial plans to the Government in December 2019[116].

[115] The Government set up the Environmental Objectives Council as a platform to promote action and intensify work on achieving Sweden's environmental targets at all levels of society. The Council presents the measures it intends to take to accelerate this work on 1 March every year. It's mandate ends on 6 May 2022.
[116] Maritime Spatial Plans for the Gulf of Bothnia, the Baltic Sea and the North Sea, reference number 3628-2019.

Simplified administration of support for photovoltaic cells

At the Government's request, the Swedish Energy Agency reviewed the management of investment support for photovoltaic cells and made some suggestions for simplifying it. It suggested that this should be done initially within the current administrative system. The administration has been streamlined in a number of respects, the application forms have been simplified, information about support has been made more accessible, applications can now be submitted electronically, the monitoring requirement has been removed and dialogue between the authorities managing the support has been improved.

The solar electricity portal - guidance on photovoltaic cells

In September 2018, the Swedish Energy Authority launched the Solelportalen.se web portal. The portal provides owners of small domestic properties and commercial premises with independent, factual information about photovoltaic systems from pre-installation planning to decommissioning. It is intended to help people considering investing in photovoltaic cells to make wise decisions.

The solar electricity portal was developed by the Swedish Energy Agency at the Government's request, It carried out the work in conjunction with several authorities with relevant information in the field.

Removal of the requirement for planning consent for solar energy installations

The requirement for planning consent for many types of installation and solar collector has been removed from the planning and building legislation to facilitate the installation of photovoltaic systems.

Since 1 August 2018, planning consent has not usually been required to install a photovoltaic or solar collector installation on a building in an area covered by the urban management plan, if it follows the contours of the building. However, the municipalities can set other requirements in the urban management plan. The exemption from planning consent does not apply to buildings in built areas which are of special historic, cultural, environmental or artistic value or are located in, or adjacent to, areas of interest for national defence.

Since the planning and building legislation did not previously contain any specific rules for photovoltaic and solar heat installations, or any guiding case-law, the conditions for solar energy installations varied between municipalities.

Areas of national interest to optimise land use

The Swedish Energy Agency is responsible for declaring national interest for energy generation and energy distribution which must be of particular national relevance.

For energy generation, this includes areas for large-scale installations which can generate large amounts of energy or power, but also installations which can provide balancing or regulating capacity or which are needed in the area when energy consumption is high. There are currently eight areas earmarked for energy generation.

For energy distribution, national interest provisions should be applied to areas for installations which are part of larger interconnected energy distribution systems of national interest.

Areas have been designated of national interest for wind use since 2004 and, since the last update in 2013, this has been very important for evaluating wind power in comparison with other interests for town and country planning[117]. There are now 313 areas of national interest for wind use, 284 of which are onshore and 29 offshore. They cover a total area of 7 900 km2 excluding developed land, which is 1.5% of the area of Sweden, including Swedish waters.

The Swedish Energy Agency is also developing a national interest scheme for hydro-electric power and has begun a preliminary study on this.

Future hydro-electric power generation must be adapted to modern environmental conditions and must also facilitate the transition to an electricity system based on 100% renewable energy. A draft national plan for reviewing hydroelectric power is currently being prepared. Eight hydroelectric power companies have also formed the Vattenkraftens Miljöfond Sverige AB, which is responsible for funding the environmental measures required for the transition of hydroelectric power operations in Sweden. The environmental initiatives must be beneficial both to fisheries and tourism and to local development and must be designed to achieve international environmental targets in water-related industries.

Renewable electricity purchase agreements

There are no specific policies or other measures to facilitate more widespread use of renewable energy purchase agreements. According to market operators, these agreements are widely used in Sweden and have played an important role in the expansion of wind power.

[117] http://www.energimyndigheten.se/fornybart/riksintressen-for-energiandamal/.

Self-consumption of renewable energy and renewable energy communities

In May 2019, the Government commissioned the Swedish Energy Markets Inspectorate to investigate how to implement the revised Renewable Energy Directive[118]. This involved investigating the measures required to implement Article 21 on renewable energy self-consumers and Article 22 on renewable energy communities. It must submit a report to the Swedish Government Offices (Infrastructure Department) by 28 February 2020.

3.1.2.6 Assessment of the necessity to build new infrastructure for district heating and cooling produced from renewable sources.

The Swedish district heating system is already well developed and district heating competes with other forms of heating. The owners assess whether new infrastructure for district heating and district cooling is necessary and will be profitable.

3.1.2.7 Where applicable, specific measures on the promotion of the use of energy from biomass, especially for new biomass mobilisation taking into account: — biomass availability, including sustainable biomass: both domestic potential and imports from third countries — other biomass uses by other sectors (agriculture and forest-based sectors); as well as measures for the sustainability of biomass production and use.

The *Klimatkliv*[119] is an investment support initiative for local and regional measures to reduce emissions of carbon dioxide and other gases which have an impact on the climate; it is administered by the Swedish Environmental Protection Agency. The funds must be invested with the primary aim of reducing greenhouse gas emissions[120]. A plant for production of biochar from forestry residues is one example of a measure that has received support under the *Klimatkliv* initiative[121].

The Swedish Energy Agency is continuously producing statistics on biofuels (prices, quantities) to increase transparency on its markets[122]. The Swedish Forest Agency records the removal of branches and tops left over from felling in its felling residue reports[123].

The 2014–2020 Rural Development Programme includes investment support for buying and planting the perennial energy crops willow, poplar and hybrid aspen[124]. The programme also includes investment support for

[118] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

[119] The *Klimatkliv* is also described in Section 3.1.1.

[120] https://www.naturvardsverket.se/Stod-i-miljoarbetet/Bidrag/Klimatklivet/Om-Klimatklivet/.

[121] https://www.landskogsbruk.se/skog/satsning-pa-biokol-far-225-miljoner/.

[122] http://www.energimyndigheten.se/statistik/.

[123] https://www.skogsstyrelsen.se/bruka-skog/skogsbransle/.

[124] https://www.jordbruksverket.se/amnesomraden/stod/stodilandsbygdsprogrammet/investeringar/jordbruktradgardochrennaring.4.6ae223614dda2c3dbc44ef5.html.

fencing for bio-energy crops and the construction of bio-energy installations.

The Government has set up a circular economy delegation[125]. The delegation is a Government advisory body within the Swedish Agency for Economic and Regional Growth. Its tasks include developing a strategy for the transition to a circular and bio-based economy, both nationally and regionally. It has chosen to focus initially on three areas: plastics, public procurement and the design of the circular economy. It has conducted a comprehensive debate on the circular economy and its importance for the sustainable development of society. Industry, for example, needs a business case and a demand for products not manufactured from virgin material, and business opportunities for by-products and manufacturing residues.

In 2016, the Environmental Objectives Council launched a project to increase knowledge of bioenergy in Sweden and the EU. The Swedish Forest Agency, the Swedish Energy Agency, the Swedish Board of Agriculture, the Swedish Environmental Protection Agency and the county councils were jointly commissioned to produce a report on the position of bioenergy and its potential.[126] This was a response to the need for sustainable measures to reduce greenhouse gas emissions under the Paris Agreement; it also took account of the fact that many different agencies are responsible for dealing with this issue. The project report stated that 'effective policies are needed to utilise the full potential of sustainable bioenergy'.

There are many bioenergy research initiatives which are described in Section 4.6.

3.1.3 Other elements of the dimension

3.1.3.1 Where applicable, national policies and measures affecting the EU ETS sector and assessment of the complementarity and impacts on the EU ETS.

The following policies affect emissions in the EU ETS:

- carbon tax and energy tax on cogeneration and heat generation – see the description in Section 3.1.1;
- the electricity certificates system – see the description in Section 3.1.2;
- energy tax on industry – see the description in Section 3.1.1;
- the *Industrikliv* initiative – see the description in Section 4.6;
- the *Energisteg* initiative – see the description in Section 3.2;
- requirements and support for energy mapping – see the description in Section 3.2
- energy and climate coaches – see the description in Section 3.2;
- energy efficiency networks – see the description in Section 3.2;

[125] https://tillvaxtverket.se/amnesomraden/affarsutveckling/delegation-cirkular-ekonomi.html

[126] The Swedish Forest Agency, the Swedish Energy Agency, the Swedish Board of Agriculture and the Swedish Environmental Protection Agency – *Bioenergi på rätt sätt – Om hållbar bioenergi i Sverige och andra länder* (Report 2017/10).

– the Environmental Code – see the description in Section 3.1.1; and
– tax on waste incineration – see the description in section 3.1.2.

These policies are designed to promote technical advances and reduce emissions from Swedish installations within the system. They complement the EU ETS and may increase the number of allowances in the Market Stability Reserve. Hence they may potentially also increase the number of allowances cancelled.

3.1.3.2 Policies and measures to achieve other national targets, where applicable

Air quality

Sweden's commitment under the National Emissions Ceiling Directive[127]

To honour its commitments, Sweden will have to take measures to reduce national emissions of ammonia and nitrogen oxides. The National Air Pollution Control Programme[128] adopted by the Government on 28 March 2018 sets out the measures that need to be taken. To achieve the reductions in nitrogen oxide emissions measures will have to be taken both in domestic transport and industry. An integrated air and climate policy will help to reduce emissions of both greenhouse gases and air pollutants.

Measures to reduce ammonia emissions include management of manure in farming, since this is the single largest source of these emissions in Sweden.

Climate change adaptation

Creating the conditions for climate change adaptation – cooperative structures, stakeholder involvement and action plans

The Ministry of the Environment is responsible for coordinating work on climate change policy in the Swedish Government Offices. Climate change adaptation is monitored and evaluated with the assistance of the National Expert Council for Climate Change Adaptation and the Swedish Meteorological and Hydrological Institute (SMHI). The National Expert Council for Climate Change Adaptation was set up in 2018 and is tasked with preparing a five-yearly report for the Government. The report must put forward proposals for national work on climate change adaptation, prioritise adaptation measures on the basis of an assessment of the risks, costs and benefits, briefly analyse the effects of climate change on society and assess national work on climate change adaptation.

[127] Directive (EU) 2016/35/EC of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.
[128] M2019/00243/KI.

In June 2018, as a result of the National Climate Change Adaptation Strategy, the Government commissioned the National Board of Housing, Building and Planning to coordinate work on climate change adaptation in the built environment

In 2012, the Government commissioned the SMHI to set up the National Knowledge Centre for Climate Change Adaptation to assist municipalities, regions, authorities and other stakeholders with their climate adaptation work. In 2019, the centre had a budget of around SEK 20 million for this work.

Many Swedish authorities play an important part in climate change adaptation through their respective sector responsibilities. They work preventively by increasing knowledge and improving resilience. The implementation of the National Climate Change Adaptation Strategy began in June 2018 with the Ordinance (2018:1428) on the Climate Change Adaptation Work of National Authorities in which the Government gives 32 national authorities and the 21 county councils the task of initiating, supporting and monitoring climate change adaptation in their respective areas of responsibility, for example by preparing action plans.

Many national authorities had already prepared action plans for their sector. Some were prepared with national funding, for example action plans for forestry, human health, cultural heritage, sustainable development and Sami industry and culture.

The county councils are responsible for coordinating the regional climate change adaptation work and for supporting local operators. They adopted regional action plans in 2014. The work on climate change adaptation measures identified in these plans is reported to the Government every year. The plans cover the whole of Sweden with nearly 800 proposed measures. Most of the measures are related to flood protection, protection of drinking water, protection of coastlines, infrastructure (roads and railways), adaptation of agriculture and forestry, resilience during heatwaves and health care.

The Governmental Agency Network for Climate Change Adaptation comprises the 21 county councils and 19 national agencies. The network coordinates climate adaptation work and provides a forum for the exchange of information; the secretariat is managed by the SMHI. There are also thematic national cooperation networks.

Some local agencies have also developed action plans for their municipalities. Significant progress has been made and awareness of the importance of climate change adaptation has increased throughout society in recent years. The Planning and Building Act (2010:900) was amended in 2018 to stimulate further progress. As a result of these amendments the municipalities are able to take greater account of climate adaptation aspects in the communal planning process.

Knowledge transfer and risk assessment

The SMHI's Rossby Centre for climate research has drafted national and regional climate scenarios up to 2100. The Swedish Civil Contingencies Agency operates the Floods Portal, which contains information from flood maps and geographical data in accordance with the Ordinance (2009:956) on Flood Risks, and a database of natural disasters. The Swedish Geotechnical Institute has worked with seven other agencies to produce geotechnical risk maps and tools to assess climate risks.

The Climate Change Adaptation Portal provides information about the impact of climate change on society along with tools for climate change adaptation, examples of climate change adaptation measures already implemented and information about current activities.

Many of the sectoral and regional adaptation plans include risk and vulnerability analyses.

Implementation

The Government funds measures to improve knowledge of the impact of climate change and to address its impact, for example with measures to prevent subsidence, landslides and floods. The budget for this in 2019 is SEK 316 million. This includes funding for measures to prevent subsidence and landslides in the Göta älv valley, which is a particularly vulnerable area of Sweden.

The Government is also making decisions on the delegation of various measures to sectoral agencies. However, climate change adaptation is multi-sectoral, which means that the work is usually carried out by several operators and sectors working together nationally, regionally and locally.

Sweden has a well-established and effective framework for work on reducing the risk of disasters, which includes emergency preparedness groups. The work is coordinated by the Swedish Civil Contingencies Agency.

Cooperation is encouraged at all levels and between sectors and operators working on land use planning, risk management, natural disasters and climate change adaptation, to reduce risks and improve preparedness.

There are currently several cooperation forums in Sweden, where sectoral agencies and other stakeholders can share experience and plan important measures. These include the Agency Network for Coastal Erosion, the Committee for Dam Design Flows from a Climate Change Perspective, The Delegation for Subsidence and Landslides, and the National Drinking Water Network.

Sweden's municipalities are obliged to carry out risk and vulnerability analyses as part of their work to prepare for extraordinary events and emergencies.

These analyses include events affected by climate change.

In the built environment, where the risk of natural disasters in particularly high, municipalities can apply for state funding for preventive measures. Around SEK 75 million a year is available for 2017–2020. The funding, which is administered by the Swedish Civil Contingencies Agency, can be given to cover up to 60% of the costs, or a maximum of 60% of the value of the object at risk. The natural disasters concerned here are mainly subsidence, landslides and floods.

Evaluation and audits

The National Climate Change Adaptation Strategy has a five-year review cycle. The cycle includes the implementation of the strategy and the production of an updated climate and vulnerability analysis, followed by review and evaluation of the work carried out. The SMHI's National Expert Council for Climate Change Adaptation is responsible for evaluating the strategy. An updated strategy will then be developed in 2023.

Gender mainstreaming

Under the Paris Agreement, the transition to a fossil-free economy must take account of human rights and promote equality. Human rights are universal and establish that all people are of equal value and have equal rights irrespective of their culture, nationality or background. Equality in turn is a human right and establishes that society must give women, men, girls and boys the same rights, resources, protection and opportunities.

According to the UN's climate convention, women are under-represented in positions of authority and sometimes lack the conditions or opportunities to influence climate-related policy, planning and implementation Women all

over the world are also affected more severely by climate change than men, as they are more vulnerable to it in many countries. Climate projects and policy often achieve better results when women are involved in making the decisions locally and nationally, because they often have local knowledge and experience of managing resources sustainably.

Sweden is working on gender equality issues both at EU and national level. Sweden's feminist policies include international work, and Sweden's gender equality policy objectives are also objectives for the Government's international cooperation. Sweden's domestic policy and foreign policy on gender equality are therefore closely linked, as with the EU cooperation. Sweden promotes gender equality work within the EU, the UN, the Council of Europe and other international organisations. It also works nationally to meet its international gender equality commitments and obligations, including those under the Beijing Platform and the UN's Convention on the Elimination of all Forms of Discrimination against Women (CEDAW).

Sweden has a feminist foreign policy which means that it always adopts a gender equality approach to its international relations with the aim of promoting rights, representation and resources for all women and girls. The feminist foreign policy is set out in an action plan, which includes specific targets for gender equality. Sweden has campaigned for many years for gender equality to be integrated into all relevant EU processes.

Sweden's gender equality work aims to ensure that all women and men have the same power and opportunities to shape society and their own lives. This aim must also embedded in climate policy and the Government intends to step up work on gender equality. At the Government's request, the Swedish Environmental Protection Agency has submitted a proposal for further integration of gender equality in the implementation of the Paris Agreement.

3.1.3.3 Policies and measures to achieve low emission mobility (including electrification of transport).

Policies and measures for the transport sector are described in Section 3.1.1.

3.1.3.4 Where applicable, national policies, timelines and measures planned to phase out energy subsidies, in particular for fossil fuels;

Environmentally damaging subsidies must be phased out both in Sweden and worldwide. However, Sweden has not set deadlines for phasing out energy subsidies. In response to the proposals in the revised spring budget for 2019, the reduction of energy and carbon taxes for mining operations was abolished (see Section 3.1.1). The compatibility of policy with climate objectives is also evaluated continuously through the Climate Policy

Framework (see Section 1.2.1).

3.2 Dimension energy efficiency

3.2.1 Planned policies, measures and programmes to achieve the indicative national energy efficiency contributions for 2030 as well as other objectives referred to in point 2.2, including planned measures and instruments (also of a financial nature) to promote the energy performance of buildings, in particular with regard to the following:

3.2.1.1 Energy efficiency obligation schemes and alternative policy measures under Articles 7a and 7b and Article 20(6) of Directive 2012/27/EU and to be prepared in accordance with Annex III to this Regulation

Choice of policies to achieve the energy saving obligations

Under Article 7(10) of the Energy Efficiency Directive[129] Member States must achieve the amount of energy savings required under Article 7.1, paragraph 1, point b, either by establishing an energy efficiency obligation scheme referred to in Article 7a or by adopting alternative policy measures referred to in Article 7b. The Member States may combine an energy efficiency obligation scheme with alternative policy measures.

Swedish energy efficiency policy is based on the principle that:

- policies should be general and not linked to specific technologies;
- prices must give the right (or required) information;
- search costs are reduced because information is produced and distributed; and
- barriers can be removed, for example by adjusting existing regulations.

State initiatives to promote energy efficiency are targeted both at energy consumption and supply and aim to support the spontaneous efficiency improvements in society with policies tailored to the mechanisms of the market. The state's role is to identify and remedy market failures – primarily external effects and a lack of information.

The current portfolio of energy efficiency policies is consequently very broad and comprises general economic policies, such as energy and carbon taxes and emissions trading, as well as more targeted administrative policies, such as the requirement for authorisation to carry out activities that are harmful to the environment and the requirement for energy performance

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

ratings and energy labelling of energy-related products and buildings. The policies are implemented by means of various complementary initiatives, which deal in different ways with the lack of information on the market and increase awareness and knowledge of different energy-efficiency and energy-saving measures, both technical and behaviour-related, and also their legitimacy. Examples include state support for municipal energy and climate advisory services, state support for energy mapping in small and medium-sized enterprises, state support for local and regional capacity development for the energy and climate transition, including support for regional climate and energy strategies and measures for early introduction to the market. Sweden also provides various support measures for investments to promote energy efficiency. Examples include the *Energisteg* programme, the *Klimakliv* and *Industrikliv* initiatives and state support for renovation and energy efficiency measures in apartment blocks in certain areas.

The combination of economic policies and complementary and targeted information initiatives and investment assistance is considered to provide a sound basis for achieving energy efficiency cost-effectively. Energy and carbon taxes increase the cost of using energy and hence create an incentive for consumers to take energy-saving measures to reduce their energy consumption and/or consume energy more efficiently. Some of the measures are easy to introduce and to take, but there is often a lack of detailed knowledge about the measures that can be taken and are suitable in a particular case. Information about possible and suitable measures is often asymmetric, which means that those selling energy-efficient technologies or other energy-efficiency solutions often have an information advantage over the final consumer, who will be taking the measures and footing the bill. The guidance function of the energy price is often not enough. Energy consumers who respond to price signals are also influenced by other policies. Support for energy mapping can improve final consumers' knowledge about where measures should be taken. Impartial advice about suitable measures can be obtained from a municipal energy and climate advisor.

Under Article 7(11) of the Energy Efficiency Directive, when drafting policy measures to meet their energy savings obligations under 7(1) of the Energy Efficiency Directive, Member States must take account of the need to alleviate energy poverty in accordance with criteria established by them and with due regard for their existing practice in the area. The Government makes no distinction between energy poverty and poverty in general. As a result, the term energy poverty is not used, and there are no targeted policies to deal with it.

The Swedish Energy Agency has looked into whether an energy savings obligation scheme (white certificates) is an appropriate policy for Sweden on

a number of occasions. It has concluded that this kind of scheme should not be introduced in Sweden in principle, but does not categorically rule it out. It believes that white certificates aim to correct market failures that are already addressed by another policies; the scheme may also affect, and be affected by, the operation of other policies, such as the EU ETS and electricity certificates. It does not rule out the possibility of using white certificates if another objective in addition to energy efficiency is added to the scheme, by does not believe the matter needs to be investigated any further.

In the final report of its study of smaller operators in a changing energy landscape *Smaller operators in the energy landscape – effective proposals* (SOU 2018:76) it proposed that an obligation scheme should be introduced in Sweden. The proposal deals with energy efficiency and energy consumption up to 2040 and energy efficiency in general. The scheme proposed by the study was not based on the obligation scheme provided for under the Energy Efficiency Directive. The study has been sent out for consultation, and the suggestions made will be dealt with by the Swedish Government Offices.

Sweden is implementing the Directive's energy savings obligation for the period 1 January 2014 to 31 December 2020 by means of energy and carbon taxes and complementary policies which focus on managing information-related market failures.

In view of this, Sweden currently intends to achieve the savings obligation with policies other than obligation schemes, as permitted under Article 7(b) of the Energy Efficiency Directive. It will impose special energy and carbon taxes to meet the energy savings obligation. A more detailed description of energy and carbon taxes in Sweden and the EU is given below. Other complementary energy efficiency policies are described in Section 3.2.1.2 and Section 3.2.1.3.

Energy and carbon tax

Energy and carbon taxes in Sweden

The energy and carbon taxes charged in Sweden under the Energy Tax Act (1994:1776) fulfil the minimum levels of taxation required by the Energy Tax Directive[130]

The Swedish agency that administers and monitors taxation (the implementing public authority) is the Swedish Tax Agency.

[130] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.

Electricity generators and network operators are the main groups liable for energy tax[131]. They incur the tax liability when they transmit electricity to anyone who is not liable for the tax as a generator, network owner or voluntary tax payer or when the electricity is used by a party liable for the tax.

The main categories of taxpayer liable for energy and carbon tax on fuel are warehousekeepers, consignees and traders authorised by the Swedish Tax Agency[132]. Tax liability for fuel is normally incurred when it is supplied under duty suspension [133] and is therefore released for consumption or, in the case of authorised traders, when it is supplied to a buyer who is not an authorised trader or to its own sales outlet.

The Energy Tax Act gives rates of energy and carbon tax on fuel as an amount per quantity of fuel (krona and öre per litre, cubic metre or kg depending on the type of fuel). With the exception of the energy taxes on electrical energy, the information given below on tax based on energy content describes the typical energy-content equivalent of these levels of taxation or changes in these levels. The energy and carbon taxes on fuels have risen by 16–29 öre/kWh between 1995 and 2019, depending on the type of fuel. The taxes vary depending on the type of fuel and the purpose for which it is used. A reduced rate is applied to some uses, including consumption for industrial manufacturing processes. In addition to these reduced taxes, a full exemption from energy and carbon tax on fuel used in some specific industrial process, such as metallurgical processes, can be granted under the Energy Tax Act. However, there is no tax reduction on the fuel consumption of a household that uses oil for heating. Table 9 shows the changes in energy and carbon tax on fossil fuels and electricity between 2012 and 2019. The biggest change is the diesel tax reduction of 13 öre/kWh between 2018 and 2019. This was a result of the removal of the tax exemption for low-level biodiesel blends. When the reduction obligation was introduced, the energy and carbon taxes on petrol and diesel were reduced to reflect the content of fossil carbon in the fuel blend, and to avoid the effects on the petrol and diesel price which had been seen when the tax on their biofuel content was introduced.

Table 9 shows the current rates of energy and carbon tax. The rates given for fuels are a result of changing to a different taxation unit from the one specified in the Energy Tax Act. The tax rates are shown here as an amount per quantity of energy (öre/kWh). The current rates for energy and carbon tax on fuel are laid down in Chapter 2, Sections 1, 1a, 1b, 3 and 4 of the Energy Tax Act. The tax rates are not fixed over time but are reviewed and

[131] Chapter 11, Section 5 of the Energy Tax Act (1994:1776).

[132] Chapter 4, Sections 1 and 12 of the Energy Tax Act (1994:1776).

[133] Duty suspension means the suspensive procedure referred to in Council Directive 2008/118/EC of 16 December 2008 concerning the general arrangements for excise duty and repealing Directive 92/12/EEC.

changed annually to take account of changes in the consumer prices index. Since 2017, a flat rate of 2% has been charged in addition to the CPI adjustment to reflect the growth in GDP. This has maintained the guidance function of the taxes over time. Tax rates are also changed actively at other times. Applicable rates for 1 January to 30 June 2019 are given in the Ordinance (2018:1638) Establishing Energy and Carbon Tax Adjustments for 2019. Applicable rates for the second half of 2019 are given in Chapter 2, Section 1 of the Energy Tax Act.

Table 9 shows the current rates of energy tax on electricity. The current rate is given in Chapter 11, Section 3 of the Energy Tax Act. The tax rates are not fixed over time but are changed annually to take account of changes in the consumer prices index. The applicable rate for 2019 is given in the provision referred to above.

Table 9. Energy and carbon tax on fuels and electricity on 1 January every year from 2012 to 2019, öre/kWh (2018 prices).

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity	30.3	30.6	30.7	30.8	30.3	30.1	33.1	34.7
Heating oil	41.2	41.1	41.1	42.8	42.2	41.9	41.8	42.7
Diesel	49.8	51.8	51.8	54.0	58.9	59.6	60.6	48.1
Petrol	64.9	64.7	64.8	67.4	72.0	72.8	74.1	73.6
Coal	45.9	45.8	45.8	47.8	47.1	46.8	46.6	47.6
Natural gas	30.8	30.8	30.8	32.1	31.6	31.4	31.3	32.0

The Swedish Energy Authority's report *Energiindikatorer 2019*[134] gives an overview of the energy and carbon tax paid by different sectors and consumers. Full energy and carbon tax is paid on fuel used to generate heat outside the EU's emissions trading system (EU ETS). VAT at 25% is also charged on the energy price including taxes for households. VAT is generally deductible for companies. Electricity and fuel used to generate electricity are exempt from energy and carbon tax. The electricity generated is taxed instead. The amount of energy tax depends on where in the country the energy is consumed and for what purpose[135]. Other fuels besides petrol and high-tax oils used in industrial manufacturing processes outside the EU ETS are subject to 30% energy tax and 100% carbon tax. The same applies to fuels used for purposes other than operating motor vehicles or ships or boats in commercial agriculture, forestry or aquaculture. Fuels used for

[134] The Swedish Energy Agency – *Energiindikatorer 2019* (ER 2019:11).

[135] Electricity consumption in households and service companies in the following municipalities is subject to lower energy tax on electricity: all municipalities in the counties of Norrbotten, Västerbotten and Jämtland, Torsby in the county of Värmland, Sollefteå, Ånge and Örnsköldsvik in the county of Västernorrland, Ljusdal in the count of Gävleborgs and Malung-Sälen, Mora, Orsa and Älvdalen in the county of Dalarna. Electricity consumption in industrial manufacturing processes is also subject to a lower level of energy tax.

industrial manufacturing processes within the EU ETS are subject to 30% energy tax and no carbon tax. Fuels other than crude tall oil and high-tax oil used within the EU ETS to generate heat for purposes other than industrial manufacturing are subject to 100% energy tax and 91% carbon tax. Different levels of taxation are applied to transport depending on the fuel, environmental classification and purpose of the vehicle. Low-tax diesel and fuel oils used in rail transport and in ships used for non-private purposes, and aviation gasoline and kerosene used for non-private purposes are exempt from energy and carbon tax. Aviation and marine fuel used for private purposes is taxed. Natural gas used as a fuel is subject to carbon tax but exempt from energy tax. Electricity used for rail transport is also exempt from tax.

On 1 July 2018, the tax reduction on low-level biofuel blends was removed and replaced with a reduction obligation. The petrol and diesel suppliers liable to pay tax are obliged to gradually increase the amount of biofuel in their fuels, which increases the price at the pump. To compensate for this, the tax on petrol and diesel was reduced. The overall pump price for petrol and diesel may however be higher. Pure biofuels or high-level blended biofuels are still completely exempt from tax.

The EU's minimum levels of taxation

The EU's minimum levels of taxation applicable to motor fuels are shown in Table A of Annex I to the Energy Tax Directive[136]. Table B of this annex shows minimum levels of taxation applicable to motor fuels used for the purposes set out in Article 8(2) of Directive 2003/96/EC. Table C of the annex shows minimum levels of taxation applicable to heating fuels and electricity. Article 15(3) of the Directive states that Member States may apply a level of taxation down to zero to fuels and electricity used for agricultural, horticultural or piscicultural works, and in forestry. The EU's minimum levels or taxation are shown in Table 10 and Table 11. They have not changed since 2010.

Table 10. The EU's minimum rates of taxation for fuels and electricity.

	Unit for the tax rate	Tax rate
Motor fuels		
Leaded petrol	€/1 000 litres	421
Unleaded petrol)	€/1 000 litres	359
Diesel	€/1 000 litres	330
Kerosene	€/1 000 litres	330
LPG	€/1 000 kg	125
Natural gas	€/GJ gross calorific value	2.6
Motor fuels used for the purposes set out in Article 8(2) (agriculture, stationary motors, construction etc.)		

[136] Council Directive of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.

Diesel	€/1 000 litres	21
Kerosene	€/1 000 litres	21
LPG	€/1 000 kg	41
Natural gas	€/GJ gross calorific value	0.3
Heating fuels and electricity		
Diesel	€/1 000 litres	21
Heavy fuel oil, heating	€/1 000 kg	15
Kerosene	€/1 000 litres	0
LPG	€/1 000 kg	0
Natural gas	€/GJ gross calorific value	0.15
Coal and coke	€/GJ	0.15
Electricity, business use	€/MWh	0.5
Electricity, non-business use	€/MWh	1.0

Table 11. Current minimum levels of taxation under the Energy Tax Directive (2003/96/EC), converted to krona for petrol, diesel and electricity for non-business use[137].

Year	Motor fuels		Electricity, non-business use
	SEK/l petrol	SEK/l diesel	SEK/l diesel
2018	3.10	2.85	0.86

Projected contribution of policies to achieving the energy savings obligation

Under Article 7(9) of the Energy Efficiency Directive, Member States must ensure that savings resulting from policy measures referred to in Articles 7a and 7b and Article 20(6) are calculated in accordance with Annex V. Under Article 7(12) of the same Directive Member States must demonstrate that where there is an overlap in the impact of policy measures or individual actions, there is no double counting of energy savings.

Overview of the calculation of energy savings

As described, Sweden intends to apply a wide range of complementary policies. Specific energy efficiency measures will be taken on the basis of the synergies between these policies.

To avoid the risk of double counting energy savings from different complementary policies, Sweden proposes to consider the effects of the different policies as a whole for calculation purposes. The fundamental principle of Swedish energy efficiency policy is that general energy and carbon taxes should be imposed to influence price signals. The cumulative effect of Sweden's policies will therefore be calculated by the method specified in the Directive for calculating the effects of energy and carbon taxes. The calculations currently do not take account of reduction obligations. As they increase the fuel price at the pump, the effects of the

[137] The levels have been converted on the basis of the calorific value in the report *Energiläget i siffror 2012*, and the ECB's official exchange rate for 2014 on 1 October 2013: SEK/EUR 8.6329.

policy should perhaps be treated in the same way as a tax in future. The effects of the other, complementary policies described in Section 3 will therefore not be monitored and calculated as specified in Article 7a and 7b of the Energy Efficiency Directive. Sweden implements the obligation under the Directive to achieve national energy savings in the period 2014–2020 in a similar way. This approach to calculating and monitoring energy savings is applied only to the implementation of the provisions of Article 7, 7a and 7b of the Directive.

Method for calculating energy savings from taxes

The Directive does not provide a detailed calculation method, but the provisions state that credit should be given only for energy savings from taxation measures exceeding the minimum levels of taxation applicable to fuels as required in the Energy Tax Directive or the VAT Directive[138]. Furthermore, price elasticities for the calculation of the impact of the taxation measures must be estimated on the basis of recent and representative official data.

Credit can therefore be given for the energy savings obtained from the price difference when Sweden's levels of energy and carbon taxes and VAT are higher than the EU's minimum taxation levels. A simple way of calculating the energy saving is to multiply the price difference by the price elasticity and energy consumption.

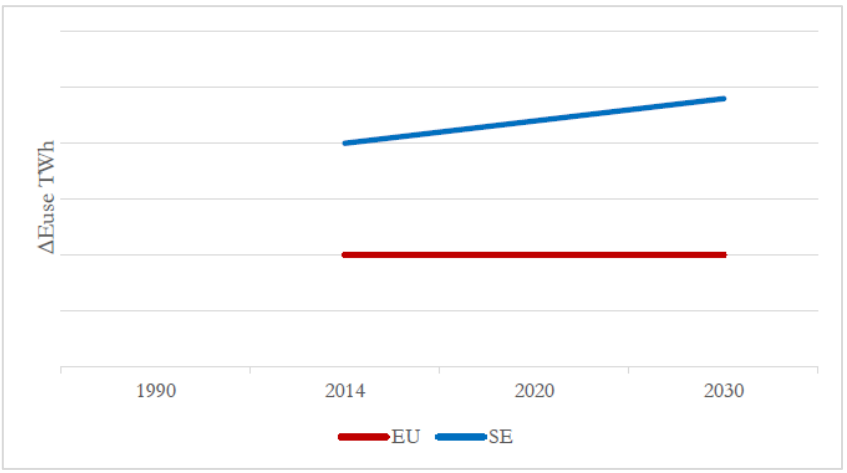
Articles 7, 7a and 7b of the Energy Efficiency Directive do not require the cumulative energy saving to be achieved by new policies; however it must be achieved by new measures. These can be measures under new and/or existing policies. The levels of energy and carbon tax and VAT in Sweden have been higher than the EU's minimum levels of taxation for a long time. They contribute to energy savings by encouraging both changes in behaviour (for example driving less) and investments in energy efficient technologies (such as buying a more energy-efficient car). The start date used is a key factor when calculating the effects of policies. The energy efficiency measures taken in 2021 are an effect of the levels of taxation (and other policies) in 2021, but also those in 2020 and before. The taxes introduced in and after 2021 will have an effect beyond 2030.

Since Sweden estimated the effects of the taxes on energy saving in the period 2014–2020, 2014 should also be the start year for calculations for 2021–2030. To calculate the effect of taxes, energy savings in the period 2014–2030 should be evaluated counterfactually, in other words compared on the basis of an alternative scenario to reduce the levels of taxation to the EU's minimum on 1 January 2014, when the savings requirement under the

[138] Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax.

Directive was originally introduced, for example to introduce an alternative policy in the form of white certificates. The guiding effect of the higher levels of taxation keeps energy consumption lower than the alternative scenario in which taxes are reduced. The cumulative energy savings are therefore the difference between the scenarios, which is the increased energy consumption resulting from educed taxes (see Figure 7). If we included effects in the period 2014–2030 of taxes introduced before 2014, the energy savings would be far higher, because the full effect of price differences would already have been achieved in 2014 and would have continued to be felt since that date. The levels of energy and carbon tax in Sweden are also regularly adjusted in line with the Consumer Prices Index (and in some cases also with increases in real earnings (GDP)), which maintains – and sometimes increases –their guidance function even if prices in general rise. The guidance function of the taxes is therefore not eroded in real terms. They have been adjusted regularly to ensure this. As an example, energy taxes on electricity were increased on 1 July 2017 and 1 January 2019 as a result of the Energy Agreement.

Figure 7. Energy saving as a result of differences between the level of taxation in Sweden and the minimum level of taxation.



Source	Target
ΔEuse Twh	ΔEuse Twh
EU	EU
SE	SE

As stated above, the taxes increase prices both in the short- and the long-term. To capture this effect, the energy savings should be calculated dynamically and cumulatively as far as possible, taking account of both short- and long-term price elasticity.

As regards the use of long-term price elasticity, the calculation method does not assume that the full effect is achieved in the first year after the introduction of a tax increase. This is not a risk in a dynamic model, but if a dynamic model is not available, an assumption must be made about how long it will take to achieve the full effect and how the effect will develop over time. There are various ways of doing this. More detailed information about the calculation models, price elasticity etc. used to calculate energy savings achieved by Swedish policies in different sectors is given in the next section. The calculations are made for different fuels/energy sources in the housing and services (excluding agriscience businesses) and transport sectors.

In 2013, Runar Brännlund produced economic estimates of short- and long-term price elasticities for electricity consumption in the housing and services sector[139] and petrol and diesel consumption in the transport sector[140]. The elasticities in these estimates are lower than those in previous estimates made in 2008[141]. The Swedish Energy Agency produced new estimates of short- and long-term price elasticities in 2019; these covered the period 1975–2017 for electricity consumption in housing and services and 1976–2017 for the

[139] Brännlund (2013) *Bostadssektorns elefterfrågan i Sverige,* Rapport till Finansdepartementet.

[140] Brännlund (2013) *The effects on energy saving from taxes on motor fuels: The Swedish case,* CERE Working Paper 2013:6.

[141] See *Ett energieffektivare Sverige,* SOU 2008:25, Annex 5.

transport sector[142]. It based its estimates on the models used in 2013 for energy demand. The resulting price elasticities have been used for these effect calculations, as set out in the Swedish Energy Agency's memorandum[143].

The actual final energy consumption data are used for calculation and future monitoring for 2014–2017. The final energy consumption for 2017 is then used for 2018–2030. The actual energy prices, taxes and VAT are used for 2014–2018[144]. The values for 2018 are then used for 2019–2030. All of these prices are expressed as fixed prices as at 2015. Actual conversion factors are used to convert petrol and diesel prices from SEK/litre to SEK/kWh and vice versa.

The minimum EU tax and VAT levels set out in the respective directives are used for the contrafactual reference scenario[145]. The EU's lowest levels of taxation for each fuel has been converted to SEK/kWh at the current official exchange rate (see Table 10). This level is used for the whole of the period 2014–2030. The EU's VAT Directive states that the lowest level of normal taxation is 15%, as compared with the Swedish level of 25%. VAT at the EU's minimum level has been calculated on the Swedish energy price[146] and the lowest permitted level of normal taxation. The total minimum price has then been compared with the Swedish energy price including excise duty and VAT.

The effect of the price differences between excise duties and VAT in Sweden and the EU is calculated for each year. The price differences resulting from the above assumptions are the same as those for the years up to 2019, which produces the same annual, but preliminary, effect from that year onward.

Annex 2 contains descriptions and results of energy savings calculations in the housing and service and transport sectors. Full sources and data can be obtained from the Swedish Government Offices. The Swedish Energy Agency updates all of the data every year when new official statistics are published. It will also refine the calculation methods, as they currently underestimate the effects of the taxes. The calculations can be updated when the report on the energy savings achieved under the EU's Governance Regulation[147] is submitted.

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[142] The Swedish Energy Authority's Memorandum, 2019: *Beräkningsmetod för energi- och CO2-skatternas effekter på energianvändningen*. (ref. 2018–12739).

[143] Ibid.

[144] The Swedish Energy Agency – *Energiläget i siffror 2019*.

[145] The Directive states that credit should be given only for energy savings from taxation measures exceeding the minimum levels of taxation applicable in the EU.

[146] Excluding Swedish tax and VAT.

[147] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

Overall assessment of energy savings from Swedish policies

Table 12 shows the combined annual and cumulative energy savings from Swedish policies, calculated as the effect of higher levels of energy and carbon tax and VAT in Sweden compared with the EU's minimum levels of taxation. According to the tables, the overall cumulative energy saving from Swedish policies during the whole of the period 2014–2030 is estimated conservatively to be around 290 TWh: 119 TWh in 2014–2020 and 172 TWh in 2021–2030. This exceeds the cumulative energy saving to be achieved by Sweden for those periods[148]. The Swedish Energy Agency updates all of the data every year when new official statistics are published. It will also refine the calculation methods, as they currently underestimate the effects of the taxes. The calculations can be updated when the report on the energy savings achieved under the EU's Governance Regulation[149] is submitted.

Table 12. Annual and cumulative energy savings from Swedish policies for the period 2014–2030.

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Housing and services	*TWh/year*	10.8	11.6	11.4	11.3	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7
	TWh/cum.	10.8	22.4	33.8	45.1	56.7	68.4	80.1	91.7	103.4	115.1	126.7	138.4	150.1	161.7	173.4	185.0	196.7
Transport	*TWh/year*	4.7	5.4	6.2	5.8	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
	TWh/cum.	4.7	10.2	16.4	22.2	27.8	33.3	38.9	44.4	50.0	55.6	61.1	66.7	72.2	77.8	83.3	88.9	94.5
Total	***TWh/year***	15.5	17.0	17.6	17.1	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
	TWh/cum.	15.5	32.6	50.2	67.3	84.5	101.7	118.9	136.2	153.4	170.6	187.8	205.1	222.3	239.5	256.7	273.9	291.2
Housing and services	*TWh/year*								11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7
	TWh/cum.								11.7	23.3	35.0	46.7	58.3	70.0	81.7	93.3	105.0	116.7
Transport	*TWh/year*								5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
	TWh/cum.								5.6	11.1	16.7	22.2	27.8	33.3	38.9	44.5	50.0	55.6
Total	***TWh/year***								17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
	TWh/cum.								17.2	34.4	51.7	68.9	86.1	103.3	120.6	137.8	155.0	172.2

3.2.1.2 Long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private (2), including policies, measures and actions to

[148] 268 TWh in total, 106 TWh of which was achieved in 2014 –2020; 163 TWh is estimated for 2021–2030.

[149] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

stimulate cost-effective deep renovation and policies and actions to target the worst performing segments of the national building stock, in accordance with Article 2a of Directive 2010/31/EU.

Sweden will report its long-term renovation strategy under Article 2a of the Energy Performance of Buildings Directive[150] by 10 March 2020.

National Board of Housing, Building and Planning Building Regulations (BBR)

The Planning and Building Act (2010:900) establishes requirements for buildings. The regulations apply both to new buildings and to alterations to buildings. The National Board of Housing, Building and Planning Building Regulations (BBR)[151] contain detailed regulations under the Planning and Building Act for the design, accessibility and usability of housing, fire protection, hygiene, health, environment, water and waste management, noise protection, safe use and energy management.

The building regulations contain energy management requirements which specify the limits for energy consumption in buildings. One requirement sets limits for energy consumption in buildings (primary energy) expressed as kWh per square metre per year. This requirement covers energy for heating, comfort cooling, domestic hot water and domestic energy and is given for normal use of the building. The primary energy requirement is currently 90 kWh/m2 for small buildings, in other words one- and two-dwelling buildings, 85 kWh/m2 for multi-dwelling buildings and 80 kWh/m2 for non-residential buildings.

Support for renovation and energy efficiency measures in rented properties

On 1 October 2016, support was introduced to encourage renovation and energy efficiency measures in rented properties in areas facing socio-economic challenges[152].

The support is divided into two parts – one for renovation and one for energy efficiency. The renovation support, which is 20% of the costs, is given directly to the tenants as a rent rebate over seven years. The energy efficiency support is calculated on the basis of the energy saving achieved after the renovation. This part of the support is given to the property owner. To be eligible for this part of the support, the renovations must improve energy performance by at least 20%. Support cannot be sought for renovation or energy efficiency alone, as that does not fulfil the purpose of the measure[153].

The support is being phased out after the Riksdagen's decision on the state

[150] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.

[151] The National Board of Housing, Building and Planning regulations (BFS 2011:6, incl. amendments up to BFS 2018:15).

[152] The Ordinance (2016:837) on Support for Renovation and Energy Efficiency Measures in Some Residential Areas.

[153] The National Board of Housing, Building and Planning – *Information om stöd till renovering och energieffektivisering i vissa bostadsområden* (November 2016).

budget for 2019[154]. SEK 165 million has been allocated to fund existing measures in 2020[155].

The renovation, conversion and extension deduction

The tax deduction for renovation, conversion and extension applies to the labour costs for house repairs, maintenance, conversions and extensions. It was introduced in 2008 to increase the supply of labour and reduce undeclared work[156]. Some of the measures covered also help to increase energy efficiency[157]. An obvious effect of the deduction is that it gives property owners an incentive to carry out more renovations. On 1 July 2016 the tax reduction was cut from 50% to 30% of the labour costs. The maximum support will now be SEK 50 000 per person per year. The facility is offered to owners of small buildings, owner-occupied apartments and holiday homes and to tenants.

The National Renovation Centre (NRC)

The NRC works with businesses and academic institutions to improve knowledge and distribute information to operators in the building industry, to enable them to carry out renovations efficiently. The aim is to make existing buildings more environmentally, economically and socially sustainable from a life-cycle point of view, while improving or retaining their function so that they meet the requirements of users and the authorities[158].

Renoveringsinfo.se information website

The website renoveringsinfo.se is an initiative of the NRC and Svensk Byggtjänst AB. It aims to improve knowledge and distribute information to help operators in the industry to carry out renovations efficiently. The website collects opinion pieces, news, examples of renovation projects, research and comprehensive information on specific renovation measures. The news section is a subscriber service, but the other parts of the website are free.

The Sustainable Building Information Centre

The Sustainable Building Information Centre was set up on 1 January 2018 and is run by Svensk Byggtjänst AB on behalf of the National Board of Housing, Building and Planning[159]. The Government has commissioned the National Board of Housing, Building and Planning to monitor the Centre's operations and results on a regular basis. The contract expires in 2021 and

[154] Report 2018/19:CU1, Riksdag communication 2018/19:83.

[155] Government bill 2019/20:1, Report 2019/20:CU1, Riksdag communication 2019/20:96.

[156] Government bill 2006/07:94, Report 2006/07:Sk U15, Riksdag communication 2006/07:181 and Government bill 2008/09:97, Report 2008/09:FiU18, Riksdag communication 2008/09:183.

[157] Owners of small buildings are entitled to a tax reduction for drilling and installation of geo-thermal heating systems, changing windows, doors and taps, installing additional insulation and installing and changing ventilation systems. Tenants are entitled to a tax reduction only for the renovation, conversion and extension work carried out on the property. (www.skatteverket.se).

[158] http://www.renoveringscentrum.lth.se/.

[159] Svensk Byggtjänst AB works with IVL Swedish Environmental Research Institute, Rise Research Institutes of Sweden AB, Energy Agencies of Sweden, The National Renovation Centre at the Lund University Faculty of Engineering (NRC) and Sustainable Innovation (SUST).

will then be renewed for a year at a time, after evaluation.

The Sustainable Building Information Centre's mission is to 'promote energy efficient renovation and building, using sustainable materials while minimising the impact on the environment from a life-cycle point of view'. This includes collecting information about sustainable building, adapting it to specific target groups and disseminating it. The Centre's website provides information about research, results and experience. The Centre's information is targeted at all relevant groups, including professional builders, owners of small buildings, housing association board members, property owners or those involved in the building process in any other capacity[160].

3.2.1.3 Description of policy and measures to promote energy services in the public sector and measures to remove regulatory and non-regulatory barriers that impede the uptake of energy performance contracting and other energy efficiency service models

Development of local and regional capacity, including sustainable transport solutions

In the 2018 spending authorisation, the Swedish Energy Agency was assigned two tasks which promote efficiency improvements in transport. The first is to carry out initiatives in 2018–2020 to promote strategic work for the energy transition and reduced climate impact at local and regional level ('Local and Regional Capacity Development') and the second is to work in dialogue with the National Board of Housing, Building and Planning, the Swedish Transport Administration, the county councils and operators responsible for regional development on planning and implementing initiatives in the form of support to increase digital ways of working, cooperation on coordinated distribution of goods, town and country planning measures to improve transport efficiency, advice and education initiatives and financial support for measures or demonstrations ('Sustainable Transport Solutions'). The Agency has set up a support programme for these two tasks, which distributes funds by means of public calls. The support programme aims to help local and regional public operators to contribute to the energy transition and reduced climate impact. It is designed to develop operators' ability to work systematically and strategically on integrating energy and climate matters into various areas of public-sector responsibility, including public procurement, town and country planning and improving transport efficiency. The 75 or so projects which have been given support must end by 2020. In 2019 and 2020 the Swedish Energy Agency will also arrange for the projects to exchange experience and share knowledge and produce guidelines and other knowledge aids for operators wishing to carry out similar work.

[160] https://ichb.se/.

Since 2018, the county councils have been tasked by the Government with promoting, coordinating and leading the regional implementation of the Government's policies for the energy transition and reduced climate impact in the long-term. This involves:

- leading and coordinating the development of new long-term regional energy and climate strategies based on the Riksdag's long-term energy and climate policy in dialogue with operators in other county councils; and
- coordinating measures to promote fossil-free transport and developing regional plans for infrastructure for electric vehicles and renewable fuels as part of its work on regional energy and climate strategies, in dialogue with the Swedish Energy Agency and the Swedish Transport Administration.

The regional strategies and plans were adopted in autumn 2019 and are now being implemented.

Dissemination of information

To promote energy services, the Swedish Energy Agency is currently working as a contact point, providing relevant information to customers and suppliers on the internet. In its Performance-Based Energy Management project[161], the Residential Property Owners' Network's has developed a model contract for housing associations. The report *Nulägesanalys av energitjänster med garanterad energibesparing i Sverige*[162] was produced in 2017.

The Energy Efficiency Council

The Energy Efficiency Council is responsible for improving state cooperation and implementing and monitoring measures and instruments to achieve the Riksdag's energy efficiency objectives. It plays and important part in implementing the Energy Efficiency Directive. The Council is an arena for addressing strategically important issues to improve cooperation within the Government and increase the transparency of energy efficiency, including public procurement and energy efficiency measures. It is an advisory body and meets four times a year.

3.2.1.4 Other planned policies, measures and programmes to achieve the indicative national energy efficiency contributions for 2030 as well as other objectives referred to in point 2.2 (for example measures to promote the exemplary role of public buildings and energy-efficient public procurement, measures to promote energy audits and energy management systems (2), consumer information and training measures (3), and other measures to promote energy efficiency (4)).

[161] https://energiradgivningen.se/lagenhet/malstyrd-energiforvaltning.

[162] http://www.enveco.se/wp-content/uploads/2018/03/Anthesis-Enveco-rapport-2017-13.- Nul%C3%A4gesanalys-av-energitj%C3%A4nster-med-garanterad-energibesparing-i-Sverige.pdf.

Besides the energy efficiency provisions adopted at European level and implemented in Sweden, such as the Ecodesign Directive[163], the Energy Labelling Regulation[164], the Energy Performance of Buildings Directive[165] and the Energy Efficiency Directive[166] the following policies and measures apply.

Sectoral energy efficiency strategies

In 2017 the Government commissioned the Swedish Energy Agency to formulate sectoral energy efficiency strategies with various industries, in consultation with the relevant agencies. The sectoral strategies are designed to help Sweden to achieve the target of a 50% improvement in energy efficiency by 2030.

The aim of sectoral strategies is to set up a dialogue between the Swedish Energy Agency, various industries and relevant agencies at an early stage, to discuss indicative targets and measures in each sector and thus make a cost-effective contribution to achieving the national energy and climate objectives. This task was assigned to it under the Energy Agreement (see Section 1.2) and will continue until 2030. The sectoral strategies are described in Section 2.2.

Municipal energy and climate advisory services[167]

Energy and climate advisory services have existed in various forms for nearly 40 years. They were reviewed in 2015, and the Government decided to introduce new guidelines in the Ordinance (2016:385) on Contributions to Communal Energy and Climate Advisory Services. Advisory services provide impartial, free, technologically neutral and commercially independent advice to households, companies, housing associations and organisations. This can be done by telephone or email or face-to-face.

All municipalities can provide basic local energy and climate advice. Municipalities in remote areas can obtain additional coordination and travel support to allow them to provide these services. In addition to a basic advisory service, municipalities can run a more comprehensive energy and climate advisory service with additional financial support from the Swedish Energy Agency. The additional support can allow them to provide more advice and cooperate with other municipalities or work together on projects which focus on a local priority target group.

[163] 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.
[164] Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU.
[165] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.
[166] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.
[167] http://www.energimyndigheten.se/energieffektivisering/program -och-uppdrag/kommunal-energi-och-klimatradgivning/.

Environmental supervision and guidance for supervision

The Environmental Code came into force in 1998. The Code increased the importance of energy management and the use of renewable energy sources by highlighting them in one of the rules for consideration which are its fundamental pillars. The Environmental Code specifies that all operators must manage energy and use primarily renewable energy sources. Operators must therefore:

- find out how much energy they are using;
- identify possible measures; and
- take reasonable measures at all times.

The supervisory authorities must check that the management principles are being followed. They are also responsible for giving advice. The authorities have the right to request the information required for supervision, for example maps, analyses and measures. It is therefore particularly important to document energy management work. Under the Environmental Supervision Ordinance (2011:13), the Swedish Energy Agency has been responsible for providing supervisory guidance for operators' internal audits of energy management and the use of renewable energy sources since 2011. The work involves supporting and advising operational supervisory authorities, municipalities and county councils and coordinating, monitoring and evaluating operational supervision.

Energy mapping in large companies

The Energy Mapping (Large Companies) Act (2014:266) aims to promote energy efficiency. The Act is one of the ways in which Sweden meets the requirements imposed on Member States under the EU's Energy Efficiency Directive[168]. The Act requires large companies to produce energy maps, which must contain information about their total energy consumption and suggestions for cost-effective ways of improving energy efficiency. Energy mapping must be carried out at least every four years.

The *Energisteg* programme

Energisteg is a programme to support energy efficiency in industry and thus help to achieve the Energy Agreement target of a 50% improvement in energy efficiency by 2030. The programme has a total funding allocation of SEK 125 million and runs from 2018–2020. Industry accounts for a large proportion of Sweden's total energy consumption and the programme is targeted particularly at the mining and manufacturing industries.

Industrial companies that have produced an energy map under the Energy

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

Mapping (Large Companies) Act, can seek two types of financial support: design support or investment support. Design support is a contribution to an in-depth design or study of energy efficiency measures. Investment support covers the additional cost of investing in energy efficiency measures identified by statutory energy mapping.

The European Regional Development Fund

During the 2014–2020 programming period, the Commission allocated around SEK 2.8 billion (including national co-finance) to Sweden to implement Thematic Objective 4 of the Regional Funds: 'supporting the shift towards a low-carbon economy in all sectors'. These funds have been divided between eight regional and one national Regional Fund programme to encourage businesses, specifically small and medium-sized enterprises, to improve the energy efficiency of their operations and to contribute to innovative solutions in this area. More than 12 000 companies are expected to have received support through the projects funded up to now.

Energy efficiency support for small and medium-sized enterprises[169]

Since 2015, the Swedish Energy Agency has run initiatives to promote energy efficiency in small and medium-sized enterprises. The support is co-financed by the European Regional Development Fund via the National Regional Fund Programme. The Programme includes support to companies for energy mapping. Companies that have already mapped their energy use, but need to carry out in-depth analyses before making investment decisions, can apply for support for environmental studies. Companies can also apply for investment support for energy efficiency measures. Besides this financial support. small companies are also offered coaching and the opportunity to take part in regional business networks.

The National Regional Fund Programme's Priority Axis 3, which supports the shift towards a low-carbon economy in all sectors, aims to promote energy efficiency and the use of renewable energy in companies, along with research and innovation. The Priority Axis also aims to support the capital requirements of companies whose operations assist with the transition to a low-carbon economy.

The eight Swedish Regional Fund Programmes grant funding to projects specifically aimed at energy efficiency in small and medium-sized enterprises. The projects include cooperation between universities, companies and the public sector to improve the energy efficiency of small and medium-sized enterprises in the region.

Support for introduction to market, technology development and innovation clusters

[169] http://www.energimyndigheten.se/nrp/.

Technology procurement is an instrument designed to initiate a transition in the market and to disseminate new, more efficient technologies and methods and new products, systems and processes. Network-based procurement for the development of technology is a method which covers the whole decision-making process, from the preliminary study and purchasing groups, to requirements specifications and the dissemination and further development of more energy-efficient technologies. It is used in areas such as heating and control, ventilation and lighting. The Swedish Energy Agency coordinates innovation clusters for cities (BeBo), commercial and public premises (BeLok), small house builders (BeSmå), public sector bodies renting premises (HyLok) and food distribution (BeLivs).

The aim of these purchaser groups and networks is to create a forum and a platform where the state, businesses and academic institutions can develop energy-efficient methods, produce good examples and give demonstrations etc. The networks test, introduce and evaluate new technologies, new models and new products and overcome knowledge barriers on the market. The networks also act as a platform for cooperation and engagement for various sector operators, agencies and academic institutions.

Energy declarations

The Energy Declarations for Buildings Act (2006:985) came into force in 2006 and governs the use of energy declarations in Sweden. The National Board of Housing, Building and Planning has produced rules for implementing the Act and supervises the declarations and the independence of energy experts. An Energy Declaration must be prepared for buildings when they are built, sold or rented out and for large buildings often visited by the public. It is drawn up by an independent expert commissioned by the owners and is valid for 10 years.

An Energy Declaration contains information about the building's energy consumption and is intended for future house buyers or tenants. Energy Declarations must provide buyers with information about energy consumption which they can take into account when buying a property. They must also contain any energy-saving measures suggested by the energy expert.

Energy Declarations were introduced 13 years ago and many early declarations have now expired as they are only valid for 10 years. New declarations have therefore been issued for many buildings in the past few years. In June 2019, 689 000 buildings with an Energy Declaration were registered in the National Board of Housing, Building and Planning's database[170].

[170] The National Board of Housing, Building and Planning. *Trend – Energideklarationer 2009-07-01 – 2019-06-30*.

Training programmes for low-energy buildings

Since 2016, the Swedish Energy Agency, together with other operators, has been responsible for a range of capacity-building programmes for low energy consumption in buildings. The programmes are aimed at various operators in the building industry, such as architects, engineers, customers, technicians, installers, site managers and teachers of secondary school building courses.

Information initiatives

The Swedish authorities, particularly the Swedish Energy Agency[171], have developed web-based tools to disseminate information about energy consumption and energy efficiency to specific target groups. The information initiatives are targeted at households, companies and authorities.

- *Energikalkylen*[172] is a web-based calculation programme which provides households with information about energy efficiency.
- *Energilyftet*[173] is a free web-based training course on low-energy building aimed at customers, architects, engineers, building project managers, administrators and control technicians.

The Sustainable Building Information Centre[174] was set up in December 2017 at the request of the National Board of Housing, Building and Planning and on the Government's initiative. The Centre is run by Svensk Byggtjänst AB in conjunction with IVL Swedish Environmental Research Institute, Rise Research Institutes of Sweden AB, Energy Agencies of Sweden, The National Renovation Centre at the Lund University Faculty of Engineering (NRC) and Sustainable Innovation (SUST) and promotes energy-efficient renovation and building using sustainable materials which have a low climate impact from a life-cycle point of view. It is tasked with collecting information about sustainable building, adapting it to specific target groups and disseminating it and has published scientific reports and articles, produced guides to sustainable building and taken part in conferences.

3.2.1.5 Where applicable, a description of policies and measures to promote the role of local renewable energy communities in contributing to the implementation of policies and measures in points i, ii, iii and iv.

The Swedish Energy Markets Inspectorate is currently tasked with examining how the Internal Market for Electricity Directive should be

[171] https://www.energimyndigheten.se/energieffektivisering/.

[172] http://energikalkylen.energimyndigheten.se/.

[173] http://www.energimyndigheten.se/energieffektivisering/jag-arbetar-med-energieffektivisering/byggbranschen/energilyftet/.

[174] https://www.ichb.se/, https://www.boverket.se/sv/byggande/uppdrag/informationscentrum-for-hallbart-byggande/.

incorporated into Swedish legislation. At present there are no measures or policies for this.

3.2.1.6 Description of measures to develop measures to utilise energy efficiency potentials of gas and electricity infrastructure

Amendments to the Electricity Act

The Electricity Act (1997:857) was amended in 2014 to comply with the requirements of the Internal Market for Electricity Directive. A provision was inserted into Chapter 3, Section 16a of the Act, which states that grid operators may not establish technical requirements or other conditions which hamper the provision of services in the form of altered electricity consumption, unless the conditions are justified in the interests of a secure, reliable and efficient network. This avoids the possibility of network tariffs preventing load levelling by balancing services, for example, and the purchase of additional services.

Provisions were also inserted into Chapter 4, Section 1 of the Electricity Act, stating that network tariffs must be compatible with efficient use of the grid and efficient generation and consumption of electricity. The Swedish Energy Markets Inspectorate may issue regulations for network tariffs to promote effective use of the grid.

Regulatory model for network operators

In 2014, an incentive to encourage energy efficiency was introduced into the economic regulation of grid operators[175]. The incentive gives a bonus to network operators that help to increase energy efficiency by reducing network losses and improving the utilisation of capacity a bonus.

3.2.1.7 Regional cooperation in this area, where applicable.

Since 2018, the county councils have been tasked by the Government with promoting, coordinating and leading the regional implementation of the Government's policies for the energy transition and reduced climate impact in the long-term. This involves:

- leading and coordinating the development of new long-term regional energy and climate strategies based on the Riksdag's long-term energy and climate policy in dialogue with operators in other county councils; and
- coordinating measures to promote fossil-free transport and developing regional plans for infrastructure for electric vehicles and renewable fuels as part of its work on regional energy and climate strategies, in dialogue with the Swedish

[175] *Energimarknadsinspektionens föreskrifter (EIFS 2019:4) om vad som avses med kvaliteten i nätverksamheten och vad som avser med ett effektivt utnyttjande av elnätet vid fastställande av intäktsram.*

The regional strategies and plans were adopted in autumn 2019 and are now being implemented.

3.2.1.8 Financing measures, including Union support and the use of Union funds, in the area at national level.

Besides the national financing measures described above, the following EU finance is relevant:

EU financial support for energy efficiency in buildings

The EU promotes improvements in the energy performance of buildings with a range of financial support programmes. The Energy Efficiency Finance Facility (EEFF) was established in 2011 and offers facilities for loans, equity and guarantees and support for technical assistance for project development support.

The European Regional Development Fund

The European Regional Development Fund (ERDF) aims to improve economic and social cohesion within the EU by reducing regional differences. In 2014–2020, the ERDF rules require Member States to allocate an obligatory part of the support to the 'transition to a low-carbon economy'. The priorities for the next programming period, 2021-2027, have not yet been established, but are likely to include comprehensive initiatives for Sweden's climate transition.

During the 2014–2020 programming period, the Commission allocated around SEK 7.5 billion (including national co-finance) to Sweden for the Regional Funds; SEK 1.4 billion of this was intended for thematic objective 4: 'supporting the shift towards a low-carbon economy in all sectors'.

EU funds for Thematic Objective 4 in 2014–2020 have been divided between eight regional programmes (SEK 8 million excluding co-finance) and one national Regional Fund programme (SEK 700 million excluding co-finance) to encourage businesses, specifically small and medium-sized enterprises, to improve the energy efficiency of their operations and to contribute to innovative solutions in this area.

The National Regional Fund Programme

Priority Axis 3 of the National Regional Fund Programme 'supporting the shift towards a low-carbon economy in all sectors' aims to promote energy efficiency and the use of renewable energy in companies, as well as research and innovation, and the application of low-carbon technologies. This

priority axis is implemented as a national initiative to encourage small and medium-sized enterprises to improve their energy efficiency, which will make them more competitive on the market. The Priority Axis also aims to support the capital requirements of companies whose operations assist with the transition to a low-carbon economy.

The initiatives described below are run by the Swedish Energy Agency to enable companies throughout the country to improve their energy efficiency.

Energy mapping support

Small and medium-sized enterprises have been entitled to apply for financial support for energy mapping since 2010 to improve their energy efficiency[176]. Energy mapping should include energy maps, suggestions for measures and an energy plan. Each company can apply for 50% of the cost of energy mapping, up to a maximum of SEK 50 000.

Energy efficiency networks

The Swedish Energy Agency launched a network project for small and medium-sized enterprises in 2015. The project aims to operate 40 networks comprising 400 companies in all, and to help them to introduce energy management principles with the assistance of regional coordinators and energy experts. Sharing experience and learning from each other through the networks are also important factors for success. The network activities aim to reduce the energy consumption of participating companies by 15%. This will reduce the companies' costs, improve their competitiveness and provide new opportunities for growth.

Development of technologies and innovation

Investment support for energy-efficiency measures. Some measures identified by energy mapping may be expensive but necessary for the company to achieve the higher level of energy efficiency. Companies can apply for investment support for up to 50% of the additional cost of these investments.

Energy-efficiency incentives

Advice for small and medium-sized companies subject to supervision under the Environmental Code. The supervision officers of the county councils and municipalities give companies advice on supervision to enable them to go beyond the legal requirements.

Dissemination of information about energy services

The Swedish Energy Agency has specific initiatives to promote energy

[176] The Ordinance (2009:1577) on State Support for the Production of Biogas.

services to small and medium-sized enterprises (SMEs). It carries out these initiatives in conjunction with industry organisations, energy management agencies and county councils all around the country to reach both customers and suppliers of energy services. Activities include a variety of seminars, workshops and network meetings.

Energy and climate coaches

The Energy and Climate Coaches project is a national initiative aimed particularly at small and medium-sized enterprises with an annual energy consumption of less than 300 megawatt hours (MWh).

The programme, which is free to participants, combines individual coaching with group lectures and exchanges of information between companies. The coaching activities aim to increase energy efficiency and reduce greenhouse gas emissions. The benefits to the companies are lower costs and improved competitiveness.

The municipalities are entitled to apply for funding for a part-time energy and climate coach.[177] Around 130 municipalities currently have coaches, which means that coaching can be provided locally. The programme started in January 2017 and continued until 2019.

Other activities under the National Regional Fund Programme.

ClimateSync knowledge support is run jointly by the Swedish Energy Agency and the Swedish Agency for Economic and Regional Growth to support all of the initiatives in Thematic Objective 4; it includes mapping, project manager meetings, results work, learning processes and dissemination activities.

Green Funds are equity funds for investment in start-ups providing products and services to reduce climate impact. Green Funds are managed by ALMI Invest AB.

Regional Structural Funds Programme

Within the eight Swedish regional ERDF programmes, more than 20 projects aimed specifically at energy efficiency in small and medium-sized enterprises have been granted finance in 2014-2020. The projects include cooperation between universities, companies and the public sector (regions, municipalities etc.) aimed at improving the energy efficiency of small and medium-sized companies in the region.

[177] The Ordinance (2016:385) on Contributions to Municipal Energy and Climate Advisory Services.

Besides these energy efficiency projects for small and medium-sized enterprises, finance has so far been granted to around 150 projects for:

- research and innovation: low-carbon technology;
- sustainable building;
- sustainable transport;
- renewable energy in small and medium-sized enterprises; and
- business support.

3.3 Dimension energy security

3.3.1 Policies and measures related to the elements set out in point 2.3.

Electricity supply

Measures for power cuts

Svenska kraftnät is Sweden's emergency preparedness authority for electricity; it's job is to reinforce the electricity supply to ensure that it can withstand severe stresses. It ensures that measures are taken to improve preparedness, that there are trained personnel and that resources are available to carry out repairs and provide communication equipment. For the funding of preparedness measures, see Section 3.3.3.

Network owners are obliged to ensure that power cuts last for no more than 24 hours (see also Section 2.3) unless they are caused by factors beyond their control[178]. If a power cut lasts for more than 12 hours, customers are entitled to compensation[179].

Measures are also taken to increase public awareness of suitable preparedness measures at home to alleviate the effects of power cuts[180].

Measures for electricity shortages

Crisis management measures have been prepared both to prevent electricity shortages and to alleviate the effects of any shortages. The measures include a national information campaign to encourage consumers to reduce their consumption voluntarily to avoid shortages. If this is not sufficient, there are plans for a possible rationing system in the future. The Swedish Energy Agency is the agency in charge of measures to deal with electricity shortages.

[178] Chapter 3, Section 9a of the Electricity Act (1997:857).

[179] Chapter 3, Section 9a of the Electricity Act (1997:857).

[180] http://www.energimyndigheten.se/trygg-energiforsorjning/nar-det-blir-el--eller-varmeavbrott-i-ditt-hem/.

Measures for capacity shortages

Capacity shortages must be avoided because market operators act in balance. The Swedish system operator, Svenska kraftnät, has a number of technical and commercial mechanisms which it can use to maintain the balance in the electricity system if this is not sufficient.

The capacity reserve can be used if the balance cannot be restored by ordinary measures. To create the capacity reserve, Svenska kraftnät sets up agreements with electricity generators and consumers to maintain a specific generation capacity or reduce their consumption.

If these mechanisms are not sufficient to remedy the problem, load shedding (manual disconnection) is the last resort; that means disconnecting some consumers to avoid system collapse. *Styrel*, a method for planning and prioritising socially important electricity consumers, has been developed to alleviate the consequences for society[181].

The Government has commissioned the county councils in Skåne, Stockholm, Västra Götaland and Uppsala to carry out a local and regional analysis of the conditions for a secure electricity supply in their respective regions. The aim is to find ways of improving coordination between the regional and local operators to increase the efficiency of network supply. The county councils must collect information and views from relevant local and regional operators, such as municipalities and grid operators, to obtain a good basis for their analysis of the local and regional capacity requirements. They must also identify, and coordinate with, national initiatives and projects and work which is important for their assessments for the particular area.

They must submit a report to the Swedish Government Offices (Infrastructure Department) by 07 August 2020.

Gas supply

The Security of Gas Supply Regulation[182] contains operational requirements for security of the gas supply. On the basis of the Regulation and the Swedish

legislation[183] a risk assessment had been carried out which forms the basis for a national preventive action plan[184] and national crisis management plan. In addition to these plans, the Swedish Energy Agency has also produced regulations and general advice[185], which contain certain requirements for natural gas companies and major natural gas consumers. The requirements

[181] The Ordinance (2011:931) on Planning to Prioritise Socially Important Electricity Consumers.

[182] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010

[183] Act (2012: 273) on the Security of the Natural Gas Supply and the Ordinance (2012:275) on the Security of the Natural Gas Supply.

[184] This corresponds to the requirement in Article 6(1) of Regulation (2017/1938) to introduce a 'risk preparedness plan'.

[185] The Swedish Energy Agency's regulations and general advice (STEMFS 2016:1) on security of the national gas supply.

aim to increase preparedness for any future gas supply crises and thus secure the supply of gas to domestic customers, who have special protection under the Security of Gas Supply Regulation. The Regulation specifies that the competent authorities must oblige natural gas companies to take measures to secure the gas supply to protected customers in the following circumstances:

- when temperatures are extreme for seven days which, statistically, happens once every 20 years;
- when there is an exceptional demand for gas for a period of 30 days which, statistically, happens once every twenty years; and
- when the largest single gas infrastructure is interrupted for 30 days under average winter conditions

Oil supply

The IEA Agreement[186] and the Oil Stocks Directive[187] oblige Sweden to hold emergency stocks equivalent to 90 days' net imports. The Swedish Energy Agency determines the size of the oil stocks once a year; it also establishes who is responsible for holding them and how large individual stocks should be. The extent of the storage obligation is based on the sales or consumption of the party obliged to hold them during the previous reference year. A stock year runs from 1 April to 31 March of the following year. From 2020, the stock year will change to 1 July to 30 June of the following year. The emergency stocks include biofuels if they are blended with stored fuel on sale or consumption, or if they are stored in Sweden and the party obliged to store them can demonstrate that they are intended for blending with stored fuel and will be used for transport.

Information security

Implementation of the NIS Directive

The NIS Directive[188] on information security has been transposed into Swedish legislation by the (2018:1174) Socially Important and Digital Services (Information Security) Act and the accompanying Ordinance and regulations.

The purpose of the Information Security (Socially Important and Digital Services) Act is to achieve a high level of network and information-system security for socially important services in the energy, transport, banking, financial market infrastructure, health, drinking water supply and distribution, digital infrastructure and digital services sectors. The Swedish

[186] The International Energy Agency's Agreement on an International Energy Programme.

[187] Council Directive 2009/119/EG of 14 September 2009 imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products.

[188] Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union.

Civil Contingencies Agency coordinates the work under the Act and the individual sectors have dedicated supervisory authorities. In short, the Act obliges suppliers of socially important services to register with the supervisory authorities, to report incidents and to carry out systematic information security work.

The Government has appointed the Swedish Energy Agency as the supervisory authority for the energy sector in Sweden under the Act. The Agency is therefore required to supervise suppliers of socially important services in the energy sector to ensure that they comply with the Act and the associated regulations. It is also responsible for providing information and training about information security and risk and continuity management. It is currently developing regulations for risk analysis and security measures for the energy sector. The Agency provides training on legislation, threats and risk analysis.

The Government's digitisation strategy

The National Digitisation Strategy[189] sets out the Government's digitisation policy. The vision is sustainable digitisation in Sweden. The overall objective is to make Sweden the world leader in exploiting the possibilities of digitisation. Reliable people with good digital skills have the opportunity to drive innovation, which requires strong leadership and good infrastructure. The strategy contains five subsidiary objectives for digital competence, digital security, digital innovation and digital infrastructure to help achieve the overall objective. The subsidiary objectives show how digitisation will benefit social development.

National strategy for information and cybersecurity

The Government has also presented a national strategy for developing and improving information and cybersecurity in Sweden[190]. The strategy sets out objectives in six priority areas to create permanent conditions which will allow social operators to work effectively on information and cybersecurity and raise awareness and improve knowledge throughout society.

3.3.2 Regional cooperation in this area

The security supply work and crisis management measures are based on the geographical extent of the market. Since the oil and fuel markets are global, cooperation on crisis management measures is also global, partly within the IEA. The risk of a potential oil or fuel shortage is analysed both in Sweden and in the EU, by the IEA. The IEA assesses the severity of an interruption to the market supply and analyses how much of the emergency stocks should be used to cover it. It can suggest measures, including collective

[189] https://www.regeringen.se/49adea/contentassets/5429e024be6847fc907b786ab954228f/digitaliseringsstrategin_slutlig_170518-2.pdf.

[190] https://www.regeringen.se/49f639/contentassets/04c9e2929f474f14bb05f182e7054c87/faktablad -en- nationell-strategi-for-samhallets-informations--och-cybersakerhet.pdf.

measures, but Sweden is responsible for deciding on the measures to be taken.

Since the Swedish electricity system is linked to the other Nordic countries, the Nordic region works together on crisis management measures. NordBER is a forum for cooperation between the Nordic energy and electricity preparedness authorities and system operators on electricity preparedness. Two Swedish agencies, the Swedish Energy Agency and Svenska kraftnät, are members.

Sweden and Denmark have cooperated on gas supply for many years. The EU's new Security of Gas Supply Regulation[191] formalises regional cooperation by dividing Member States into different regional risk groups so that they can produce joint regional risk assessments to improve cooperation on disruption which affects the region. Sweden is in three of these groups[192]. The transmission network operators in Sweden and Denmark have set up a joint balancing zone which will increase regional cooperation.

3.3.3 Where applicable, financing measures in this area at national level, including Union support and the use of Union funds

Svenska kraftnät is given a budget allocation for preparedness measures. Some of this allocation is also used for administrative costs linked to its role as the authority in charge of preparedness, funding for research and information related to its duty to promote the security of the country's flood defences. The annual allocation is normally equivalent to the electrical preparedness charge paid by the grid operators (SEK 255 million in 2018[193]).

The crisis management measures aim to prevent, resist and manage disruption of the electricity supply which may place the country under severe strain. Examples include technical reinforcement measures, increased physical protection of vital installations, strong IT-security and the acquisition of resources for repair and training.

3.4 Dimension internal energy market

3.4.1 Electricity infrastructure

3.4.1.1 Policies and measures to achieve the targeted level of interconnectivity as set out in point (d) of Article 4.

[191] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010

[192] Group 1 comprises Denmark, Germany, Luxembourg and the Netherlands, Group 2 Belgium, Czechia, Denmark, Germany, France, Luxembourg, the Netherlands, Austria and Slovakia and Group 3 Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Luxembourg, the Netherlands, Portugal and the United Kingdom.

[193] Svenska Kraftnät – *Årsredovisning 2018*, p. 35.

As regards the dimension 'Internal Energy Market':

1. The level of electricity interconnectivity that the Member State aims for in 2030 in consideration of the electricity interconnection target for 2030 of at least 15%, with a strategy with the level from 2021 onwards defined in close cooperation with the Member States affected, taking into account the 2020 interconnection target of 10% and the indicators of the urgency of action based on price differential in the wholesale market, nominal transmission capacity of interconnectors in relation to peak load and to installed renewable generation capacity as set out in point 2.4.1 of Section A of Part I of Annex I. Each new interconnector shall be subject to a socioeconomic and environmental cost-benefit analysis and implemented only if the potential benefits outweigh the costs.

2. Key electricity and gas transmission infrastructure projects, and, where relevant, modernisation projects, that are necessary for the achievement of objectives and targets under the five dimensions of the Energy Union.

3. National objectives related to other aspects of the internal energy market such as: increasing system flexibility, in particular through policies and measures related to market-based price formation in compliance with applicable law; market integration and coupling, aiming to increase the tradeable capacity of existing interconnectors, smart grids, aggregation, demand response, storage, distributed generation, mechanisms for dispatching, re-dispatching and curtailment and real-time price signals, including a timeframe for when the objectives should be met, and other national objectives related to the internal energy market as set out in point 2.4.3 of Section A of Part 1 of Annex I

As described in Section 2.4, the Swedish interconnectivity level in 2018/2019 is 27%, which is higher than the EU's target of 15% by 2030. Svenska kraftnät is building connections to other countries on the basis of socio-economic cost-benefit assessments.

A third AC connection to Finland is currently in the design phase and the Hansa Powerbridge to Germany is part of the current network development plan. Planned and new connections are analysed every other year, when Svenska kraftnät's network development plan is updated.

3.4.1.2 Regional cooperation in this area

Svenska kraftnät cooperates with other European national grid companies through the European Network of Transmission System Operators for Electricity (ENTSO-E). It contributes to various ENTSO-E products such as the Ten Year Development Plan (TYNDP) and is also a member of various ENTSO-E working groups.

It also produces joint Nordic network development plans with the other Nordic national grid companies every other year. The last plan, which was published in August 2019[194][194], describes planned and current projects.

3.4.1.3 Where applicable, financing measures in this area at national level, including Union support and the use of Union funds

The planned AC connection[195] (400 kV) between Sweden (SE1) and Finland has PCI status[196] and is therefore eligible for funding from the EU. This is being handled by Fingrid (the Finnish transmission system operator).

3.4.2 Energy transmission infrastructure

3.4.2.1 Policies and measures related to the elements set out in point 2.4.2, including, where applicable, specific measures to enable the delivery of Projects of Common Interest (PCIs) and other key infrastructure projects.

Removing regular bottlenecks from the national grid is a continuous process. Regional and local network companies are responsible for their own parts of the grid. Regular bottlenecks are removed if that is worthwhile from a socio-economic point of view. However there is no justification for reinforcing the grid to the point where bottlenecks never occur. Reinforcing the grid to minimise bottlenecks is a long-term measure.

3.4.2.2 Regional cooperation in this area

See Section 3.4.1.2.

3.4.2.3 Where applicable, financing measures in this area at national level, including Union support and the use of Union funds

A new scheme[197] was introduced on 1 May 2015 which allows regional network companies to apply for grid reinforcement loans. The aim of the new regulation is to enable large renewable generation projects to connect to the grid.

The grid reinforcement loan is a temporary solution to allow regional network companies to obtain a loan from Svenska kraftnät under certain circumstances. The loan covers the grid reinforcement costs that facilitate future connection of electricity generation. This means that an operator connecting to the grid only needs to pay the costs of the capacity required for its own project, which was not the case with previous regulations.

[194] Statnett, Fingrid, Energinet, Svenska kraftnät – Nordic Grid Development Plan 2019.

[195] https://www.svk.se/natutveckling/stamnatsprojekt/messaure-keminmaa/.

[196] https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest.

[197] The Ordinance (2015:213) on Loans to Network Companies for the Connection of Renewable Generation.

3.4.3 Market integration

3.4.3.1 Policies and measures related to the elements set out in point 2.4.3

Sweden does not have any national targets for market integration, as stated in Section 2.4.3. While there are no national targets, the measures for market integration are described in more detail below.

3.4.3.2 Measures to increase the flexibility of the energy system with regard to renewable energy production such as smart grids, aggregation, demand response, storage, distributed generation, mechanisms for dispatching, re-dispatching and curtailment, real-time price signals, including the roll-out of intraday market coupling and cross-border balancing markets.

An electricity market with a higher proportion of renewable generation in the form of wind and solar power also presents greater challenges for the electricity system. Domestic customers and industries can help to meet some of the challenges by being flexible in their use of electricity. A flexible electricity system is essential for maintaining the balance between production and consumption. Those responsible for the balance hold the key to this, since they have an incentive to reduce their costs by increasing the flexibility of resources under market conditions. In a future electricity market with a higher share of renewable and variable electricity generation, it will be important to use all of the electricity system's flexibility resources, in other words flexible production and storage, and demand response.

The SmartGrid Forum has produced a strategy[198] to increase flexibility in the electricity system with smart grids. Four areas have been identified which need to be developed to achieve this. These four areas combined are essential for the development of services and products to stimulate flexibility in the electricity system. The Forum has produced 20 recommendations for activities in the following four areas:

- establishing the conditions for new business models for flexible services;
- developing the markets for system services;
- carrying out IT-security and integrity measures; and
- carrying out information and awareness-raising measures.

Sweden participates in Nordic and international cooperation on demand response. The Swedish Energy Markets Inspectorate monitors developments in demand response continuously to ensure there is scope for it in the regulations. It has proposed a range of measures to facilitate and accelerate the development of demand response at the Government's request[199]. Many of these measures have been implemented. The measures implemented or

[198] http://www.swedishsmartgrid.se/globalassets/publikationer/slutrapport_flex_14sept.pdf.

[199] The Swedish Energy Markets Inspectorate – *Åtgärder för ökad efterfrågeflexibilitet i det svenska elsystemet* (Ei 2016:15).

approved are described below.

Work is being carried out in accordance with the network codes on shorter settlement periods and developed price setting for imbalances. This may give operators more of an incentive to develop business models for explicit demand response. Explicit demand response means that customers are compensated for using more or less electricity during a particular period. The energy released in this way can be offered in different marketplaces (for example intraday or balancing power markets) or used for other purposes (for example for local networks). Flexibility is therefore priced in the electricity system.

To enable customers to adapt their electricity consumption to hourly variations in the electricity price, they must be sent a price signal by means of an hourly price contract, for example; this is known as implicit demand response. An hourly price contract means that customers are charged for their actual hourly consumption rather than at a flat rate for their consumption profile. Hourly price contracts give customers a genuine opportunity and incentive to control their consumption, so that they use more electricity when the price is low and less when the price is high. Two measures have been implemented to promote hourly price contracts.

The Ordinance (1999:716) on the Measurement, Calculation and Reporting of Transmitted Electricity (the Measurement Ordinance) has been amended to remove flat-rate settlement for customers with an hourly price contract from 1 January 2020. In addition to this, hourly rate contracts will be included in *Elpriskollen* – the Swedish Energy Market Inspectorate's price comparison website. This will be done by including variable hourly rate contracts in the Inspectorate's regulations and general advice[200] about electricity suppliers' responsibility for providing information about prices and conditions applicable to consumers. Showing these contracts on *Elpriskollen* will create new opportunities for Swedish consumers to choose this type of contract.

3.4.3.3 Where applicable, measures to ensure the non-discriminatory participation of renewable energy, demand response and storage, including via aggregation, in all energy markets.

There are no specific measures, as discrimination is not permitted in the Nordic electricity system.

3.4.3.4 Policies and measures to protect consumers, especially vulnerable and, where applicable, energy poor consumers, and to improve the competitiveness and contestability of the retail energy

[200] *Energimarknadsinspektionens föreskrifter och allmänna råd (EIFS 2013:7) om elleverantörers skyldighet att lämna uppgift om priser och leveransvillkor som tillämpas mot elanvändare.*

market.

The Swedish definition of vulnerable customers is set out in the Ordinance (2016:742) containing Instructions for the Swedish Energy Markets Inspectorate and states that 'vulnerable customers are persons who permanently lack the means to pay for the electricity or natural gas transmitted or delivered to them for non-business purposes'. This category of consumer is protected on the Swedish electricity and natural gas markets by a right to receive financial assistance for payment of bills. The Swedish Energy Markets Inspectorate has estimated that around 20 000 consumers can be classified as vulnerable customers.

Both the Electricity Act (1997:857) and the Natural Gas Act (2005:403) also contain provisions which protect consumers at risk of being disconnected from the electricity or natural gas network for non-payment or another serious breach of their contract. These provisions require companies to follow a particular statutory procedure before disconnecting them. This includes providing them with accurate information, giving them the opportunity to comply without disconnecting them and notifying social services in the municipality where they live before they are disconnected.

The Energy Markets Inspectorate also runs a price comparison website, www.elpriskollen.se, to improve consumers' position on the electricity market and access to objective information. Consumers can use it to compare prices and conditions under the most common contracts offered by all electricity suppliers. The opportunity to compare prices and other factors which may influence the choice of electricity supplier is essential for encouraging active customer engagement and hence demand response.

In a future electricity market with a higher share of variable electricity generation in the form of wind and solar power, it will be important to utilise all of the flexibility resources in the electricity system, in other words flexible production and storage, and demand response.

3.4.3.5 Description of measures to enable and develop demand response, including those addressing tariffs to support dynamic pricing.

Since 2018, grid operators have been able to test new tariffs as part of a pilot project under Chapter 4, Section 4a–4b of the Electricity Act (1997:857). In its report *Åtgärder för ökad efterfrågeflexibilitet i det svenska elsystemet* (Ei R 2016:15) the Swedish Energy Markets Inspectorate concluded that network tariffs are an effective tool for exploiting the available customer demand response.

Under the new provisions of the Electricity Act, grid operators are able to

test tariffs that use demand response to encourage more efficient use of the network on a small number of customers in a customer category. This allows them to test and develop the tariffs to encourage the type of flexibility needed in their own network area.

The provisions are an exception to the requirement for uniform network tariffs. However, the tariffs must still be objective and non-discriminatory and must be compatible with efficient use of the grid and efficient generation and consumption of electricity.

On 2 October 2018, the Government decided to amend the Electricity Ordinance (2013:208). The amendments allow the Swedish Energy Markets Inspectorate to issue rules for designing network tariffs to promote efficient use of the grid. It has begun drafting these rules. The work is expected to be completed in Spring 2020. The Swedish Energy Markets Inspectorate may also issue rules for the customer information to be provided by grid operators explaining their charges and telling customers how they can influence their costs by changing the conditions or patterns of consumption. It is planning to start work on these rules in 2020.

3.4.4 Energy poverty

3.4.4.1 Where applicable, policies and measures to achieve the objectives set out in point 2.4.4.

Not applicable as energy poverty is not an element of social policy.

3.5 Dimension research, innovation and competitiveness

3.5.1 Policies and measures related to the elements set out in point 2.5

Policies for research and innovation

Energy research policies are set out in the Government bill on Research and Innovation for Sustainability, Competitiveness and Security of Supply in the Energy Sector (Government bill 2016/17:66) and are implemented by the energy-related activities under the National Energy Research and Innovation Programme. They complement the policies presented in the Government bill A Cooperative Approach to Knowledge – Meeting Society's Challenges and Enhancing Competitiveness (Government bill 2016/17:50).

These bills set out the policy and the budget for the next four years and similar bills have been presented every four years. The next Government bill on the energy research and innovation policy is currently being prepared and the Government will make a decision on it in autumn 2020. The

Government has commissioned the Swedish Energy Agency to prepare the background information for this bill to provide a sound basis for continued funding for the sector.

The Agency has overall responsibility for research, development, innovation and demonstration and for the National Energy Research and Innovation Programme. Some related activities are also carried out by other agencies working in conjunction with the Swedish Energy Agency. Basic research on nuclear fission and fusion is funded by the Swedish Research Council. Overall basic energy research is carried out jointly by the Swedish Research Council (which evaluates the quality of the research) and the Swedish Energy Agency (which evaluates its relevance to energy).

The Energy Development Board is the ultimate decision-making body for the National Energy Research and Innovation Programme. Its members are appointed by the Government and represent various fields and disciplines. They are drawn from the academic and commercial world and from the public sector. The Board usually makes decisions on major programmes and large individual projects. It can also delegate decisions to the Swedish Energy Agency.

The National Energy Research and Innovation Programme

Sweden's activities under the National Energy Research and Innovation Programme, which has an annual budget of around SEK 1.6 billion for 2017–2020, are based on the principle that energy research and innovation should help to find solutions for five overall challenges[201]:

- to create a fully renewable energy system which meets the challenges presented by the energy system's impact on the climate, while considering the environmental impact of the different types of renewable energy;
- to ensure that the energy system is flexible and robust and provides security of supply for society as a whole as part of a fully renewable energy system;
- to create a resource-efficient society which improves competitiveness, facilitates the transition to a renewable energy system and enables society as a whole to use available resources efficiently;
- to increase action on innovation, jobs and the climate to give Sweden a leading position in the transition to a renewable energy system; to use the transition as an opportunity to develop businesses;
- to facilitate interaction between various operators, sectors,

[201] Government bill *Research and Innovation for sustainability, competitiveness and security of supply in the energy sector* (Government bill 2016/17:66).

standards and business models in the energy system with the aim of creating the conditions for cooperation and diversity to speed up the transition.

Sweden will carry out initiatives to address these challenges under the 2017–2020 National Energy Research and Innovation Programme. The programme runs research and innovation initiatives in nine areas:

- the transport system
- bioenergy
- buildings in the energy system
- electricity generation and the electricity system
- industry
- sustainable society
- general energy system studies
- business development and commercialisation
- cooperation on information.

Section 4.6 describes some examples of current or completed projects funded by the National Energy Research and Innovation Programme.

Ten-year research programme on climate and sustainable society

In addition to the National Energy and Innovation Programme, there is also a Ten-Year National Climate Research Programme. The Programme was launched in 2017 to help achieve Sweden's aim to be a fossil-free welfare society and its ambition to be a global leader in achieving the objectives of the Paris Agreement. People must radically change and adapt their behaviour to reduce humanity's impact on the climate – in Sweden, in the EU and worldwide. Interdisciplinary and cross-sectoral research and innovation in many different fields is required to meet climate challenges. The programme was granted around SEK 75 million in 2018, and it is estimated that it will receive SEK 130 million a year from 2019 to 2026.

There is also a Ten-Year National Research Programme for Sustainable Society. The programme was launched in 2017 and will develop knowledge which may lead to the development of new solutions of in all sectors of society, to create a safe, secure, sustainable and inclusive society. The programme is based on the Agenda 2030 sustainability goals, the national environmental targets and other relevant national objectives. Its initiatives are conducted on the basis of a strategic research agenda. The results of the programme must benefit society by utilising existing knowledge and developing new knowledge. In 2019, the programme will pay around SEK 25 million to research projects and around SEK 25 million to social housing projects. The programme funding for 2019–2026 is expected to be SEK 100 million a year.

The Government's cooperative programmes

Four cooperative programmes have been launched for the Government's 2019-2022 term of office to improve cooperation between businesses, academic institutions and the Government[202]. These programmes aim to concentrate resources on enhancing Sweden's competitiveness and capacity for innovation and meeting the major challenges facing society. One of the four cooperative programmes deals with the climate transition for businesses.

The Government will also monitor and develop the work of the cooperative programme Next Generation Travel and Transport, which has decided to focus on automation, digitisation and electrification.

The National Innovation Council

The Government has set up an innovation council to devise innovative solutions for major social challenges and to promote long-term competitiveness and sustainability in Sweden[203]. The Innovation Council has an advisory role and brings a new perspective to matters of importance for innovation policy.

Its main purpose is to improve the conditions for innovation in Sweden and society's ability to find innovative solutions to challenges.

3.5.2 Where applicable, cooperation with other Member States in this area, including, where appropriate, information on how the SET Plan objectives and policies are being translated to a national context

Cooperation with other Member States

International cooperation on energy research and innovation will be an ever more important complement to national initiatives for achieving the national objectives and is particularly important for a small country like Sweden. Sweden's cooperation with other countries on research, innovation and development is conducted mainly within the EU and its various instruments. These include the EU Framework Programme for Research and Innovation (Horizon 2020) and the Strategic Energy Technology Plan (SET plan)[204]. However Sweden also participates in the work of other international forums such as the International Energy Agency (IEA) and Mission Innovation (MI).

[202] https://www.regeringen.se/regeringens-politik/regeringens-strategiska-samverkansprogram/.

[203] https://www.regeringen.se/regeringens-politik/nationella-innovationsradet/.

[204] https://setis.ec.europa.eu/actions-towards-implementing-integrated-set-plan.

The SET plan contains four key priorities and ten key actions to accelerate the energy system transition. Objectives and implementation plans have been developed for each key action at EU level. Participation is voluntary, but Sweden participates in relevant key actions which are also national priorities, as this is be best way to link national and EU objectives. Sweden participates to some extent in the following working groups and corresponding implementation plans: ocean energy, smart solutions for energy consumers, smart cities, energy systems, energy efficiency in buildings, energy efficiency in industry, batteries for e-mobility, bioenergy and renewable fuels and carbon storage and carbon utilisation. The work entails linking up parts of the National Research Programme (activities under each objective), in other words each thematic and strategic research and innovation initiative within these objectives, to assist with the joint actions and objectives of a particular key action in the SET plan.

Swedish operators also participate in some of the EU's Technology and Innovation Platforms: ETIP Renewable Heating and Cooling and ETIP Smart Networks for Energy Transition (SNET). The platforms are industry-led and carry out activities within the key actions of the respective SET plans.

ERA-NET is a Horizon 2020 instrument for cooperation on joint calls and project funding between research funding agencies in the EU. Sweden takes part in many of these cooperative programmes to complement national initiatives in a particular area, increase the dissemination of knowledge and learn from various research and development initiatives. In summary, Sweden participates in the key actions: bioenergy, ocean energy, solar energy, smart cities and communities, building a sustainable society, smart grids, wind energy, transport and adaptation to climate change. Sweden also takes part in ERA-NET cooperative programmes and a Joint Programme Initiative which assists with implementing the SET Plan's implementation plans (see Table 13).

Around SEK 45 million was paid for the cooperative programmes and initiatives in which Sweden participates in 2018; this is expected to rise to around SEK 45 million in 2019. In addition to this, Sweden plans to take part in a Horizon Europe partnership programme (co-funded by the EU).

Table 13. List of ERA-NET cooperative programmes and Joint Programme Initiatives in which the Swedish Energy Agency participates

EUROPEAN PROGRAMMES	DESCRIPTION OF THE LINK TO NATIONAL INVESTMENTS

ERA-NET BIOENERGY	Reinforces national bioenergy programmes and the networks of Swedish operators. Participation in this cooperative programme fits well with the Agency's research priorities, especially increasing the use of bioenergy. The calls require bioenergy projects in which cooperation between the operators in many of the countries taking part in the call add value to the project. The project must relate to supply or consumption or both (heating, cooling, electricity, fuel) in different biofuel chains.
SOLAR-ERA.NET COFUND 1 SOLAR-ERA.NET COFUND 2	Reinforces national programmes for solar cells and solar thermal electricity and the networks of Swedish operators. The Solar-ERA-NET Cofund aims to increase the exchange of knowledge and stimulate developments in solar electricity by financing joint projects and activities and using existing knowledge at regional, national and European level. Sweden has a lot of solar electricity know-how. To maintain its position as a global leader, it is important to promote international cooperation. It is also expected to strengthen Europe's industrial technology base, creating growth and employment in Europe and in Sweden.
OCEAN ERA-NET OCEAN ERA-NET COFUND	Reinforces national ocean energy programmes[205] and the networks of Swedish operators. The research and development carried out by universities and companies in Sweden is commercialised primarily in markets abroad. By supporting international cooperation, Swedish research and development can assist with the transition of the energy system both nationally and internationally and can be exported to foreign markets by Swedish businesses. There is also a significant need for cooperation in this area as there are many barriers to be overcome and a very limited amount of funding. Member States can work together to commercialise ocean energy in Europe.
BESTF3	Reinforces national bioenergy programmes and the networks of Swedish operators. Funding for cooperative projects on bioenergy, which must demonstrate at least one innovative step in bioenergy processes and will result in pre-commercial demonstration. The programme aims to promote the contribution of bioenergy to European climate and energy policy targets.
ERA-NET PLUS NEW EUROPEAN WIND ATLAS	Reinforces national wind energy programmes and the networks of Swedish operators. Participation in this cooperative programme fits well with the Agency's research priorities and the development of electricity generated from renewable sources. The aim is to develop and produce a new European wind atlas.
ERA-NET SMART GRIDS PLUS ERA-NET SMART ENERGY SYSTEMS ERA-NET PLUS REGSYS	Reinforces national grid programmes and the networks of Swedish operators. ERA-Net Smart Grids plus aims to contribute to the technological development of smart grids and facilitate interaction with the market and society in order to achieve the common European vision for the energy system of the future. The objective is to integrate smart grid technologies, stakeholders and market processes to help achieve Europe's short- (2020), medium- (2035) and long- (2050) term energy policy targets. ERA-Net plus Regsys aims to create new system solutions for the specific needs of local and regional energy systems and networks. The property owners, local and regional companies, municipal and county councils and others who need these solutions will be actively involved in the development of new knowledge and integrated technologies, processes, system services and prototypes.
FORESTVALUE	Reinforces national bioenergy initiatives. The aim of this cooperative programme is to promote innovation and improve competitiveness in the forestry sector in Europe and to support its transition from a resource-intensive to a knowledge-intensive, productive, resource-efficient and resilient sector. International cooperation contributes towards establishing a bioeconomy in Sweden by providing leverage for the development and testing of solutions which may achieve it
ERA-NET COFUND SMART CITIES AND COMMUNITIES ERA-NET COFUND SUSTAINABLE URBANISATION (ENSUGI)	Reinforces national initiatives for sustainable cities and a sustainable society. Participation in this cooperative programme fits well with the Agency's research priorities. The aim of ENSUGI is to address global challenges in the area covered by the call, focusing on synergies and connections within the Food-Water-Energy system and links to urbanisation and sustainable development through cooperation between European operators in the JPI Urban Europe and countries outside Europe.
ERA-NET COFUND ELECTROMOBILITY EUROPE	Reinforces national initiatives for electrification of the vehicle fleet and transport efficiency. Participation in this cooperative programme fits well with the Agency's research priorities. Testing and demonstrating knowledge and innovation in the transport system and the urban environment will help produce a breakthrough for electric mobility in Europe.
URBAN EUROPE	The strategic research and innovation agenda developed within Urban Europe is supported by participation in ERA-net and hence by the Swedish Energy Agency's sustainable cities initiatives.

Nordic cooperation

Sweden is a member of Nordic Energy Research (NEF), which is a joint energy research and analysis institution under the Nordic Council of Ministers. The overall purpose of its activities is to promote energy cooperation, use and profiling in the Nordic countries. NEF supports areas of energy research that are of common interest to Nordic stakeholders and

[205] Ocean energy is a collective term for technologies that generate energy from waves, tides, currents, temperature differences and differences in salinity.

provide potential for cross-border cooperation. It finances and coordinates research, provides administrative expertise and advice and builds networks. Sweden is paying SEK 12.5 million a year to the NEF for 2019 and 2020.

Examples of calls and projects

NordForsk, The Academy of Finland, Formas, the Swedish Research Council for Health, Working Life and Welfare (Forte), the Swedish Energy Agency and the Research Council of Norway finance a joint call for research on sustainable urban development and smart cities. The call has a total budget of NOK 50 million. The overall objective of the call is to promote cooperation between the knowledge societies in the Nordic countries to increase the possibilities for addressing the challenges facing cities of all sizes. The projects must contribute to the overall analysis and use of important knowledge for the successful implementation of possible solutions.

The Swedish Energy Agency and the Norwegian state-owned company Gassnova are providing SEK 7.7 million and NOK 9.5 million respectively in funding for a bilateral three-year demonstration project for carbon capture and storage (CCS) at the Preem refinery in Lysekil. The project is investigating the possibility of setting up a full-scale CCS plant at the refinery's hydrogen installation which will reduce its CO_2 emissions by up to 500 000 tonnes a year. The demonstration plant is a stage in the plan to set up a full-scale plant in 2025.

3.5.3 Where applicable, financing measures in this area at national level, including Union support and the use of Union funds

Financing measures

Sweden is a member of Mission Innovation, an initiative in which the governments of many countries cooperate to accelerate global clean energy innovation. The initiative aims to make new, clean energy technology affordable. Sweden has committed to double its initiatives under the energy research and innovation programme, which is operator-initiated set up as a result of public calls. This doubling is based on the average budget allocated for such initiatives from 2013-2015 until 2020.

Table 14 shows the outcome for 2016-2018 and the planned initiatives up to 2020. The initial value is estimated at SEK 134 million based on the average annual outcome for 2013-2015 and with the aim of increasing the funding to SEK 268 million by 2020. The total value of the initiatives planned for 2018 has now increased to SEK 215 million. In view of the current level and the initiatives planned by the Swedish Energy Agency, the total budget for the research categories highlighted by the Government is expected to double by

2020, in line with the Mission Innovation Commitment.

Table 14. Outcome for 2016, 2017 and 2018 and Mission Innovation budget already planned for 2019–2020, in SEK

Year	2016 (outcome)	2017 (outcome)	2018 (outcome)	2019 (budget)	2020 (budget)	Total 2016–2020
[SEK]	120 910 964	198 752 151	215 114 540	251 158 954	280 000 000	1 065 936 609

Sweden has granted the funds shown in Table 15[206],[207], in euro, for certain social challenges under Horizon 2020.

Table 15. Funds granted to Swedish operators under Horizon 2020 [EUR]

Secure, clean and efficient energy	€105 842 195
Smart, green and integrated transport	€133 942 257
Climate measures, environment, resource efficiency and raw materials	€70 041 727

4. Current situation and projections with existing policies and measures

The Swedish Environmental Protection Agency produced new climate and energy scenarios in 2018 and 2019. The scenarios are presented in full in the report *Scenarier över Sveriges energisystem*[208] and are used as a basis for the climate scenarios reported to the European Commission in the climate report[209]. Unless otherwise specified, the scenario presented here is the Swedish Energy Agency's *Referens EU* scenario, which is based on the assumptions for the development of fossil fuels and the price of emission allowances. The scenario is based on Sweden's energy and climate polices up to 1 July 2018.

4.1 Projected evolution of main exogenous factors influencing energy system and GHG emission developments

4.1.1 Macroeconomic forecasts (GDP and population growth)

The National Institute of Economic Research produces conditions for economic development with its EMEC equilibrium model. These macroeconomic forecasts are then used as a basis for the long-term climate and energy scenarios. The development of Gross Domestic Product (GDP) and population growth is an important factor for future energy consumption

[206] Data published in the European Commission's eCORDA database as at 13 November 2018.

[207] Vinnova, *Horisont 2020 – årsbok 2018* (VR 2019:04).

[208] The Swedish Energy Agency – *Scenarier över Sveriges energisystem 2018* (ER 2019:7).

[209] The Swedish Environmental Protection Agency – Report for Sweden on assessment of projected progress, March 2019.

and the impact on greenhouse gas emissions.

The development of GDP is modelled in EMEC; the figures from 2015 to 2050 are presented in Table 16.

Table 16 The development of GDP in the economic scenarios from EMEC

Year	2015-2035	2036-2050
GDP development	2.05	1.94

The assumptions for population development in the period 2016–2040 are produced by Statistics Sweden (SCB) and presented in Table 17.

Table 17 Population development assumptions

Year	2014	2020	2030	2035	2040
Population	9,995,153	10,421,344	11,172,645	11,400,957	11,595,653

Source: SCB

4.1.2 Sectoral changes expected to impact the energy system and GHG emissions

The transport sector

To achieve the climate target in the transport sector vehicles, aircraft and ships must become more energy efficient and the use of renewable biofuels and electric vehicles must increase. However, increased traffic may increase greenhouse gas emissions, particularly in the goods transport sector.

The industry sector

Electricity consumption is expected to rise in the industry sector, as many production processes run on fossil energy will be replaced with electricity. This will not reduce energy consumption, but it will reduce the consumption of fossil fuels.

Housing and services sectors

The developments in the housing and service sectors depend on energy efficient buildings and converting buildings with a direct electricity supply to heat pumps. The potential for profitable efficiency and conversion measures may fall in the long term, as more measures are carried out, and the construction of new buildings may increase energy consumption.

4.1.3 Global energy trends, international fossil fuel prices, EU ETS carbon price

The price developments for fossil fuels and carbon prices in the EU-ETS applied by the European Commission are used for the climate and energy

scenarios. These scenarios come from the Commission's modelling for reference scenarios[210]; it recommends that Member States use them to increase the comparability of their results.

The prices for fossil fuels and emission allowances used in *Referens EU* are presented below in Tables 18, 19, 20 and 21.

Table 18 Assumptions for world market prices for crude oil, USD/barrel, real prices.

Year	2015	2020	2030	2040
Price [USD/barrel]	56	97	121	135

Source: European Commission

Table 19 Assumptions for world market prices for coal USD/tonne, real prices.

Year	2015	2020	2030	2040
Price [USD/barrel]	66	86	124	137

Source: European Commission

Table 20 Assumptions for world market prices for natural gas, USD/mmBTU, real prices.

Year	2015	2020	2030	2040
Price [USD/barrel]	8	10	12	13

Source: European Commission

Table 21 Assumptions for prices of emission allowances for carbon dioxide, EUR/tonne CO2, real prices.

Year	2015	2020	2030	2040
Price [USD/barrel]	8	16	35	52

Source: European Commission

4.1.4 Development of technology costs

For the production of the energy and climate scenarios, assumptions were made about how the cost of different current technologies would develop. These assumptions are important for the result of the scenarios and play a large part in the future development of different technologies. The energy supply in the scenarios was modelled with the Times- Nordic[211] energy system model. More information about the assumptions is given in Annex B 'Förutsättningar och metod' of the Swedish Energy Agency's publication *Scenarier över Svergies energisystem 2018* (ER 2019:07).

Nuclear power

Table 22 shows the estimated costs of new nuclear power. Based on these cost and lifetime assumptions, the total cost of generating new nuclear power would be around SEK 0.60/kWh electricity (excluding any generation

[210] https://ec.europa.eu/energy/en/data-analysis/energy-modelling/eu-reference-scenario-2016.

[211] http://www.profu.se/times.htm.

taxes). The thermal power tax was phased out in 2018.

A generation-based nuclear power charge of around SEK 40/MWh electricity is paid to the Nuclear Waste Fund to fund future disposal.

Table 22 Assumptions for the cost of new nuclear power

Cost of investment (SEK/kW electricity)	Fixed O&M (SEK/kW electricity)	Mobile O&M and fuel costs (SEK/MWh electricity)	Lifetime (years)
50 000	550	100	50

Note: O&M stands for operation and maintenance costs.

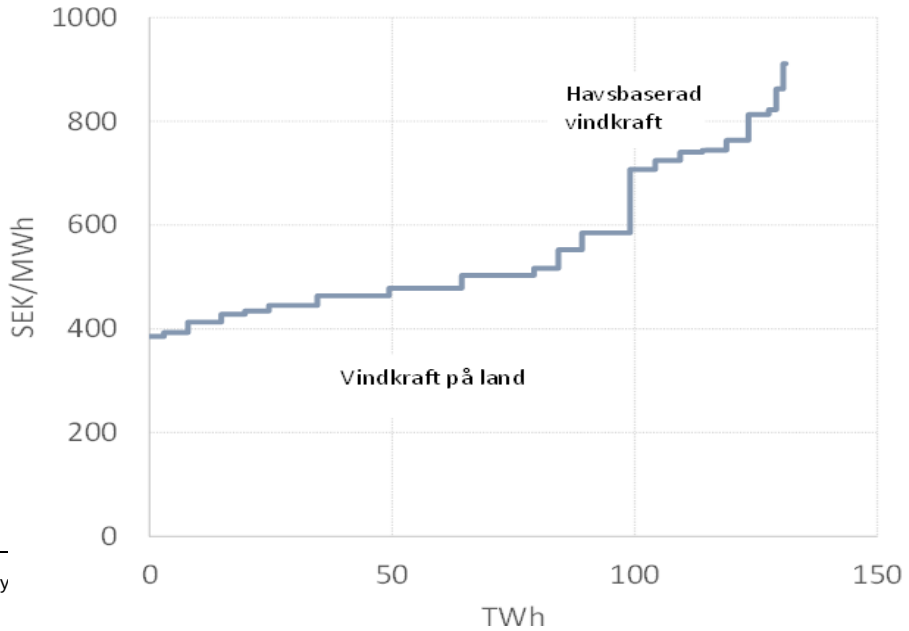
Hydropower

The scenario calculations assume that around 1 TWh of new hydropower will be added up to 2025 at a cost of around SEK 0.40–0.50/kWh, depending on the type of investment. The absolute amount consists of increases in the capacity of current large-scale hydropower, while the model assumes the potential for new small-scale hydropower to be very limited.

Wind power

Times-Nordic divides wind power in Sweden into 12 different onshore classes and 9 different offshore classes. The cost assumptions for new wind power in Sweden are based on information from the Swedish Energy Agency[212] along with a slightly less comprehensive update by the Agency in 2018. It is assumed that nearly 100 TWh of onshore wind power is available for development (see Figure 8). The model includes system integration costs (for example for reserve capacity and some grid expansion) particularly for large volumes of wind power. The model also takes into account that the earning capacity will be reduced once the proportion of wind power reaches a certain level (the more wind power in the system, the lower the price wind farms receive for their electricity).

Figure 8 Estimated generation costs for new wind power in Sweden, assuming a lifetime of 25 years and 7% real discount rate.



[212] The Swedish Energy Agency

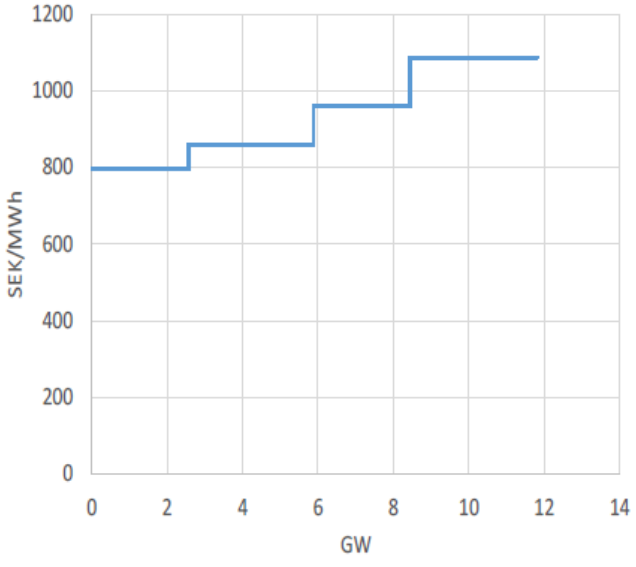
Source	Target
SEK/MWh	SEK/MWh
Havsbaserad vindkraft	Offshore wind power
Vindkraft på land	Onshore wind power
TWh	TWh

Source: The Swedish Energy Agency.

Solar power

Investments in new solar electricity are described with several cost classes for various applications of solar electricity. The description is based on a study conducted by Profu on behalf of the Swedish Energy Agency in 2018[213]. The different cost classes relate to solar electricity generated on roofs (houses, apartment blocks and business premises) and free-standing photovoltaic parks on land (see Figure 9, Figure 10 and Figure 11). Different discount rates are assumed for the investments, depending on whether the installations are roof-mounted or free-standing. This reflects the fact that private individuals (house roofs) or small operators (apartment blocks and business premises) probably have different preferences, in this case lower discount rates, from commercial operators in the energy industry, for example (who are assumed to be responsible for installations on land). On the other hand, it is assumed that the investment costs for larger scale installations on land are lower in specific terms than for roof-based installations. The estimated lifetime for all of the investments is 30 years.

Figure 9 Estimated generation costs for solar electricity on house roofs (real discount rate 3%),

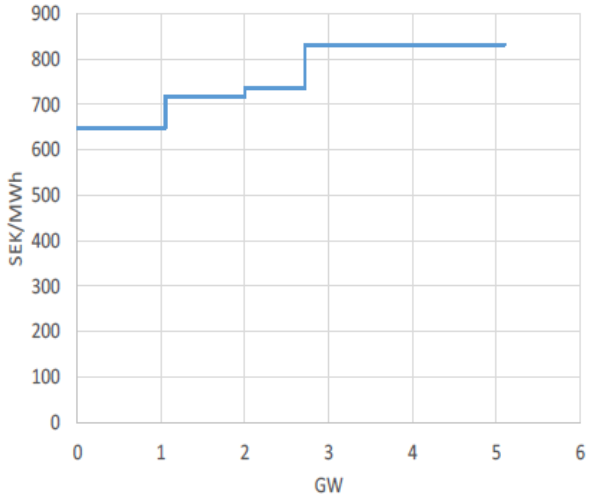


Source	Target
SEK/MWh	SEK/MWh
GW	GW

Source: The Swedish Energy Agency.

[213] Profu – *Teknisk-ekonomisk kostnadsbedömning av solceller i Sverige, 2018*.

Figure 10 Estimated generation costs for solar electricity in apartment blocks and business premises (real discount rate 4%).

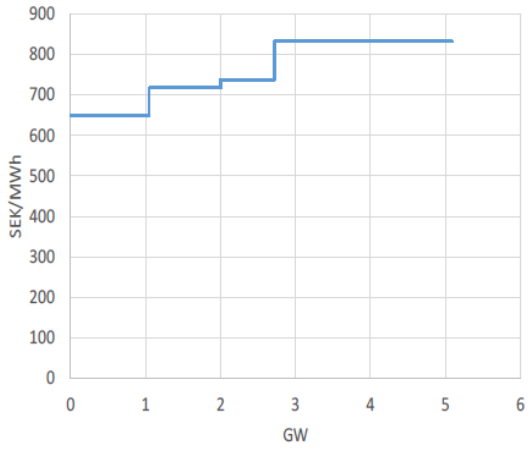


Source
SEK/MWh
GW

Target
SEK/MWh
GW

Source: The Swedish Energy Agency.

Figure 11 Estimated generation costs for solar electricity on land (real discount rate 6%),



Source
SEK/MWh
GW

Target
SEK/MWh
GW

Source: The Swedish Energy Agency.

Biofuel-based electricity generation

Estimated data for a conventional biofuel combined heat and power (CHP) plant are given in Table 23 With flue gas condensation, which is essential for these plants, the total efficiency is around 105–110%, calculated on the basis of the lower calorific value.

Table 23 Estimated data for three sizes of conventional biofuel CHP plant with flue gas condensation (some parameters, for example efficiency and index are assumed to change over time).

	Cost of investment (SEK/kW electricity)	Fixed O&M (SEK/kW electricity)	Mobile O&M (SEK/MWh electricity)	Efficiency (%)	Index	Lifetime (years)
Large plant (ca 80 MW electricity)	25 500	380	80	30-32 (electricity)	0.38-0.41	30
Medium plant (ca 30 MW electricity)	34,500	580	85	28-30 (electricity)	0.35-0.39	30
Small plant (ca 10 MW electricity)	45,000	920	85	25-27 (electricity)	0.32-0.34	30

Source: The Swedish Energy Agency.
Note: O&M stands for operation and maintenance costs.

Power generated with gas

The total capacity of gas-fired CHP in Sweden is currently around 0.8 GW electricity. It is assumed that the Öresund plant in Malmö will be phased out by 2020, as the owner intends, leaving only around 0.3 GW power generated by gas. Funds can be invested in developing new gas-generated power capacity if the models indicate that it is worthwhile. Data for gas-based power and combined heat and power generation are presented in Table 24. The efficiency develops over time.

Table 24 Estimated data for gas-based power and combined heat and power generations

	Cost of investment (SEK/kW electricity)	Fixed O&M (SEK/kW electricity)	Mobile O&M (SEK/MWh electricity)	Efficiency (%)	Index	Lifetime (years)
Condensing power	7,000	40	15	55-62	-	30
CHP, large	9,500	70	20	45-50 (electricity)	1.1	30
CHP, small	12,500	120	25	45-50 (electricity)	1	30

Note: O&M stands for operation and maintenance costs.

District heating – super-heated water boilers

Table 25 presents key data for two typical super-heated water boilers, one solid fuel-fired and one gas-fired (fuel costs and policies are fuel-specific and are included in the model but not shown in the table)

Table 25 Estimated generation costs for district heating in heating plants (super-heated water boilers).

	Cost of investment (SEK/kW electricity)	Fixed O&M (SEK/kW electricity)	Mobile O&M (SEK/MWh electricity)	Efficiency (%)	Lifetime (years)
Natural gas	4,000	25	15	90	30
Biofuel, peat or coal	8,000	100	20	90-95	30

Note: O&M stands for operation and maintenance costs.

4.2 Dimension decarbonisation

4.2.1 GHG emissions and removals

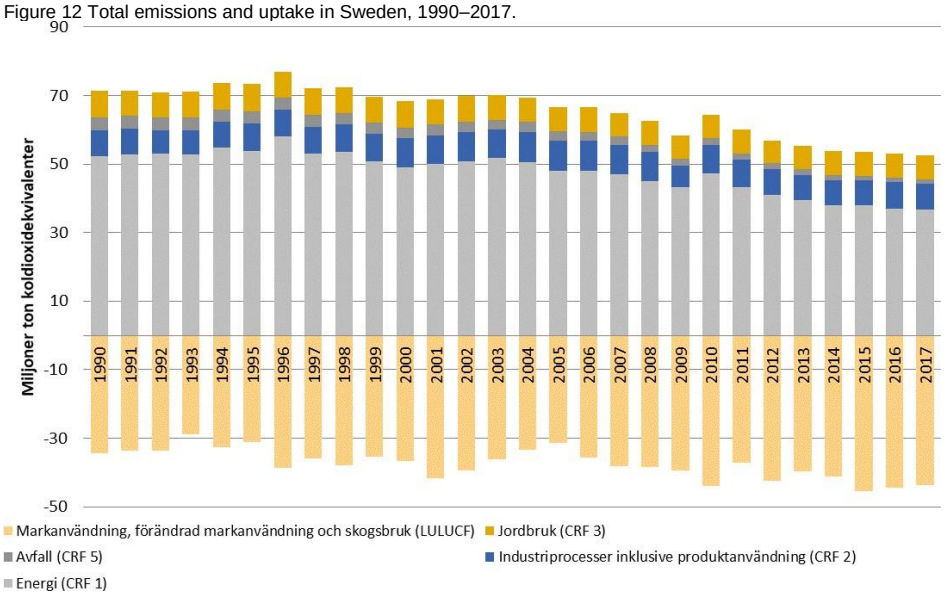
4.2.1.1 Trends in current GHG emissions and removals in the EU ETS, effort sharing and LULUCF sectors and different energy sectors[214]

Total GHG emissions and removals

Sweden emitted 5.7 million tonnes CO_2 equivalents of greenhouse gases (excluding LULUCF) in 2017. Sweden's emissions have fallen by 26% since 1990. Most of the reductions occurred in 2003-2014. The emissions varied between a maximum of 76.9 tonnes CO_2 equivalents in 1996 and a minimum of 52.7 tonnes CO_2 equivalents in 2017. Annual variations are due primarily to temperature fluctuations, rainfall patterns and the economic cycle. Sweden has a net uptake of carbon dioxide. The net sink varied in the period 1990–2017. The total net uptake in 2017 was 44 million tonnes CO_2 equivalents, which corresponds to 83% of the total emissions. See Figure 12 for total emissions and uptake in Sweden.

[214] All information in this section comes from the Swedish Environmental Protection Agency – National Inventory Report Sweden 2019, Greenhouse gas emission Inventory 1990–2017.

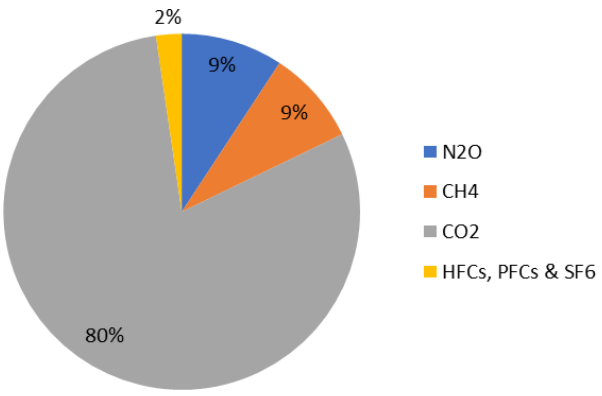
Figure 12 Total emissions and uptake in Sweden, 1990–2017.



Source	Target
Miljoner ton koldioxidekvivalenter	Million metric tonnes of carbon dioxide equivalents
Markanvändning, förändrad markanvändning och skogsbruk (LULUCF)	Land Use, Land-Use Change and Forestry (LULUCF)
Jordbruk (CRF 3)	Agriculture (CRF 3)
Avfall (CRF 5)	Waste (CRF 5)
Industriprocesser inklusive produktanvändning (CRF 2)	Industrial processes including product use (CRF 2)
Energi (CRF 1)	Energy (CRF 1)

42.1 million tonnes of fossil CO_2 (excluding LULUCF) were emitted in 2017, equivalent to 80% of the total greenhouse gas emissions, calculated as CO2 equivalents. 4.5 million tonnes CO2 equivalent (around 9% of total emissions) of methane (CH4), 4.9 million tonnes CO2 equivalent (around 9% of total emissions) of nitrous oxide (N2O) and 1.1 tonnes CO2 equivalent (around 2% of total emissions) of hydrofluorocarbons were also emitted. The distribution between the different greenhouse gases was similar throughout the whole period from 1990 to 2017. See Figure 13 for emissions of each greenhouse gas.

Figure 13 Emissions (excluding LULUCF) in 2017, by greenhouse gas, expressed as CO2 equivalents.



Source	Target
N2O	N2O

CH4
CO2
HFCs, PFCs & SF6

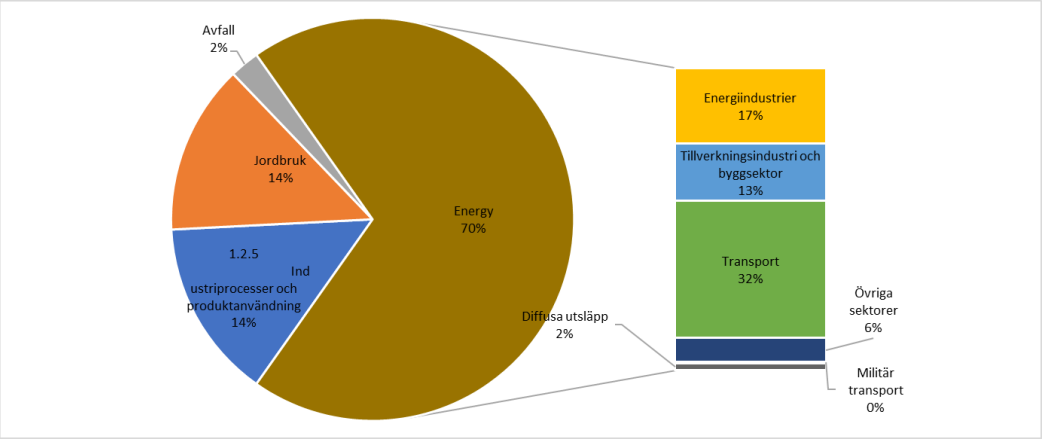
CH4
CO2
HFCs, PFCs & SF6

Emissions and uptake by sector

The largest emissions in 2017 were produced by the energy sector (70%), agriculture (14%) and industrial processes and product use (14%).

See Figure 14 for emissions by sector.

Figure 14 Emissions (excluding LULUCF) in 2017, by sector.



Source	Target
Avfall	Waste
Jordbruk	Agriculture
Industriprocesser och produktanvändning	Industrial processes and product use
Energy	Energy
Energiindustrier	Energy industries
Tilverkningindustri och byggsektor	Manufacturing industries and construction
Transport	Transport
Övriga sektorer	Other sectors
Militär transport	Military transport

The emissions fell by 26% between 1990 and 2017. The long-term reductions in emissions occurred primarily between 2003 and 2014. The reductions can be explained partly by the measures taken, for example the transition to renewable energy and energy efficiency, and partly by stagnation in industry. The measures that influenced emissions were carried out over a longer period; some of them began before 1990.

Emissions in the non-traded sector

Emissions of greenhouse gases in the non-traded sector were around 32 million tonnes CO_2 equivalents in 2017. That means a 0.7% reduction between 2016 and 2017 and a 32% reduction since 1990. Emissions from domestic transport accounted for half of the emissions in the non-traded sector in 2017. These emissions fell by 3% between 2016 and 2017 and were 19% lower in 2017 than in 2010. This reduction can be explained largely by an increase in the use of diesel and biofuel, both in the form of low biodiesel blends and, increasingly, pure biodiesel. The replacement of old passenger

cars with new, energy-efficient vehicles also helped to reduce emissions.

Emissions from Swedish installations within the EU ETS

Emissions from Swedish installations that are part of the EU's emissions trading system fell by 18% between 2005 and 2017. Domestic aviation that belongs to the ETS also reduced its emissions by 18%. However the developments differed between industries and periods. Emissions from electricity and district heating have fallen by around 26% since 2005, largely due to a reduction in the use of fossil fuel. Emissions within the sector vary from year to year, mainly as a result of differences in temperature and rainfall.

4.2.2 Projections of sectoral developments with existing national and Union policies and measures at least until 2040 (including for the year 2030)

Sweden's total greenhouse gas emissions in 2017 were 26% lower than in 1990. The scenario indicates that total greenhouse gas emissions will continue to fall. With the current policy, the estimated emissions in 2030 are 35% lower than in 1990 (see Figure 15).

Historic emissions and scenarios by sector are presented in Table 26[215]. Emissions from domestic transport come from: passenger cars, light and heavy goods vehicles, buses, motorcycles and mopeds, trains, and domestic aviation and maritime traffic.

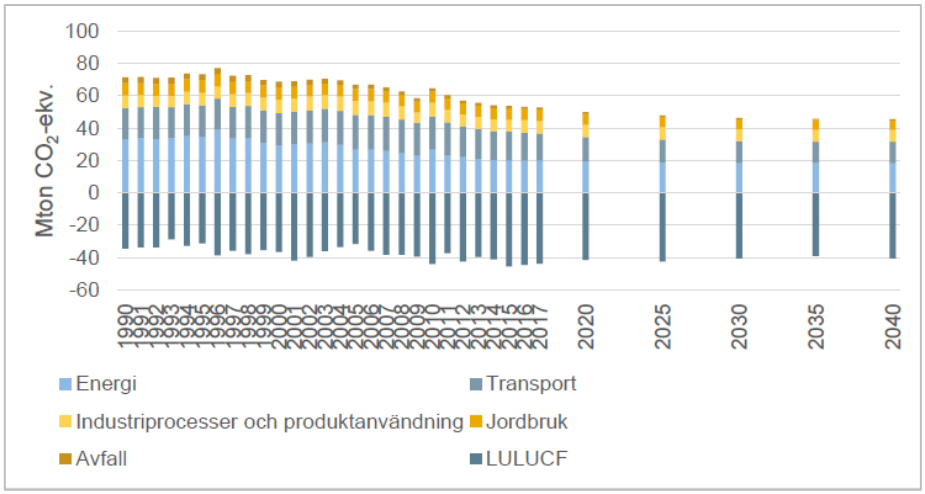
The LULUCF sector has contributed to an annual net sink in Sweden in 1990–2017 and is expected to continue to do so during the scenario period.

Figure 15. Historic emissions and uptake of greenhouse gases and scenarios with policies adoptedl[216] (million tonnes CO_2 equivalents).

[215] Ministry of the Environment. 2019 Report for Sweden on assessment of projected progress, March 2019. In accordance with articles 13 and 14 under Regulation (EU) No 525/2013 of the European parliament and of the Council

Decision on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC.

[216] Policies and measures up to 1 July 2018.



Note: The series 'Transport' refers to domestic transport.

Source	Target
Energi	Energy
Industriprocesser och produktanvändning	Industrial processes and product use
Jordbruk	Agriculture
Avfall	Waste
Transport	Transport
LULUCF	LULUCF
Mton CO_2-ekv.	MMTCDE

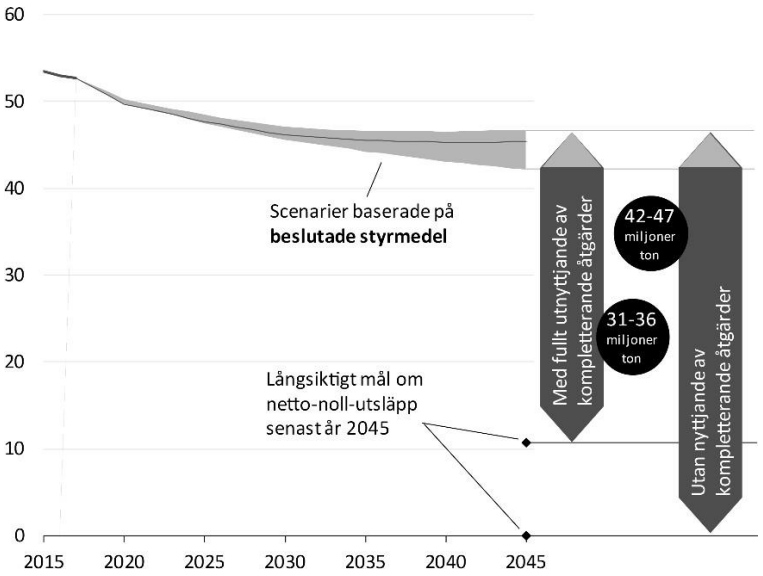
Table 26. Historic emissions and uptake of greenhouse gases by sector and scenarios with policies adopted[217] (million tonnes CO_2 equivalent).

	1990	2017	2020	2025	2030	2035	2040	1990–2030
Energy excl. transport	33.3	20.1	19.5	18.9	18.5	18.4	18.2	-44%
Domestic transport	19.0	16.6	14.8	13.9	13.4	13.2	13.3	-30%
Industrial processes and product use	7.6	7.6	7.7	7.5	7.3	7.2	7.1	-4%
Agriculture	7.7	7.2	6.7	6.4	6.2	6.1	6.1	-19%
Waste	3.7	1.3	1.1	0.9	0.7	0.6	0.6	-81%
Total emissions	**71.3**	**52.7**	**49.7**	**47.7**	**46.1**	**45.6**	**45.3**	**-35%**
LULUCF	-34.4	-43.7	-41.4	-42.5	-40.6	-39.0	-40.6	18%

According to the long-term time-based emission targets adopted by the Riksdag Sweden must reduce its net emissions of greenhouse gases to zero by 2045, and then achieve negative emissions. The remaining emissions from activities on Swedish territory must be at least 85% lower than in 1990. Sweden has also set intermediate targets to help achieve the overall environmental quality object of *Limited Impact on the Climate* (see Section 2.1.1). Figure 16 below shows forecast emissions developments compared with Sweden's targets for 2045.

Figure 16. Forecast greenhouse gas emissions compared with Sweden's targets for 2045.

[217] Policies and measures up to 1 July 2018.



Source	Target
Scenarier baserade på beslutade styrmedel	Scenarios based on policies adopted
Långsiktigt mål om netto-noll-utsläpp senast år 2045	Long-term targets for net-zero emissions by 2045
Med fullt utnyttjande av kompletterande åtgärder	Making full use of complementary measures
42-47 miljoner ton	42-47 million tonnes
31-36 miljoner ton	31-36 million tonnes
Utan nyttjande av kompletterande åtgärder	Without using complementary measures

According to the scenario, the greenhouse gas emissions (excl. LULUCF) will continue to fall, but not to the extent required to achieve the 2045 target. Total emissions in 2045 are predicted to be 34–41% lower than in 1990. That is an emissions shortfall of 42–47 million tonnes CO_2 equivalent in comparison with the target, or 31–36 million tonnes if complementary measures are fully utilised. This can be compared with the total emissions of 52.7 million tonnes in 2017. The scenario shows that further measures are needed to achieve the target.

4.2.3 Renewable energy

4.2.3.1 Current share of renewable energy in gross final energy consumption and in different sectors (heating and cooling, electricity and transport) as well as per technology in each of these sectors.

Table 27 shows the developments in the total share of renewable energy and the share of the electricity, transport and heating/cooling sectors[218] since 2005. The shares shown in Table 27 are taken from the official reports made in Shares[219], the calculation tool used in the Renewable Energy Directive[220].

[218] The heating and cooling sectors cover industry, housing and services, and district heating.

[219] Shares is a calculation tool which harmonises the calculation method for all Member States. The tool is provided by Eurostat and ensures that Member States use the same method to calculate the share of renewable energy.

[220] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

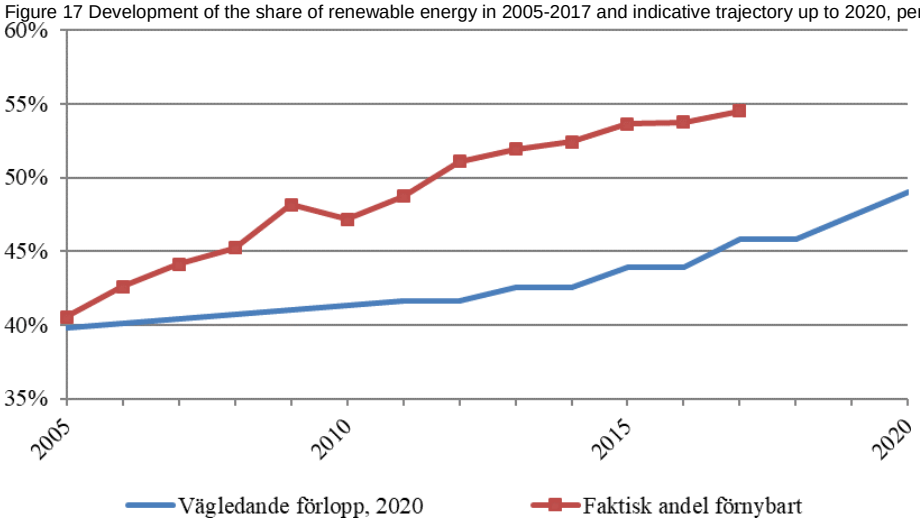
Table 27 Share of renewable energy according to the calculation tool provided in the Renewable Energy Directive, total and by sector, 2005–2017, per cent.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total share of renewable energy	40.5	42.6	44.1	45.2	48.1	47.2	48.7	51.1	51.9	52.4	53.6	53.8	54.5
Electricity	50.9	51.8	53.2	53.6	58.3	56.0	59.9	60.0	61.8	63.2	65.8	64.9	65.9
Transport[221]	6.2	7.1	8.0	8.3	8.9	9.2	11.7	14.8	17.7	19.9	22.9	28.8	27.2
Heating and cooling	51.8	56.3	58.7	61.0	63.6	60.9	62.2	65.8	67.1	67.9	68.6	68.5	69.1

Total share of renewable energy by technology/energy source

The share of renewable energy in relation to gross energy consumption in 2017 is 54.5%, as shown in Figure 17. That is 0.7% higher than in 2016. Sweden's share of renewable energy has been above the indicative trajectory since 2005[222].

Figure 17 Development of the share of renewable energy in 2005-2017 and indicative trajectory up to 2020, per cent.



Source
Vägledande förlopp, 2020
Faktisk andel förnybart

Target
Indicative trajectory, 2020
Actual share of renewable energy

The share of renewable energy depends on the development of energy consumption in overall, and specifically on the development of renewable energy consumption. Energy consumption in 2017 was 410 TWh, which is the virtually the same as 2016. Energy consumption has been relatively stable since 2005, at just over 400 TWh, in spite of the fact that the population has risen by just over a million in the same period.

229 TWh[223] of renewable energy was consumed in Sweden in 2017 according to the calculation method given in the Renewable Energy Directive[224]. That is 4 TWh more than in the previous year, most of which is

[221] Some fuels are double counted in the renewable energy share according to the calculation method provided in the Renewable Energy Directive.

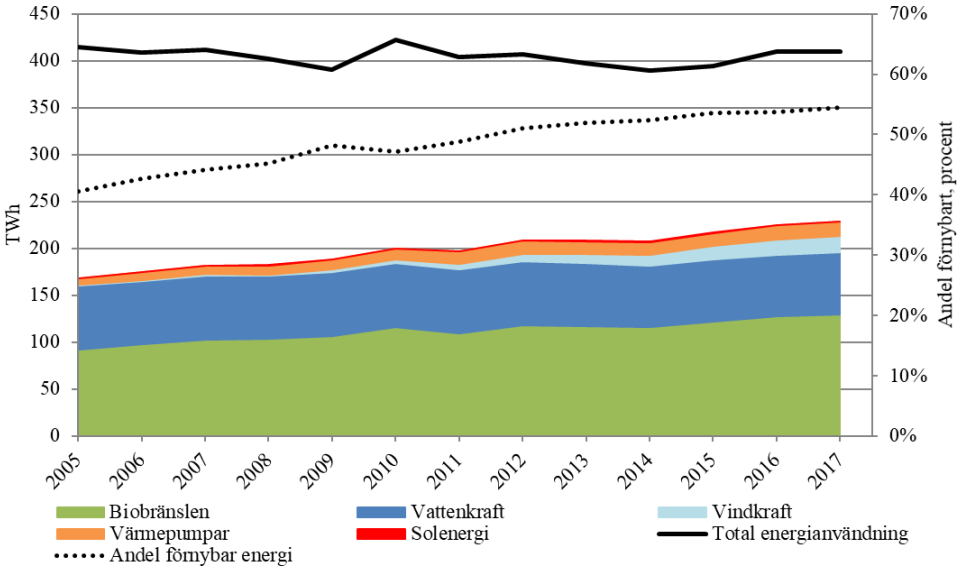
[222] The indicative trajectory is a trajectory for the development of the share of renewable energy which is calculated by a formula given in the Renewable Energy Directive (REDI). It shows the rate the share must achieve in each Member State.

[223] As the electricity certificate system is run jointly with Norway and more than half of the renewable electricity is generated in Sweden, electricity is transferred statistically to Norway. 5.4 TWh of the 229 TWh were transferred to Norway in 2017. The transfer corresponds to 1.3% of Sweden's share in 2017.

[224] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

due to the rise in biofuel consumption in the transport sector and the further expansion of wind power. The total increase since 2005 is 61 TWh. The consumption of biofuels and wind power make the biggest contribution to the high renewable energy consumption, as shown in Figure 18. The contribution of heat pumps[225] rose from 7 TWh in 2005 to 16 TWh in 2016.

Figure 18 Renewable energy and energy consumption according to the Renewable Energy Directive and the share of renewable energy in 2005-2017, TWh and per cent.

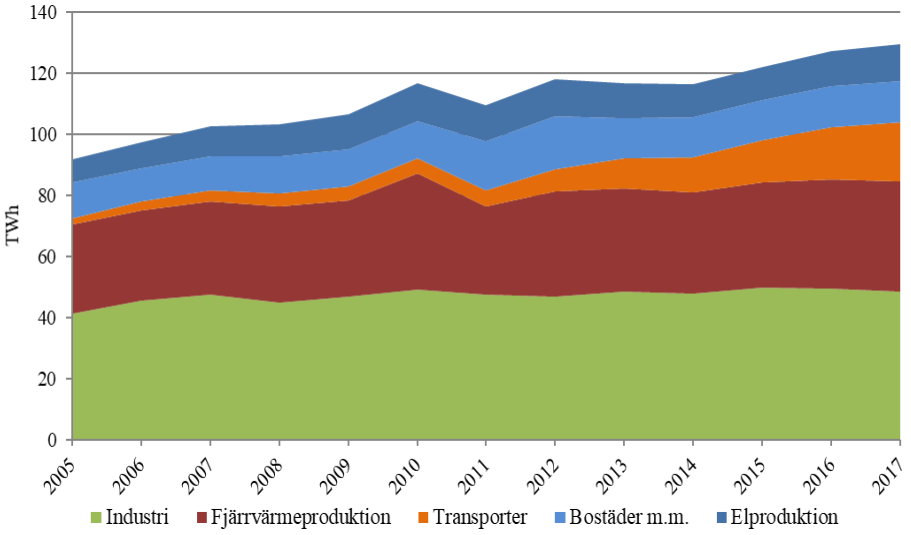


Source	Target
Biobränslen	Biofuels
Värmepumpar	Heat pumps
Andel förnybar energi	Share of renewable energy
Vattenkraft	Hydropower
Solenergi	Solar energy
Vindkraft	Wind power
Total energianvändning	Total energy consumption
Andel förnybart, procent	Share of renewable energy, per cent

Biofuels account for the largest share of the renewable energy consumed in Sweden. In 2017, biofuels accounted for 57% of renewable energy according to the Renewable Energy Directive; their share has not fallen below 55% since 2005. Biofuels are used mainly in industry and for district heating. However, the largest increase in recent years has been in the transport sector, where the consumption of biofuels has risen. Figure 19 shows the consumption of biofuels by sector.

[225] Heat pumps are included here as heat absorbed, subject to some limits.

Figure 19 Consumption of biofuels by sector, 2005-2017, TWh



Source	Target
Industri	Industry
Fjärrvärmeproduktion	District heating
Transporter	Transport
Bostäder m.m.	Housing etc.
Elproduktion	Electricity generation

Hydropower makes the next biggest contribution to the large share of renewable energy, both historically and in 2017, when it accounted for 29% of renewable energy.

Wind power has grown by the highest percentage since 2005 and accounts for 8% of renewable energy; that is slightly more than heat pumps, which accounted for 7% in 2017. Solar power accounted for 0.2% of renewable energy in 2017.

The share of renewable electricity generation by energy source/technology

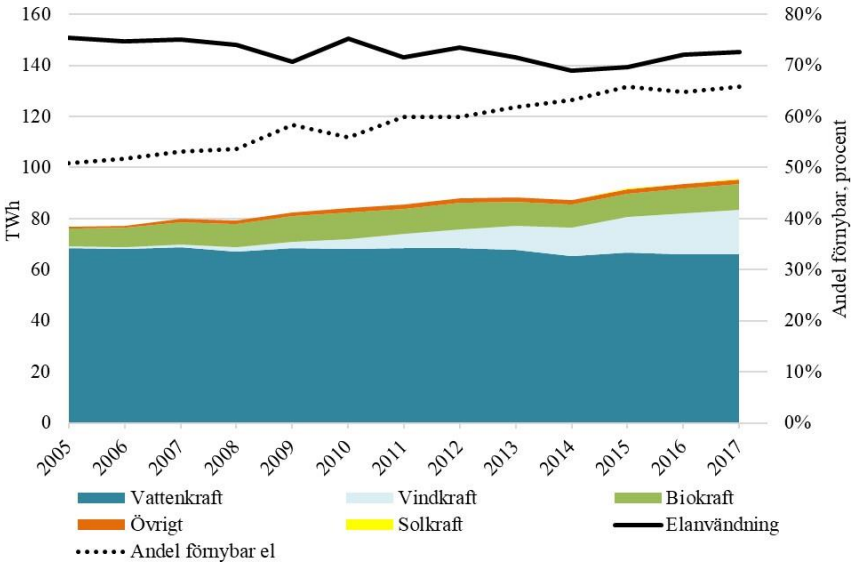
The share of renewable electricity generation in relation to total electricity consumption in 2017 was 65.9%, one per cent higher than in 2016. In 2005, the share was 50.9%. The higher share in 2017 as compared with 2016 is mainly due to an increase in wind power.

In 2017 96 TWh electricity was generated from renewable sources[226], 66 TWh[227] from hydropower, 17.2 TWh[228] from wind power and 10.3 TWh from biomass in combined heat and power plants and in industry. The remaining 2 TWh were produced with from renewable waste, bio-oils and a small amount of solar power.

[226] A temperature correction is applied to electricity generated from hydro- and wind power using the method given in the Renewable energy Directive.
[227] Temperature-corrected value, actual production was 64.6 TWh.
[228] Temperature-corrected value, actual production was 17.6 TWh.

Electricity consumption fell from 151 TWh in 2005 to 145 TWh in 2017 in spite of the fact that the population increased from 9.05 million to 10.12 million in the same period. This is mainly due to a 5 TWh reduction in electricity consumption in industry between 2005 and 2017. Figure 20 shows the development of electricity generated from renewable sources and electricity consumption.

Figure 20 Electricity generated from renewable sources and electricity consumption (2005-2017), TWh and per cent.



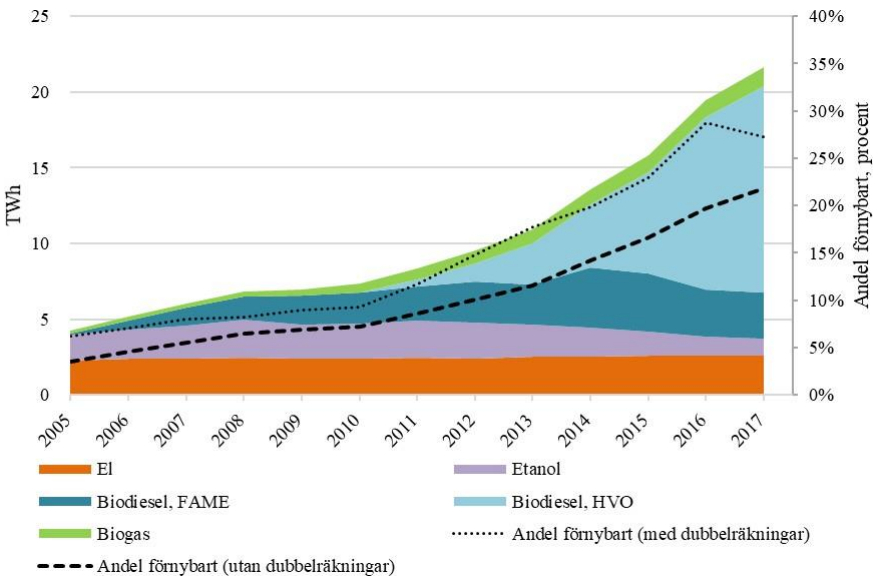
Source	Target
Vattenkraft	Hydropower
Vindkraft	Wind power
Biokraft	Bioenergy
Övrigt	Other
Solkraft	Solar power
Elanvändning	Electricity consumption
Andel Förnybar el	Share of renewable electricity
Andel Förnybar, procent	Share of renewable, per cent

Renewable share in the transport sector by energy source

In 2017, the share of renewable energy in the transport sector was 27.2% according to the calculation method given in the Renewable Energy Directive[229], as shown in Figure 21. This is a 1.5% reduction from the previous year. The reduction between 2016 and 2017 is due to the increase in the volume of biofuels which are not double counted, which have replaced some of the biofuels which are double counted. The share of renewable energy in the transport sector in Sweden has increased significantly since its 2005 level of 6.2%.

[229] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

Figure 21 Actual consumption of renewable energy and electricity (TWh) as a proportion of renewable energy with and without double counting (%), 2005–2017.



Source	Target
El	Electricity
Etanol	Ethanol
Biodiesel, FAME	Biodiesel, FAME
Biodiesl, HVO	Biodiesel, HVO
Biogas	Biogas
Andel Förnybar (utan dubbelräkningar)	Share of renewable (without double counting)
Andel Förnybar (med dubbelräkningar)	Share of renewable (with double counting)
Andel Förnybar, procent	Share of renewable, per cent

The high share of renewable energy in the transport sector is mainly due to biofuels, primarily biodiesel in the form of HVO, which was used to a far greater extent in 2017 than in 2010. As HVO has the same chemical composition as fossil diesel, a high proportion can be added to blends with fossil diesel, which are the fuels primarily used. The biofuel with the next largest share is biodiesel in the form of FAME followed by ethanol and biogas.

Biofuels produced from raw materials covered by Annex IX to the Renewable Energy Directive[230] are double counted in the Directive. This affects the share of renewable energy in Sweden, as a small proportion of HVO and a large proportion of biogas is currently produced from raw materials counted in Annex IX.

The renewable part of the electricity used in transport is also rewarded in the calculation method in the Renewable Energy Directive. The electricity consumption reported by Sweden, which is shown in Figure 21, is for rail transport.

[230] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

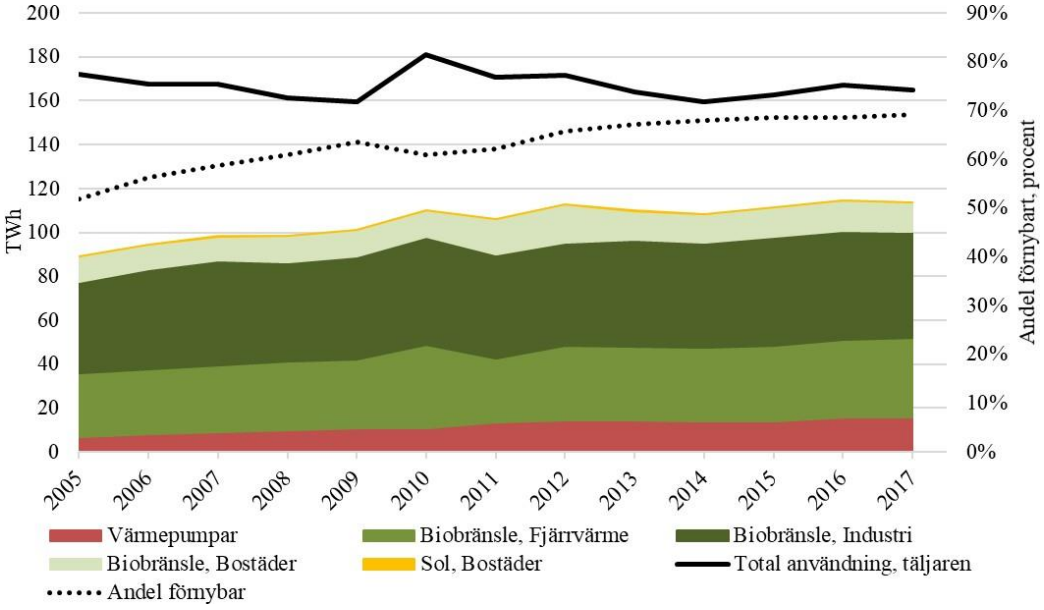
The electricity consumption of cars and other vehicle for road transport is not reported as there are no official statistics for this.

Without using the double counting calculation method given in the Renewable Energy Directive, the share of renewable in the transport sector was 22% in 2017.

Renewable share in the heating and cooling sector by technology/energy source

The share of renewable energy in the heating and cooling sector[231] in relation to energy consumption was 69.1% in 2017 and therefore 0.6% higher than in 2016, as shown in Figure 22. In 2005, the share was 51.8%.

Figure 22 Renewable energy and energy consumption in the heating and cooling sector, 2005–2017, TWh.



Source	Target
Värmepumpar	Heat pumps
Biobränsle, Fjärrvärme	Biofuels, district heating
Biobränsle, Industri	Biofuels, industry
Biobränsle, Bostäder	Biofuels, housing
Sol, Bostäder	Solar, housing
Total användning, täljaren	Total consumption, numerator
Andel Förnybar	Share of renewable
Andel Förnybar, procent	Share of renewable, per cent

There was 114 TWh of renewable energy in the sector in 2017, which is an increase in comparison with 2005, when there was 89 TWh. The renewable energy is mainly biofuels, which account for 86%, followed by heat pumps at 14%.[232]

[231] The heating and cooling sector includes industry, housing and services, and district heating, but excludes electricity consumption in these sectors.

[232] Includes a small quantity of solar heat.

Energy consumption fell form 172 TWh to 165 TWh in the same period from, which also increases the share of renewable energy.

4.2.3.2 Indicative projections of development with existing policies for the year 2030 (with an outlook to the year 2040).

The most recent long-term energy scenarios were published in the report *Scenarier över Sveriges energisystem 2018*[233] for which the base year was 2016. However, the figures and text below include the share and statistics for 2017. The *Referens EU* scenario is based on conditions set by Commission and on the energy and climate policies adopted in Sweden up to 1 July 2018.

Table 28 shows the developments in the total share of renewable energy and the share of the electricity, transport and heating/cooling sectors in the *Referens EU* scenario up to 2040.

Table 28 Share of renewable energy according to the calculation method given in the Renewable Energy Directive, total and by sector in 2017, and in the *Referens EU* scenario, 2020, 2025, 2030, 2035 and 2040, per cent.

	2017	**2020**	**2025**	**2030**	**2035**	**2040**
Total share of renewable energy	54.5%	58.2%	63.4%	66.5%	67.9%	73.4%
Electricity	65.9%	68.1%	75.6%	82.6%	85.8%	96.6%
Transport[234]	27.2%	36.1%	41.7%	47.7%	49.8%	52.1%
Heating and cooling	69.1%	69.2%	71.8%	72.2%	72.4%	73.7%

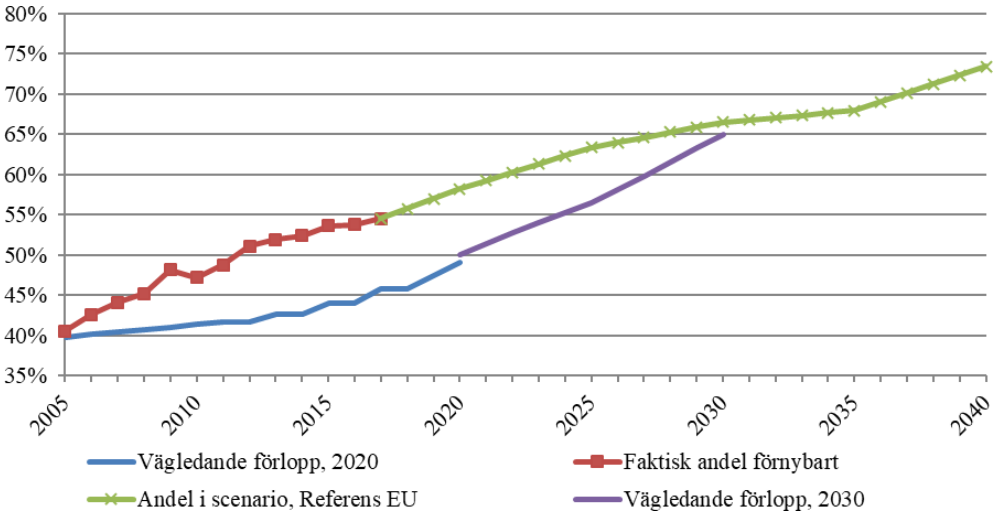
Total share of renewable energy up to 2040

In the *Referens EU* scenario, the share of renewable energy in relation to energy consumption increases from 54.5% in 2017 to 66% in 2030, as shown in Figure 23. The scenario estimates that the share will rise to 73% in 2040.

[233] The Swedish Energy Agency – *Scenarier över Sveriges energisystem 2018* (ER 2019:7).

[234] Some fuels in the renewable energy share in the transport sector are double counted according to the calculation method provided in the Renewable Energy Directive.

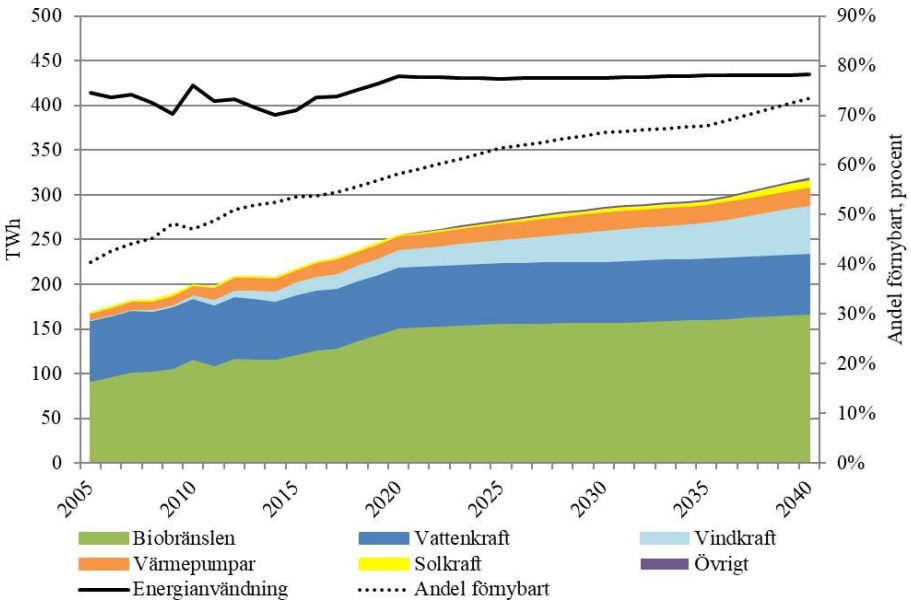
Figure 23 Development of the share of renewable energy, actual and in the *Referens EU* scenario, 2005–2040, and indicative trajectories up to 2020 and 2030.



Source	Target
Vägledande förlopp, 2020	Indicative trajectory, 2020
Faktisk andel förnybart	Actual share of renewable energy
Andel i scenario, Referens EU	Share in the *Referens EU* scenario
Vägledande förlopp, 2030	Indicative trajectory, 2030

The increasing share of renewable energy is based on the expectation that the production of renewable energy will rise from 2020 onwards, while energy consumption will remain relatively stable, as shown in Figure 24. The largest increase is in wind energy, which is expected to rise by 35 TWh between 2020 and 2040. Biofuel consumption is also expected to rise by 15 TWh by 2040. In the scenarios, biofuel consumption is distributed relatively evenly between industry, the housing sector and electricity for generating heat in CHP plants; but there is also a small increase in the transport sector.

Figure 24 Renewable energy by energy source and energy consumption in the scenario *Referens EU,* 2005–2040, TWh.



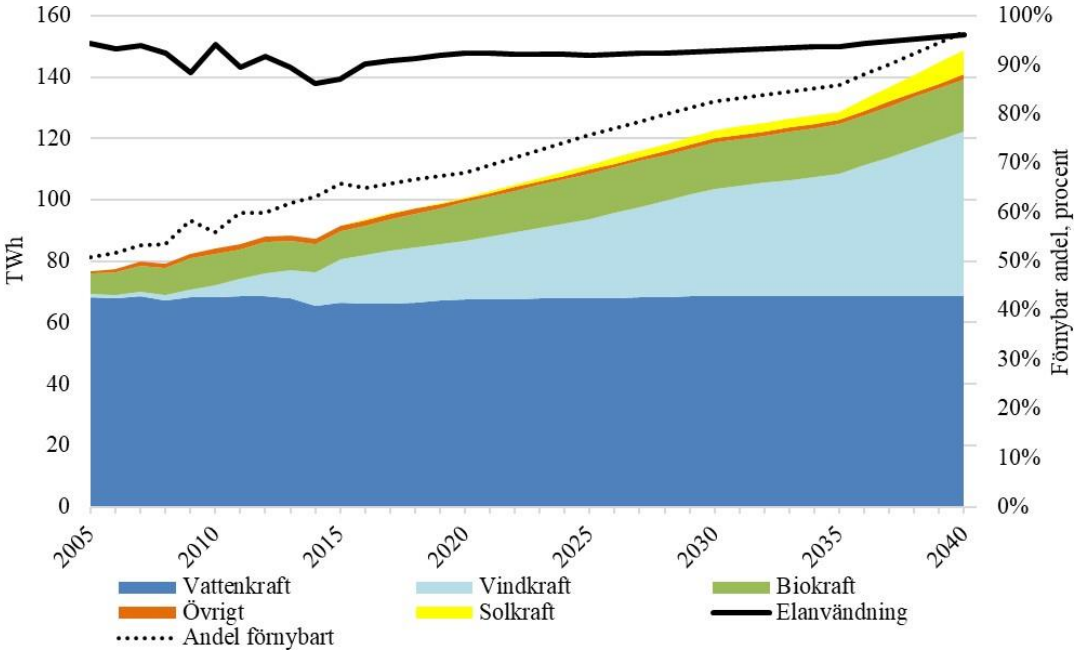
Source	Target

Biobränslen	Biofuels
Vattenkraft	Hydropower
Vindkraft	Wind power
Värmepumpar	Heat pumps
Solkraft	Solar power
Övrigt	Other
Energianvändning	Energy consumption
Andel Förnybar	Share of renewable
Andel Förnybar, procent	Share of renewable, per cent

Share of electricity generated from renewable sources up to 2040

The share of electricity generated from renewable sources according to the Renewable Energy Directive[235] increases in *Referens EU* from 66% in 2017 to 83% in 2030 and 97% in 2040, as shown in Figure 25.

Figure 25 Electricity generated from renewable sources and electricity consumption in *Referens EU, 2005–2040,* TWh



Source	Target
Vattenkraft	Hydropower
Vindkraft	Wind power
Biokraft	Bioenergy
Övrigt	Other
Solkraft	Solar power
Elanvändning	Electricity consumption
Andel Förnybar	Share of renewable
Andel Förnybar, procent	Share of renewable, per cent

Electricity generated from wind power increases the most in the scenario, but electricity from solar power is also expected to increase, particularly towards the end of the period. The result depends on the conditions set in the model, especially those for future technology and electricity prices. The actual expansion of wind will very probably exceed the result in *Referens EU*,

[235] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

at least in the short term, as many projects are currently being planned and built.

If the share of electricity generated from renewable sources is compared with the total amount of electricity generated instead, the result for 2040 is lower, at around 84%. This is mainly due to the fact that the scenario still contains some nuclear power and some of the electricity is generated with fossil fuels from waste and steel production residues. Sweden will therefore not achieve its target of 100% electricity generated from renewable sources by 2040.

Renewable share in the transport sector up to 2040

The scenario estimates that, when calculated by the method given in the Renewable Energy Directive[236], the share of renewable energy in the domestic transport sector will rise from 27% in 2017 to 48% in 2030 and 52% in 2040, as shown in Figure 26. The share of renewable energy in 2017 is relatively low, in spite of the increase in the amount of HVO, because only a certain amount of the HVOs is produced from raw materials covered by Annex IX to the Renewable Energy Directive and therefore double counted. The introduction of the reduction obligation system in Sweden is expected to increase the share of double-counted biofuels during the lifetime of the system[237]. Section 3.1.1 provides more information about the reduction obligation.

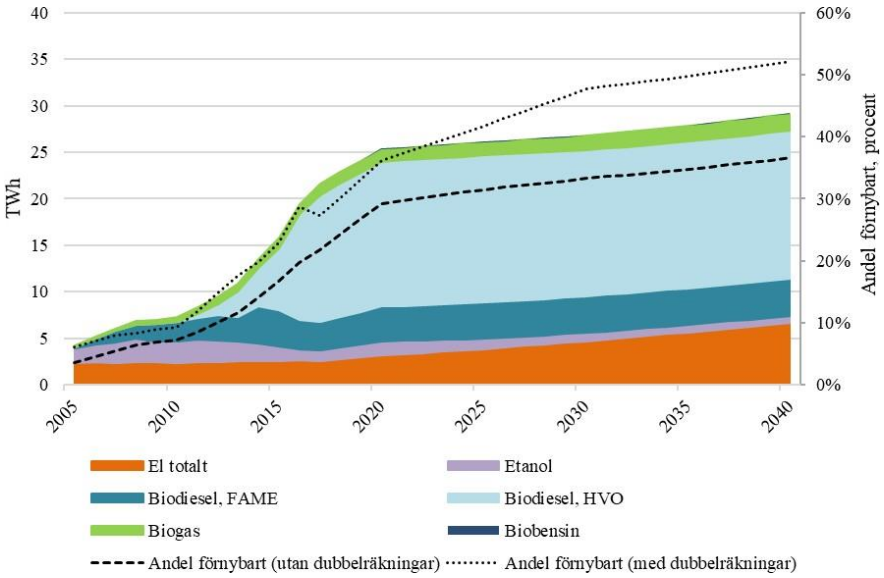
However, in *Referens EU*, the consumption of biofuels, particularly HVOs, increases most, which contributes to a sustained increase in the share of renewable energy. Electricity consumption is also expected to rise in line with the share of electricity generated from renewable sources, and therefore increases the share of renewable energy.

Total energy consumption in the transport sector falls during the period covered by the scenario, which also increases the share of renewable energy.

[236] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

[237] The fuels that reduce climate emissions the most tend to be those that are double counted. See the list of raw materials in Annex IX to Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

Figure 26 Consumption of renewable energy and electricity (TWh) calculated according to the method in the Renewable Energy Directive and share of renewable energy with and without double counting (%), 2005-2040.

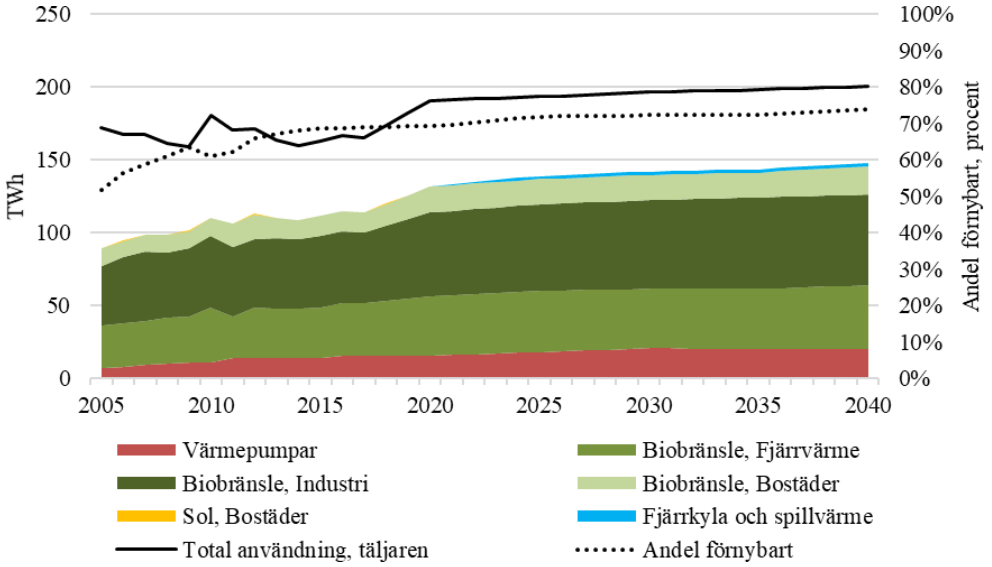


Source	Target
Vattenkraft	Hydropower
Vindkraft	Wind power
Biokraft	Bioenergy
Övrigt	Other
Solkraft	Solar power
Elanvändning	Electricity consumption
Andel Förnybar	Share of renewable
Andel Förnybar, procent	Share of renewable, per cent

Renewable share in the heating and cooling sector up to 2040

The share of renewable energy in relation to energy consumption in the heating and cooling sector is expected to rise from 69% in 2017 to 72% in 2030, as shown in Figure 27. *Referens EU* estimates that the share will be 74% in 2040.

Figure 27 Renewable energy and energy consumption and share of renewable energy in the heating and cooling sector, 2005–2040, TWh and per cent.



Source	Target
Värmepumpar	Heat pumps
Biobränsle, Fjärrvärme	Biofuels, district heating
Biobränsle, Industri	Biofuels, industry
Biobränsle, Bostäder	Biofuels, housing
Sol, Bostäder	Solar, housing
Total användning, täljaren	Total consumption, numerator
Fjärrkyla och spillvärme	District cooling and waste heat
Andel Förnybar	Share of renewable
Andel Förnybar, procent	Share of renewable, per cent

The energy consumed in the sector is largely renewable already, but the consumption of renewable energy is expected to rise slightly. This is mainly due to the expected rise in the consumption of biofuels in industry and for district heating. The use of heat pumps also increases with the introduction of waste heat[238] into the calculations from 2025 onwards. Energy consumption for heating and cooling increases slightly between 2020 and 2040 in the scenarios, which reduces the share.

4.3 Energy Efficiency dimension

4.3.1 Current primary and final energy consumption in the economy and by sector (including industry, households, services and transport).

Table 29 shows total and final energy consumption in the whole economy and by sector.

[238] A cautious estimate of 40% of waste heat has been included in the renewable energy calculations for the sector in the scenarios.

Table 29 Energy consumption 2017 [TWh],

	2017
Total energy consumption[239] including non-energy uses	573
Total energy consumption excluding non-energy uses, including international aviation	545
Total final energy consumption, excluding international aviation and shipping	378
Total final energy consumption, including international aviation and shipping	389
Industry	*143*
Housing	*87*
Services, etc.	*59*
Transport (domestic)	*88*
International aviation	*11*

4.3.2 Current potential for the application of high-efficiency cogeneration and efficient district heating and cooling

The information under this heading is taken from the report provided for under Article 14(1) of the Energy Efficiency Directive[240], entitled 'Comprehensive assessment of the potential for the application of high-efficiency cogeneration, district heating and cooling – Promotion of efficiency in heating and cooling'. Please note that the information in that report differs from the long-term scenarios[241] from 2018 used as a basis for this plan. The next comprehensive assessment report in accordance with Article 14 is due on 31 December 2020.

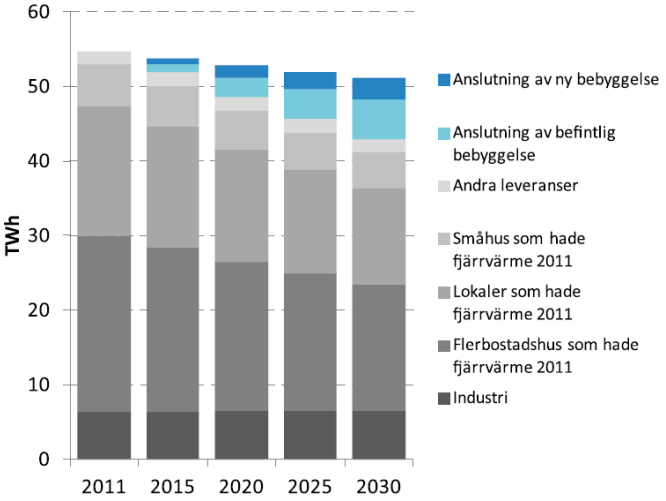
According to the report on the potential for high-efficiency cogeneration, district heating and cooling, new district heating connections in both existing and new developments are not expected to compensate for the reduction caused by energy efficiency measures and the conversion to heat pumps in buildings that have already been connected. In 2011, 54.7 TWh of district heating was generated, which is expected to fall to 51 TWh by 2030, despite the fact that new connections to existing and new buildings are expected to amount to 8 TWh in 2030. The net reduction is thus expected to be 4 TWh, or 12 TWh without new connections, as shown in Figure 28.

[239] Total energy consumption corresponds to total input energy and includes all domestic energy consumption, including transformation and transmission losses and fuels for non-energy uses. International transport is not included.

[240] Swedish Energy Agency – Comprehensive assessment of the potential for the application of high-efficiency cogeneration, district heating and cooling (ER2013:24).

[241] Swedish Energy Agency – Scenarios of Sweden's energy system 2018 (ER2019:7).

Figure 28. Projected development of Sweden's cumulative deliveries of district heating to 2030[242].



Source	Target
Anslutning av ny bebyggelse	Connection of new buildings
Anslutning av befintlig bebyggelse	Connection of existing buildings
Småhus som hade fjärrvärme 2011	Smaller buildings with district heating in 2011
Lokaler som hade fjärrvärme 2011	Premises with district heating in 2011
Flerbostadshus som hade fjärrvärme 2011	Multi-dwelling buildings with district heating in 2011
Industri	Industry

District cooling currently amounts to approx. 1 TWh. The potential for district cooling has been estimated at a further 2 TWh by 2030.

The total cogeneration potential consists of cogeneration in district heating systems and industrial cogeneration, also known as industrial back pressure. The additional potential for electricity production from cogeneration amounts to approx. 5 TWh by 2030. This is based on the assumption that deliveries of district heating will decrease slightly in the long term.

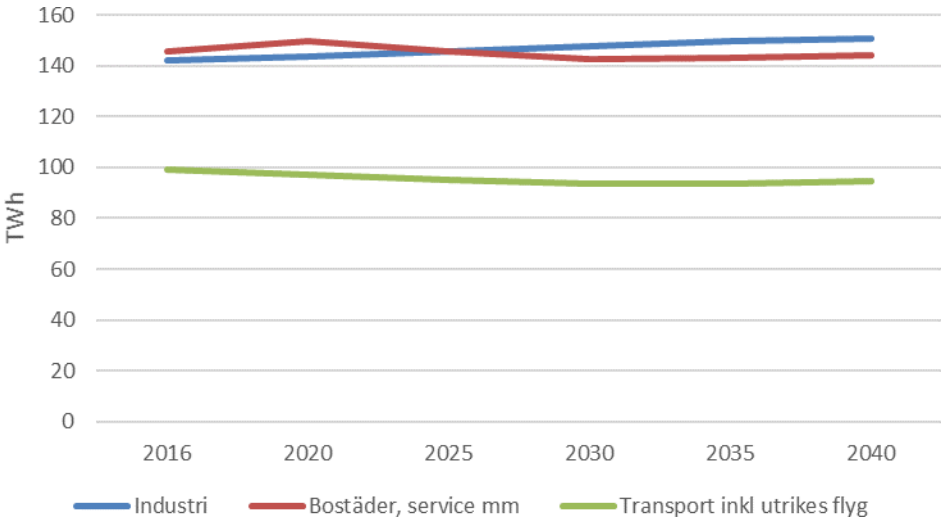
Electricity production from industrial cogeneration is currently approx. 6 TWh per year. The potential from industrial cogeneration is estimated to be approx. 9 TWh by 2030.

4.3.3 Projections on the basis of existing instruments, measures and programmes on energy efficiency in accordance with point 1.2, paragraph ii, for primary and final energy consumption for each sector until at least 2040 (including 2030)

Figure 29 shows the EU baseline scenario for Sweden's final energy consumption to 2040, broken down by sector. The scenario is based on instruments and measures adopted on 1 July 2018.

[242] Swedish Energy Agency – Comprehensive assessment of the potential for the application of high-efficiency cogeneration, district heating and cooling (ER2013:24).

Figure 29 Scenario for energy consumption 2016-2040 for industry, transport, and housing and services, etc., TWh.



Source	Target
Industri	Industry
Bostäder, service mm	Housing, services, etc.
Transport inkl utrikes flyg	Transport, including international aviation

Energy consumption in the housing and services sector is expected to decrease slightly towards 2040. This is the result of energy efficiency measures in buildings and the fact that buildings with a direct supply of electricity are being converted to heat pumps.

Energy consumption in the transport sector also decreases towards 2040, which is due to the fact that vehicles, aircraft and ships are becoming more energy efficient, as well as an increase in the use of electric vehicles and ships.

Energy consumption in industry is expected to increase slightly, however. A number of production processes powered by fossil fuels are being replaced with electricity, which will bring about an increase in energy consumption.

4.3.4 Cost-optimal levels of minimum energy performance requirements resulting from national projections, in accordance with Article 5 of Directive 2010/31/EU.

Table 30 shows the cost-optimal levels of minimum energy performance requirements resulting from national projections, in accordance with Article 5 of the Energy Performance of Buildings Directive[243]. The results are shown as a range, with the applicable minimum requirements in brackets.

[243] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.

Table 30 Cost-optimal levels and minimum energy performance requirements.

	Cost-optimal level primary energy rate (EP_{pet}) kWh/m^{2}A$_{temp}$ year
Smaller buildings	74-88 (90)
Multi-dwelling buildings	50-88 (85)
Premises	53–70 (80)

The National Board of Housing, Building and Planning has developed a proposal on new levels for minimum energy performance requirements, which was put forward for consultation during the summer and autumn of 2019 and had a proposed date of entry into force of 1 July 2020.

4.4 Energy Security dimension

4.4.1 Current energy mix, domestic energy sources, import dependency, including relevant risks

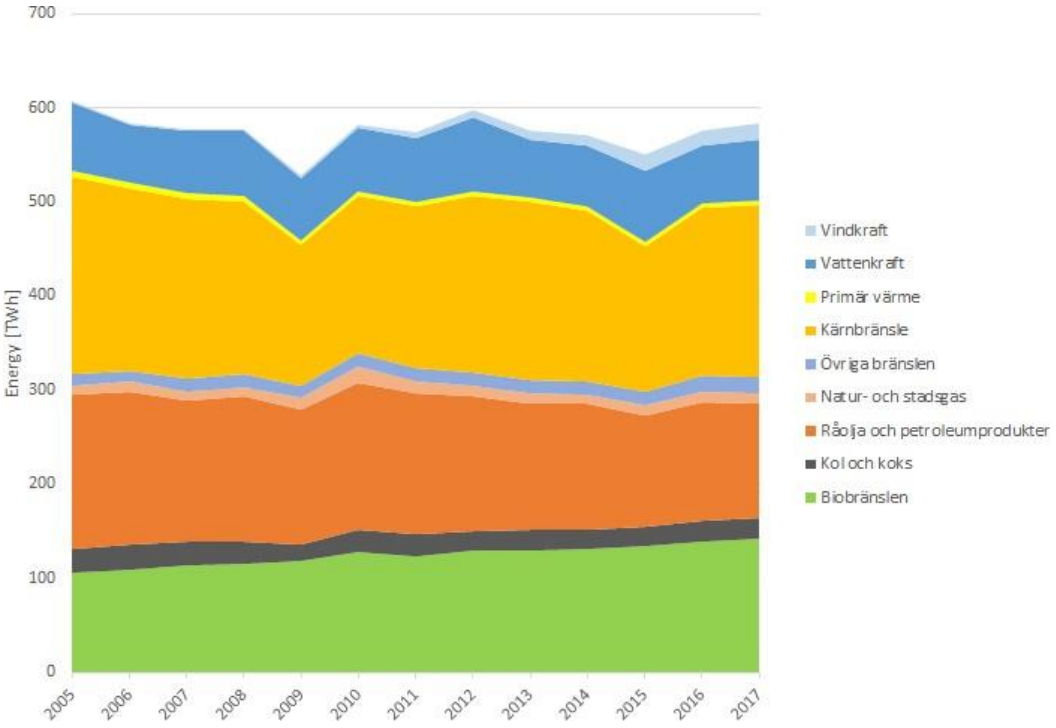
The energy mix in Sweden is dominated by biofuels, crude oil and petroleum products, nuclear fuel and hydroelectric power. Significant domestic energy carriers are hydroelectric power, biofuels, wind power and absorbed heat from heat pumps[244]. Biofuels accounted for 24% of input energy in 2017[245]. Trends in total energy input between 2005 and 2017 are shown in Figure 30.

However, a large proportion of energy input is dependent on imports, for example nuclear fuel and fossil fuels, such as natural gas and oil, with the latter energy carrier being widely used in the transport sector. In total, fossil fuels accounted for 27% of input energy in 2017. The energy self-sufficiency ratio, defined as the ratio between domestic energy and total input energy, has increased slightly in recent years, reaching 44% in 2017.

[244] All historical statistical data are based on the Swedish Energy Agency's 'Energy indicators in figures 2019'.

[245] Excludes net imports.

Figure 30 Total energy input per energy carrier, TWh, 2005-2017.



Source	Target
Vindkraft	Wind power
Vattenkraft	Hydroelectric power
Primär värme	Primary heat
Kärnbränsle	Nuclear fuel
Övrigabränslen	Other fuels
Natur-och stadsgas	Natural and town gas
Råolja och petroleumprodukter	Crude oil and petroleum products
Kolochkoks	Coal and coke
Biobränslen	Biofuels

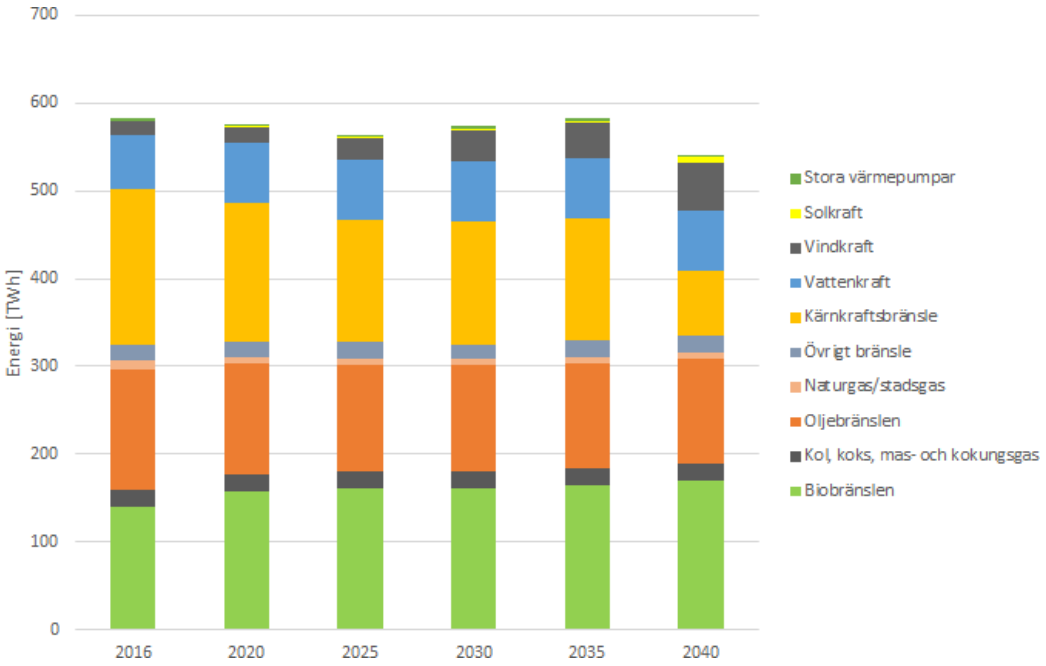
Source: Swedish Energy Agency, Energy indicators in figures 2019.

Electricity production in Sweden is primarily based on hydroelectric power and nuclear power, which accounted for 40% and 39%, respectively, of total electricity production in 2017. The wind power expansion continues, accounting for 11% of total electricity production in 2017. The consumption of biofuels for electricity and heat production is also increasing.

4.4.2 Development forecasts based on existing instruments and measures until at least 2040 (including 2030)

Figure 31 shows total input, broken down by energy carrier, for the period 2016 to 2040 in the EU baseline scenario. Input energy decreases from 2035. This is based on the assumption that the process to phaseout the remaining nuclear power reactors will begin and nuclear fuel use thus decreases over time.

Figure 31 Total input, broken down by energy carrier, in the EU baseline scenario, TWh, 2016-2040.



Source	Target
Stora värmepumpar	Large heat pumps
Solkraft	Solar power
Vindkraft	Wind power
Vattenkraft	Hydroelectric power
Kärnkraftsbränsle	Nuclear fuel
Övrigt bränsle	Other fuels
Naturgas/stadsgas	Natural gas/town gas
Oljebränslen	Oil fuels
Kol, koks, mas- och kokungsgas	Coal, coke, blast furnace and coking gas
Biobränslen	Biofuels

Source: Swedish Energy Agency – Scenarios of Sweden's energy system 2018 (ER2019:7). Note: Net imports of electricity are excluded.

The scenario involves an expansion of renewable electricity production and a phasing-out of existing nuclear power. The scenario is based on the closure of reactors 1 and 2 of the Ringhals nuclear power plant in 2020 and 2019, respectively, as per the owners' announcement, with it being expected, based on information provided by the owners, that the remaining six reactors will be phased-out after 60 years of operation. However, nuclear power plants will continue to operate for as long as they are profitable and safety requirements are met, which may be either shorter or longer than the expected 60 years. It is expected that approx. 60% of nuclear power will have been phased-out by around 2040, with 25 TWh remaining in the electricity system. The wind power expansion is driven by higher electricity prices from 2030 onwards, amounting to 54 TWh in 2040. Electricity production from solar cells amounts to almost 8 TWh in 2040.

The consumption of biofuels increases over time. The largest increase in biofuels in absolute terms occurs in relation to electricity and heat production in district heating networks, although there are also significant increases in domestic transport and industry. The consumption of oil decreases over time and is primarily driven by developments within the transport sector, where increased electrification and efficiency measures

reduce the demand for vehicles and ships powered by fossil fuels.

The electricity balance is strengthened continuously up to 2035, when net exports account for 35 TWh. This is primarily due to an increase in wind power generation accompanied by relatively weak growth in electricity demand. During the period 2035-2040, however, the electricity balance weakens and net exports fall to 33 TWh in 2040. This is mainly attributable to the fact that the expansion of wind power and, to a certain extent, solar power cannot compensate for the loss of electricity production resulting from a partial phasing-out of nuclear capacity.

The phasing-out of nuclear power, with additional electricity production being primarily generated by wind and solar power, poses a challenge for the stability of the electricity system and thus increases the risk of disruption if no action is taken. This is due to the fact that system inertia[246] decreases as a result of the phasing-out of nuclear power, while additional electricity production, primarily from wind and solar power, does not naturally contribute to system inertia.

Reduced reactive power[247] as a consequence of the phasing-out of nuclear power has additional significance when it comes to the possibility of transferring electricity between different electricity price areas. The aforementioned change to the power system also poses the risk that the power balance will weaken over time, resulting in an increased risk of rising costs and higher prices. This is due to the fact that wind power is unpredictable and there is an increased need for balancing resources in the system.

Analyses of future power adequacy

Svenska kraftnät (the government agency responsible for the national grid) continuously analyses Sweden's short- and long-term future power adequacy. There are two different methods for evaluating power adequacy.

The statistical method compares expected available domestic production against expected electricity consumption during winter periods with the highest electricity consumption. This is known as a power balance and is carried out in respect of a normal one-year winter, a 10-year winter (a cold winter that recurs, on average, once every ten years) and a 20-year winter.

If power adequacy is evaluated using the dynamic method (also known as

[246] The nominal frequency in the Nordic synchronous power system is 50 Hz. Imbalances occur momentarily and cause the frequency to deviate from 50 Hz. Active power balancing, which is able to counteract such imbalances, is subject to a short delay. Therefore, a certain degree of spinning mass in the system is required to be able to counteract rapid changes in frequency. The spinning mass of the rotating parts (generators) creates inertia and gives the system's active frequency regulation extra time in which to act. The more system inertia, the slower the frequency change of a given disruption.

[247] Reactive power is generated when there is a phase shift between current and voltage. Reactive power reduces the possibilities to transmit active power into the grid, which is considered to be the type of power that carries out useful work when consumed by the load.

the probabilistic method), the entire electricity system is simulated as part of an electricity market model with connections between electricity price areas (and countries) and consumption and production units. The model simulates a large number of years of weather, during which wind, water and consumption levels, etc., vary. This method thus takes account of the import/export capacity between electricity price areas, both domestic and international production resources, and forced outages in terms of both production and interconnectors.

Using the statistical method, Svenska kraftnät considers that the 2020 power balance amounts to -2 100 MW during a normal one-year winter and -3 700 MW during a 20-year winter[248]. A negative power balance means that electricity consumption during winter periods with the highest electricity consumption exceeds expected available domestic production. Therefore, this illustrates the need for imports during periods with the highest electricity consumption. A short-term weakening of the power balance is primarily due to the fact that Ringhals reactor 2 was decommissioned in 2019 and Ringhals reactor 1 is scheduled to be decommissioned during 2020.

Svenska kraftnät also evaluated power adequacy using the dynamic method[249]. When production and imports do not adequately cover the load, a power shortage occurs. This is referred to as Loss of Load Expectation (LOLE) and Expected Energy Not Served (EENS). LOLE is measured in number of hours per year, while EENS is measured in number of MWh per year. Overall, the simulations show a higher risk of power shortages after 2030. However, it should be noted that the risk is assessed as remaining at a low level. In the reference scenario for 2040 used by Svenska kraftnät, LOLE amounts to 0.19 hours per year on average, while EENS amounts to 69.3 MWh per year. It should be noted, however, that there is a great deal of variation.Some winter periods see no problems at all, while the risk of power shortages may be significantly higher during years with cold winters and during years in which an unusually large number of problems arise with regard to interconnectors or production. However, it should be noted in this respect that the model has included a great deal of consumption flexibility and storage on the continent. If this flexibility should fail to be realised, the simulated power shortages would increase.

In the event that nuclear power is phased-out and replaced with weather-dependent, unpredictable electricity production, for example from wind and solar power, it will be necessary to implement measures in the form of increased demand flexibility, energy storage and fast-balancing electricity production capacity in order for such an electricity system to

[248] Svenska kraftnät – Long-term market analysis 2018 (Ref. SVK 2018/2260).

[249] Svenska kraftnät – Long-term market analysis 2018 (Ref. SVK 2018/2260).

function. Research and development, as well as the commercial conditions for these technical solutions, are of crucial importance when deciding which solutions to employ. This is explained further under Heading 4.6.

4.5 The Internal Energy Market dimension

4.5.1 Electricity interconnection

4.5.1.1 Current level of interconnection and major interconnections.

At the end of 2018/beginning of 2019[250], Sweden had an interconnection level of 27%. Total import capacity was 10 350 MW and installed production capacity amounted to 39 026 MW. Existing connections with neighbouring countries are shown in Table 31.

Table 31. Current connections and import capacity (max. NTC).

From	Type	Name	MW
Denmark	AC		1 700
Denmark	HVDC	Konti-Skan 1&2	740
Finland	AC		1 100
Finland	HVDC	Fenno-Skan 1&2	1 200
Lithuania	HVDC	NordBalt	700
Norway	AC		3 695
Poland	HVDC	Swe-Pol link	600
Germany	HVDC	Baltic cable	615
Total			**10 350**

4.5.1.2 Projections for increased interconnection requirements (including for 2030)

The interconnection level is expected to reduce slightly towards 2027, to 26%, despite Sweden increasing interconnections to neighbouring countries. New connections are shown in Table 32. The decrease in interconnection level is caused by the expected significant expansion of domestic renewable production, which thus contributes to the level decreasing.

Table 32. New connections by 2027.

From	Type	Name	MW
Finland	AC	3:e AC	900
Germany	HVDC	Hansa Power Bridge	700
Total			1600

[250] Svenska Kraftnät – The Power Balance on Sweden's Electricity Market, 2018 report (Ref. 2018/587).

There are no further plans for interconnections from 2027 onwards. However, analyses show that the construction of additional connections may be beneficial from a socio-economic perspective, particularly if nuclear power is phased-out in the long term. This is the subject of ongoing analysis by Svenska kraftnät. An estimated service life of 60 years is frequently cited as a benchmark for nuclear power.

Nuclear power plants will continue to operate for as long as they are profitable for the owners and safety requirements are met, which may be either shorter or longer than the expected 60 years.

Internal reinforcement of the Swedish national grid is currently under way for the purpose of reducing bottlenecks between electricity price areas and enabling additional connections and interconnections. The Nord-Syd (North-South) programme[251], which includes some fifty different projects, is addressing this problem and will run until around 2040.

4.5.2 Energy transmission infrastructure

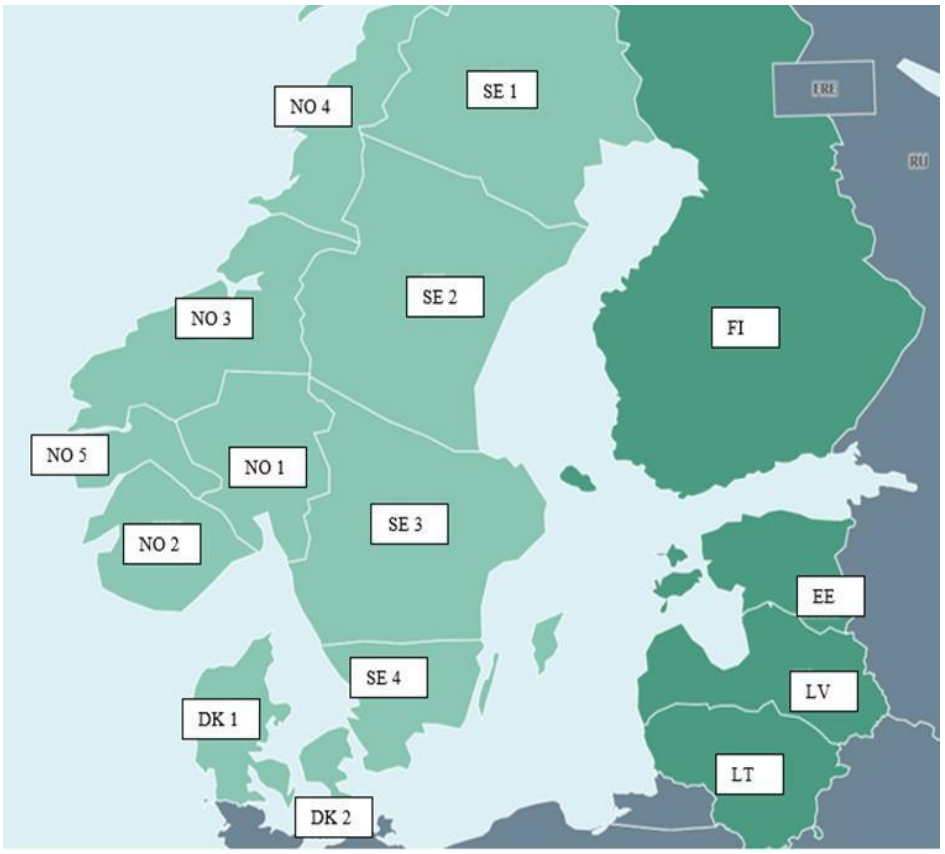
4.5.2.1 Important characteristics of existing electricity and gas transmission infrastructure.

Existing infrastructure for electricity

Sweden is an elongated country, with most electricity consumption occurring in the south and hydroelectric power production in the north. Sweden is split into five electricity price areas, see Figure 32.

[251] Svenska kraftnät – The NordSyd investment package: Significant reinforcement of the Swedish national electricity grid between electricity price areas 2 and 3 (March 2019).

Figure 32 Electricity price areas.



Source	Target
SE 1	SE 1
NO 1	NO 1
DK 1	DK 1
FRE	FRE
RU	RU
EE	EE
LV	LV
LT	LT

Source: Drawn up by NordPool and the Swedish Energy Agency.

Nuclear power is localised in electricity price area 3, but is expected to be gradually phased-out as the reactors age and/or as profitability decreases.

Wind power is primarily exploited in the north of Sweden, as a result of good project locations and the fact that it is easier to obtain authorisation to build electricity networks there, despite the fact that spot prices are generally lower in the north compared with the south.

The main function of the national grid is thus to transmit electricity from the north of Sweden to the south. This function is supported by the expansion of wind power in the north of Sweden. The configuration of the national grid is shown in Figure 33.

Figure 33. National electricity grid 2017.

Source: Svenska kraftnät.

Source	Target
Det Svenska stamnätet för el består av 15 000 km kraftledningar, 160 transformator- och kopplingsstationer och 16 utlandsförbindelser.	Sweden's core electricity network consists of 15 000 km of power lines, 160 substations and 16 interconnections.
400kV ledning	400 kV line
275kv ledning	275 kV line
220kV ledning	220 kV line
HVDC (likström)	HVDC (direct current)
Samkörningsförbindelse för lägre spanning än 220kV	Interconnections for voltages below 220 kV
Planerad/under byggnad	Planned/under construction
Vattenkraftstation	Hydroelectric power station
Värmekraftstation	Thermal power station
Vindkraftpark	Wind farm
Transf./kopplingsstation	Substation

Planerad/under byggnad
SVERIGE
NORGE
ESTLAND
LETTLAND
DANMARK
LITAUEN

Planned/under construction
SWEDEN
NORWAY
ESTONIA
LATVIA
DENMARK
LITHUANIA

Hydroelectric power in Norway and north Sweden also represents a crucial balancing resource for the whole of the Nordic synchronous power system[252].

There are hours during which the transmission from north to south is insufficient. For this reason, Sweden is split up into different price areas on the basis of the structural bottlenecks present in the network. Although structural bottlenecks are to be removed, it is not viable, from a socio-economic perspective, for the same price to always be guaranteed throughout Sweden.

Gas infrastructure

The Swedish natural gas system is small in comparison to most other natural gas networks in Europe. Only 30 of Sweden's 290 municipalities have access to the natural gas network in western Sweden. Gas enters Sweden via the Danish Dragör pipeline. In Sweden, the transmission network is owned and operated by Swedegas AB, which also has responsibility for balancing the Swedish natural gas network. The system of balancing responsibility has changed since the introduction of a joint balancing zone between Sweden and Denmark, which entered into force on 1 April 2019. Imbalances are corrected by the Balancing Area Manager (BAM), which is jointly owned by Swedegas AB and Energinet.

There is also a town and vehicle gas network in the Stockholm area, which is owned by Gasnätet Stockholm AB. The production and supply of gas to the town gas network mainly occurs from a gas plant in Stockholm, which supplies both biogas and liquefied natural gas (LNG).

There are also smaller regional and local gas networks throughout Sweden. Many of these small local networks are mostly used to transport biogas intended for vehicles from a production site to refuelling stations.

4.5.3 Projections for network expansion requirements until at least 2040 (including 2030)

Future need for network expansion

[252] All electricity price areas in the Nordic region with the exception of DK1, i.e. electricity price areas that are interconnected via alternating current.

Electricity network

Svenska kraftnät has a Ten-Year Network Development Plan[253], which is updated every two years. In addition, there is the NordSyd investment package, which includes some fifty different projects whose main purpose is to strengthen the capacity between electricity price areas 2 and 3 and to replace a number of older lines running between these two areas. These projects will run until 2040. However, the actual investments included in the package may be reviewed in the event that requirements change in the period up to 2040.

The network development plan is based on various different scenarios[254] for the period to 2040. The most important elements of the scenarios are nuclear power, wind power and electricity consumption. Nuclear power is expected to be gradually phased-out as the reactors age, with no current plans for new reactors. Ringhals reactor 2 was decommissioned in 2019 and Ringhals reactor 1 will be decommissioned during 2020, as per the owners' announcement. The remaining six reactors will continue to operate for as long as is safe and profitable. It is not possible to predict how long those reactors will continue to operate, but a service life of approximately 60 years is often cited, which would suggest that the reactors will continue to be operational until the first half of the 2040s, depending on the year in which they were commissioned. However, nuclear power plants will continue to operate for as long as they are profitable for the owners and safety requirements are met, which may be either shorter or longer than the expected 60 years. All reactors are located in electricity price area 3.

Wind power continues to expand, driven in the short term by the fact that the electricity certificate system has been extended to 2030. However, wind power is starting to prove commercially competitive without any support system and it now seems that the target set for 2030 in the electricity certificate system[255] may be achievable as early as the first few years of the 2020s. One challenge posed by wind power expansion is that most new wind farms seem to be being built in electricity price areas 1 and 2, despite the fact that the majority of electricity consumption occurs in electricity price areas 3 and 4. The potentially lower price for electricity in the north of the country is offset by better wind conditions and generally clearer authorisation procedures.

Future electricity consumption represents a major uncertainty factor, but electrification of both transport and industry processes is a powerful driving force. Sweden and the Nordic region are also attractive locations in which to

[253] Svenska kraftnät – System Development Plan 2018-2027 (November 2017).

[254] Svenska kraftnät – Long-term market analysis 2018 (SVK 2018/2260).

[255] For more information on the objective of the electricity certificate system, see Heading 3.1.2.

establish data centres, largely because of their low electricity prices, cool climate, and generally stable markets and political systems.

At European level, moreover, the scenarios for future development of power systems and electricity markets created by ENTSO-E[256] are partly based on the various scenarios used by the transmission system operators themselves. These scenarios are partly at European level and partly at regional level, specifically the Regional Group Baltic Sea (RGBS) for Sweden.

Gas network

There are currently no development forecasts relating to the Swedish natural gas network.

4.5.4 Electricity and gas markets, energy prices

4.5.4.1 Current situation on the electricity and gas markets, including energy prices

The electricity market

The electricity market is made up of a wholesale and a retail market. Electricity is traded between producers and larger consumers on the wholesale market. Sweden's transmission system is linked to Denmark, Norway, Finland, Germany, Poland and Lithuania, and, indirectly, to the whole of Europe. The largest marketplace on the wholesale market is the NordPool spot market. This is a day-ahead market, where trading takes place via an auction process that accounts for transmission capacity in the electricity network between Sweden's four bidding zones. There is also an intraday market, where participants are able to adjust their positions as required. A number of entities that have responsibility for balancing have a financial responsibility for maintaining balance during the planning stage, but, during operating hours, Svenska kraftnät is responsible for maintaining the balance of the electricity system and carrying out necessary positive and negative adjustments, by trading in balancing power on the real-time market, operated in conjunction with other Nordic system operators.

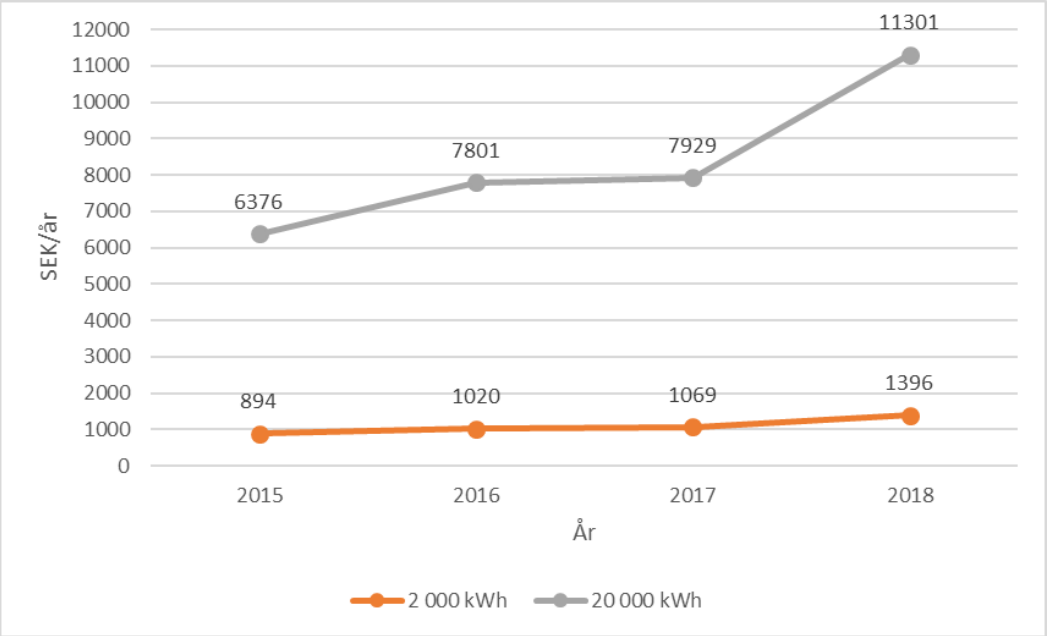
The electricity cost for end consumers consists of the electricity trade price, electricity network price, energy tax and value-added tax (VAT). In addition to the above costs, many retailers pay a fixed annual fee, which they pass on to the end consumer. This annual fee is usually in the range of SEK 100 to 500. All of these costs are subject to VAT.

[256] ENTSO-E & ENTSOG – TYNDP 2018, Scenario Report.

Electricity traders are obliged to purchase electricity certificates corresponding to a given share of their customers' electricity consumption. Since 2007, the electricity certificate fee has been included in the electricity trade price.

Figure 34 is based on typical customers consuming either 2 000 or 20 000 kWh, who have a variable electricity price contract in electricity price area 3. The costs are calculated at the 2018 price level and are averaged.

Figure 34 Cost (electricity price area 3) including annual fees and excluding VAT and other taxes.



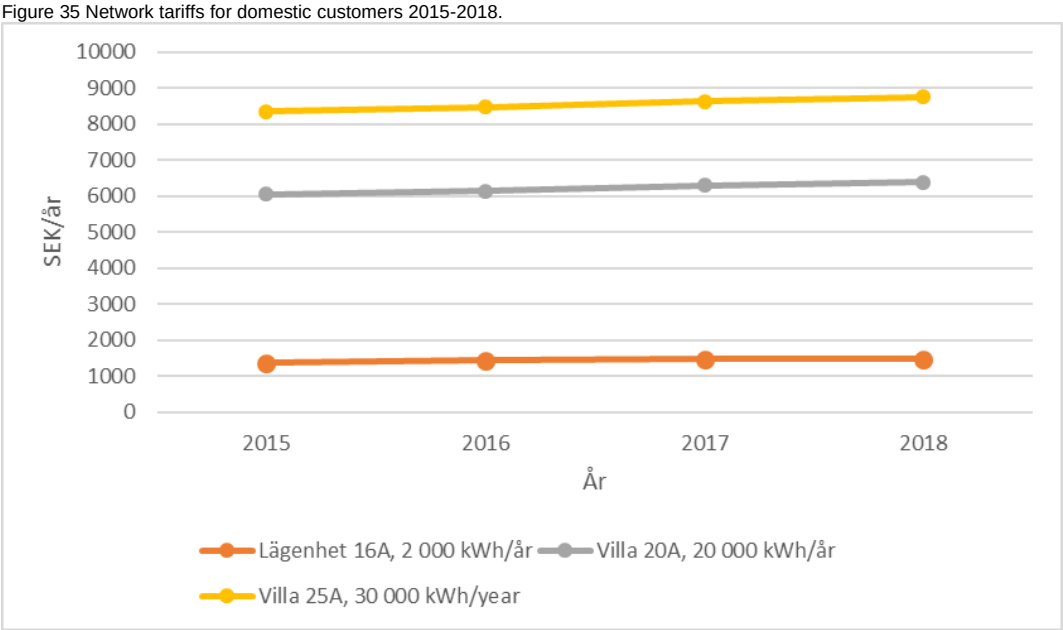
Source	Target
SEK/år	SEK/year
År	Year

Source: Swedish Energy Markets Inspectorate

Electricity network tariffs consist of a fixed cost and a variable cost (transmission fee). VAT is paid on both the fixed subscription fee and the variable transmission fee.

Figure 35 shows network costs for the three most common types of domestic customers. The costs are calculated at the 2018 price level and are averaged.

Figure 35 Network tariffs for domestic customers 2015-2018.



Source	Target
SEK/år	SEK/year
Lägenhet 16A, 2 000 kWh/år	Apartment 16A, 2 000 kWh/year
Villa 20A, 20 000 kWh/år	Detached house 20A, 20 000 kWh/year
Villa 25A, 30 000 kWh/year	Detached house 25A, 30 000 kWh/year

Source: Swedish Energy Markets Inspectorate

The gas market

Sweden does not produce natural gas; however, biogas is produced on a smaller scale. The natural gas consumed in Sweden mainly comes from the Danish gas fields in the North Sea, via the Dragör line[257]. Because of the design of the Swedish gas network, the Swedish natural gas market is closely linked to the Danish market. Stakeholders in the Swedish natural gas system may, therefore, also be active on the Danish gas market, particularly Gaspoint Nordic, which has been a member of the pan-European gas exchange platform, PEGAS, since 24 November 2016.

Consequently, competition, price trends and transparency on the Swedish natural gas market are largely dependent on trends in Denmark. The Swedish natural gas market's affiliation with the Danish market was further strengthened on 1 April 2019 with the creation of a joint balancing zone between the countries. The project, known as the Joint Balancing Zone[258], began in 2017 and has been implemented in collaboration with end consumers, gas suppliers, network owners and supervisory authorities in Sweden and Denmark. Its aim is to increase market size and to ensure even greater security of supply.

All trading of gas in the natural gas network in western Sweden is carried out

[257] It should be noted that, during the redevelopment of the Danish Tyra gas field from the autumn of 2019 to the summer of 2022, both Sweden and Denmark's gas markets will be supplied by imported gas from continental Europe.
[258] https://www.swedegas.se/sv-SE/Vara%20tjanster/Systemansvar/Joint%20Balancing%20Zone.

through Gaspoint Nordic/PEGAS. Operators must have an agreement in place with the Danish transmission system operator Energinet.dk. Through Gaspoint Nordic/PEGAS, an operator may trade in gas and transport capacity on a daily, weekly, monthly, quarterly and annual basis. Intraday trading also occurs. Energinet.dk, which has responsibility for balancing the Danish transmission system, uses Gaspoint Nordic/PEGAS' intraday market to manage the balance in the Danish natural gas network.

The price on Gaspoint Nordic/PEGAS is based on supply and demand and also forms the basis of what is known as the balancing price used by Energinet to resolve imbalances between market players.

Trading in domestically produced biogas also occurs outside the natural gas market in western Sweden. This happens most commonly when a particular biogas producer produces biogas and sells the gas produced to a specific customer, for example a municipal operator. The price that is set depends on local conditions and may also be affected by the cost of competing fuels, such as the price of diesel.

4.5.4.2 Development forecasts based on existing instruments and measures until at least 2040 (including 2030)

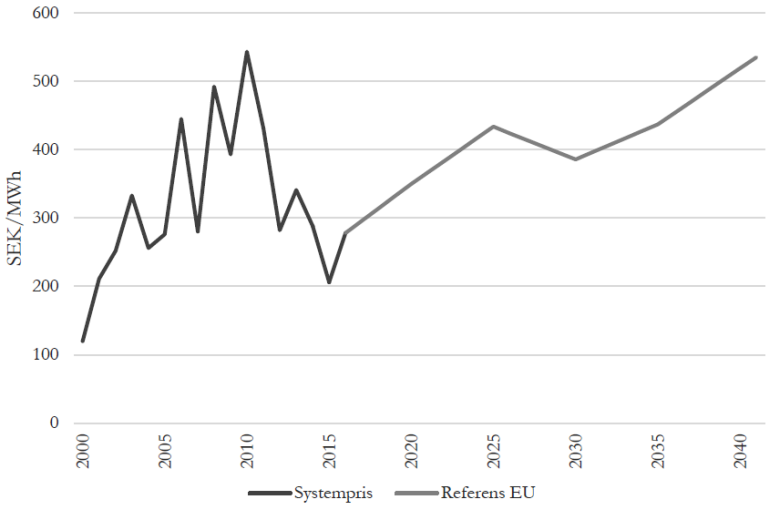
An evolution of the price of electricity is being developed as part of the work on the long-term energy scenarios[259]. The price of electricity follows the TIMES-Nordic model and is based on assumptions relating to fossil fuel prices and prices for emission allowances obtained from the Commission.

Electricity price trends for the EU baseline scenario are shown in Figure 36. The price of electricity is calculated as an annual average for Sweden, which is treated as a price area.

The price of electricity increases from 2030 to 2040 as a result of fuel prices and prices for emission allowances increasing throughout that period.

[259] Swedish Energy Agency – Scenarios of Sweden's energy system 2018 (ER2019:7).

Figure 36 Electricity price trend according to the Swedish Energy Agency's EU baseline scenario, SEK/MWh.



Source	Target
Systempris	System price
Referens EU	EU baseline

4.6 Research, Innovation and Competitiveness dimension

4.6.1 The current situation within the low-carbon technologies sector and, to the greatest possible extent, its position on the global market (this analysis should be carried out at EU level or global level)

The annual budget of the National energy research and innovation programme is approximately SEK 1.6 billion. Sweden excels in a number of fields of research and innovation, including the field of low-carbon technologies, and is also at the forefront of international efforts in the fields listed below.

Efficient biofuels for low-carbon energy transition, forestry and bioenergy

Efforts in this field are focused on:

- fuel supply; cultivation and extraction of biofuels, logistics, planning and fuel processing, with a focus on domestic biofuels from forests, arable land, waste, and marine biomass;
- energy transformation; processes for producing electricity and heat in cogeneration installations and products of what are known as combined heat and power plants, in which surplus heat is used to produce pellets, biofuels or other energy carriers, for example.

Sweden is a global leader in the field of biofuels and waste-based cogeneration. Research has played an important role in the development of efficient and environmentally friendly biofuel- and waste-based cogeneration plants.

A great deal of research is being carried out in Sweden in relation to the use of forests as carbon sinks and the efficient use of bioenergy stocks. The aim of the project 'Cost-effective and sustainable harvesting of fuels based on forest products' was to find a way to use machinery more efficiently and widely in order to reduce the cost per cubic metre of extracting fuels based on forest products and to be able to spread machine costs over more hours. The project also focused on the extraction of small trees and best practice for drying and breaking down small trees for roadside storage. The project enhanced Swedish expertise in this field and the results provide a basis for more competitive fuels based on forest products.

The Industriklivet (Industrial Evolution) initiative – resource optimisation, energy efficiency measures and carbon neutrality in industry

Sweden is at the forefront of research aimed at helping energy-intensive industry become more energy and resource efficient, with the ultimate aim of eliminating carbon emissions completely. The Industriklivet[260] initiative is a long-term campaign to reduce greenhouse gas emissions in industry. A total of SEK 300 million per year will be spent during the period 2018-2040 in order to support the transition in Swedish industry towards zero emissions of greenhouse gases into the atmosphere in 2045. During 2019, the Swedish parliament acted on a proposal from the government to earmark a further SEK 200 million for this initiative, partly to increase the original remit and partly as a supplement to facilitate financing of measures contributing to negative greenhouse gas emissions[261]. The initiative provides support to companies at every step, from research and innovation projects to pilot and full-scale plants. The target group for this support measure is made up of industries with what are known as process-related emissions, but also universities or research institutes.

HYBRIT

Within the framework of HYBRIT (HYdrogen BReakthrough Ironmaking Technology), which is financed by the Industriklivet initiative, research and pilot studies are under way in Sweden that may result in a breakthrough for fossil-free production of steel from iron ore. In addition to the support received from the Industriklivet initiative, the three HYBRIT-related projects described below have also received a total of SEK 906 million in funding from industry.

In 2016, a preliminary study received a grant of SEK 7.2 million and, in February 2017, the decision was made to support a four-year research project within the framework of the National energy research and

[260] Government press release, https://www.regeringen.se/pressmeddelanden/2017/08/langsiktig-satsning- for-att-minska-industrins-utslapp-av-vaxthusgaser/

[261] Bill No 2018/19:99, Report No 2018/19:FiU21, Parliamentary Letter No 2018/19:288.

innovation programme. As part of this research project, studies were carried out into processes for fossil-free pellet production, hydrogen direct reduction,[262] and the use of sponge iron[263] in electric arc furnaces, as well as ways of supplying electricity for hydrogen production and storage. The research project has a budget of SEK 99 million, with the Swedish Energy Agency providing SEK 54 million in funding and the remaining SEK 45 million coming from the private sector.

During 2018, SEK 9.7 million was awarded for a feasibility study aimed at identifying the conditions for a pilot plant, as well as its basic design, location, and technology choices for further development. Later that same year, a total of SEK 528 million was awarded for the construction of two pilot plants. In one pilot plant, studies will be conducted on the development of fossil-free heating technology for sintering iron ore pellets. These studies aim to reduce emissions, but also to improve knowledge for designing an entirely new pelletisation process. In the other pilot plant, studies will be conducted to develop a process in which hydrogen gas is used to produce sponge iron from iron ore pellets, with that sponge iron then being smelted in an electric arc furnace to produce steel. Both the feasibility study on the pilot plant and the pilot plants themselves were authorised through the Industriklivet initiative.

Transition to a renewable electricity system and use of smart grids

The Forum on smart electricity networks is a national forum set up by the Swedish government in 2016, see Heading 3.4.3. There are also a number of national centres and research and innovation programmes relating to smart electricity networks, namely SamspEL, the Swedish Centre for Future Electricity Grids and Energy Storage (SweGRIDS) and KTH ACCESS Linnaeus Centre (ACCESS-Autonomic Complex Communication Networks, Signals and Systems).

Wind and solar energy are priority fields within Swedish energy research, with a number of projects under way in this field. One of these is the project 'High-efficiency silicon multi-junction solar cells'. The aim of the project is to develop silicon multi-junction solar cells. The ultimate goal is to demonstrate dual-junction solar cells with an efficiency level of close to 30% and triple-junction solar cells with an efficiency level of approximately 35%.

Research and demonstration in the transport sector

Swedish authorities provide funding to a number of programs and large-scale projects that cover the entire chain, from cultivation of raw materials for bio-based motor fuels to the use of new fuels. All of the programmes listed below are funded within the framework of the National energy research and innovation programme. Strategic Vehicle Research and

[262] Direct reduction, https://www.jernkontoret.se/sv/om-oss/biblioteket/ordlista/ordlista-d/.

[263] Sponge iron, https://www.jernkontoret.se/sv/om-oss/biblioteket/ordlista/ordlista-j/.

Innovation (Fordonsstrategisk Forskning och Innovation – FFI) also receives funding from the Agency for Innovation Systems, VINNOVA.

- FFI, a collaboration between the state and the automotive industry with regard to joint funding for research, innovation and development activities, with a focus on the fields of climate, environment and safety.
- The Renewable Fuels and Systems 2018-2021 collaboration programme, a collaboration between the Swedish Energy Agency and the Swedish Knowledge Centre for Renewable Fuels (f3).
- The Swedish Gasification Centre (Svenskt Förgasningscentrum – SFC), a research centre where numerous academic bodies collaborate with industry.
- The Battery Fund Programme, a research programme focusing on battery recycling and batteries for electricity system and automotive applications.
- Transport-Efficient Society, a research programme aimed at developing new knowledge and increasing competence in academia, institutes, the public sector and industry, by supporting research, development, innovation and demonstration and thus helping to ensure a transport-efficient society that is equal, accessible and resource efficient.
- A maritime programme aimed at creating a sustainable maritime transport system.

One example of such a project is the company RenFuel K2B AB, which received support to develop and test its technology for producing renewable petrol and diesel from raw forest products at pilot scale. In the pilot project, lignin will be extracted from raw forest products at a pulp mill and transformed into an oil. The oil will then be transformed into renewable petrol and diesel in a conventional refinery.

The transition to electricity in the transport sector creates new opportunities. Large-scale battery production is crucial to Sweden's key role in this transition and in order to reduce the climate impact of the transport sector, both in Sweden and worldwide. As part of this process, Northvolt Labs was awarded a sum of up to SEK 146 million for a pilot plant for large-scale battery production in Sweden. This decision represents an important step towards a new domestic industry and sustainable energy systems. The project relates to the construction and operation of a pilot plant for producing lithium-ion batteries, located in Västerås. The project is divided up into a number of phases and will run from 2018 to the end of 2023. In addition to testing and validating a new production and process model that will reduce the environmental impact of battery production, the pilot plant will also function as a research and development centre for sustainable and flexible battery production. The construction of a pilot plant in Västerås is a crucial step on the road to establishing Northvolt's battery factory in

Skellefteå, and has triggered the creation of a European battery production supply chain. The support provided is also helping to create an ecosystem of Swedish companies across the entire battery value chain – from raw materials to battery systems. It is estimated that around 100 people, in addition to research and development personnel, will be employed at the pilot plant in Västerås. The factory in Skellefteå is expected to be fully operational in 2023 and should directly create between 2 000 and 2 500 jobs[264].

A contract for a research and innovation platform for a fossil-free freight transport system has been awarded to a large consortium, Triple F[265], by the Swedish Transport Administration. Triple F is focusing on three challenges: a more transport-efficient society, energy-efficient and fossil-free vehicles and aircraft; and a greater share of renewable fuels. The expected outcome is sector-wide collaboration and knowledge building to help reduce CO_2 emissions in the freight transport system in line with set targets.

Electric aircraft may help reduce both direct emissions from aviation and the effects of altitude adjustments, particular over shorter distances, which may prove useful for air routes subject to public procurement for reasons of regional policy, amongst other things. A fully electric aircraft was flown for the first time in Sweden in 2018. The Swedish aviation industry is working to develop hybrid or fully electric aircraft with support from the ELISE (Elektrisk lufttransport i Sverige – Electric Air Transport in Sweden) initiative, amongst others. This initiative aims to have the first certified Swedish-made hybrid aircraft, with a flight limit of 400 km, flying domestic services in 2026. In the longer term, and as electric aircraft evolve, the need for charging infrastructure in the aviation industry will increase.

Energy-related building research

The Swedish Energy Agency, as sectoral authority, has primary responsibility for the coordination of energy-related building research. Projects in this area are funded by Formas and VINNOVA, as well as by the Swedish Energy Agency. The Swedish Consumer Agency, the National Board of Housing, Building and Planning, and the Environmental Protection Agency also have energy-related responsibilities in the construction sector. A key characteristic of energy-related building research is its system-wide perspective, with the aim of achieving resource- and energy-efficient construction through collaboration. The Swedish Energy Agency focuses on energy efficiency in a number of programs: Research and innovation for energy-efficient construction and housing, Design for energy efficiency in everyday life, and Energy efficiency in the lighting sector.

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[264] Press release from the municipality of Skellefteå dated 12 June 2019 http://www.mynewsdesk.com/se/skellefteakommun/pressreleases/klart-foer-byggstart-av-northvolts-batterifabrik-i-skellefteaa-2885665.

[265] https://triplef.lindholmen.se/.

From research to market

Sweden was named the 2019 innovation leader in the European Innovation Scoreboard, followed by Finland, Denmark and the Netherlands.[266] The above report provides a comparative analysis of innovation performance in EU countries, other European countries, and regional neighbours. The report compares relative strengths and weaknesses of national innovation systems (Human resources, Attractive research systems, Innovation-friendly environment, Finance and support, Firm investments, Innovators, Linkages, Intellectual assets, Employment impacts and Sales impacts) and helps countries identify areas they need to address.

The transition to a sustainable energy system is creating a growing global demand for new technologies and new services. Due to its commercial and international nature, energy research and innovation in Sweden offers significant potential to meet this demand. Sweden provides support to companies for business development and the commercialisation and distribution of new energy technologies and services, at various different stages of development. This support is provided until such time as the innovation has achieved a stage of maturity at which private operators are willing to take on, finance and pursue continued development. Over the last three years, agencies have intensified their efforts to reach out to innovative companies and offer various different kinds of support. One of the tools used is the 'A Challenge from Sweden' initiative – a challenge-driven innovation programme. The programme brings together relevant customers, suppliers and investors across the globe, in order to facilitate society's transition towards carbon-free growth. The initiative focuses on ambitious challenges with the potential to transform fields such as fossil-free transport and 100% renewable energies. The programme uses competitions, tests and events to inspire the commercialisation of sustainable solutions and the creation of viable projects.

Sweden has supported several successful companies in bringing their research and innovations to market. In the field of solar energy, these include, for example, Exeger (Heffa Solar – a new cost-efficient Grätzel solar cell). In the field of marine energy, they include, for example, CorPower Ocean AB, high-efficiency Wave Energy Converter (WEC), Minesto, Waves4Power and Ocean Harvesting Technologies.

Pilot and demonstration collaborations between public and private operators

Sweden has also supported successful pilot and demonstration projects in collaboration with public and private operators.

[266] https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en.

- AB Volvo and Scania AB's zero-emission haulage through the manufacture of electric, hybrid, plug-in hybrid and other hybrid vehicles, including fuel cell vehicles and heavy machinery, and support for the development of electric roads.

- Smart electricity networks, with demonstrations carried out in Norra Djurgårdsstaden, Hyllie and Gotland.

4.6.2 Public and – if available – private spending on research and innovation relating to low-carbon technologies, current number of patents and current number of researchers.

Public and private spending

State contributions to research amounted to SEK 37.5 billion in 2018. Funding for the National energy research and innovation programme accounted for SEK 1.43 billion, i.e. approx. 3.8% of this amount[267].

Table 33 shows the allocation of funds awarded within the framework of the National energy research and innovation programme in millions of SEK and industry funding, as a percentage of total funding during the period 2015-2018. Other private spending is difficult to estimate.

Table 33. Public and private funding within the framework of the National energy research and innovation programme 2015-2018.

	2015	2016	2017	2018
Total state funding and business contributions	MSEK 1 890 (100%)	MSEK 2 287 (100%)	MSEK 2 671 (100%)	MSEK 2 969 (100%)
Swedish Energy Agency	MSEK 1 075 (57%)	MSEK 1 212 (53%)	MSEK 1 309 (49%)	MSEK 1 247 (42%)
Companies/representative intermediary organisations	MSEK 815 (43%)	MSEK 1,075 (47%)	MSEK 1,362 (51%)	MSEK 1,722 (58%)

Number of patents

There was a total of 893 Swedish patent applications in energy-related fields filed domestically during the period 2013-2015, and 1 080 filed worldwide.

Number of researchers

The number of active doctoral candidates and senior researchers employed in projects funded to a level of at least 20% by the National energy research and innovation programme is shown below. The proportion of female project managers is approximately 32%.

2018: 1 098 (771 men, 327 women)

[267] https://www.scb.se/hitta-statistik/statistik-efter-amne/utbildning-och-forskning/forskning/statliga-anslag-till- forskning-och-utveckling/pong/statistiknyhet/statliga-anslag-till-forskning-och-utveckling-2018/.

2017: 1 202 (896 men, 306 women)

2016: 1 183 (861 men, 322 women)

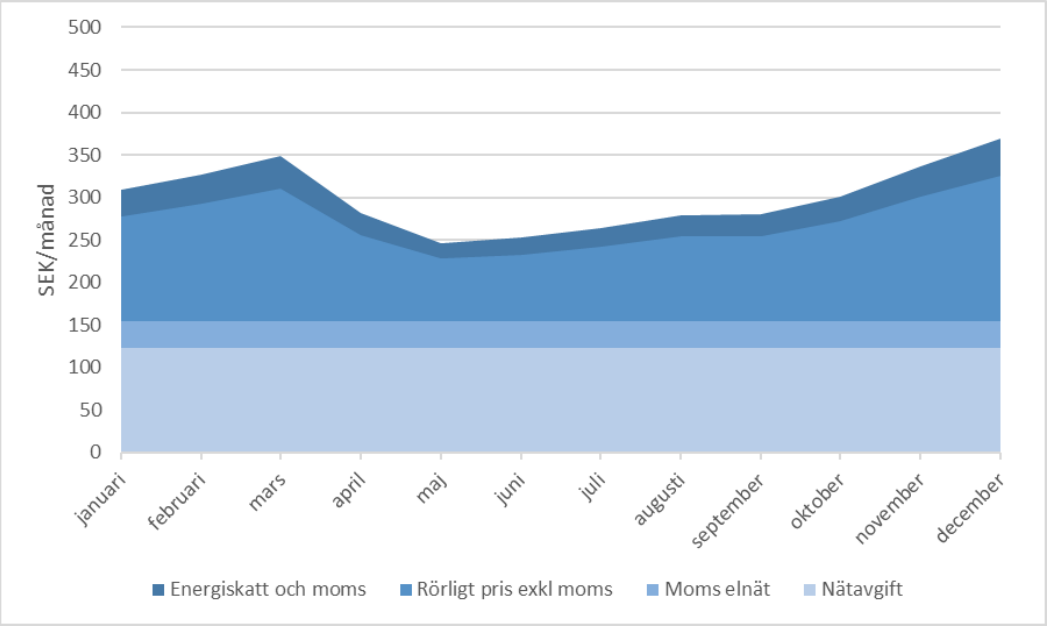
2015: 1 071 (768 men, 303 women)

4.6.3 Breakdown of current price components making up the three main price components (energy, network charges and taxes/fees)

Electricity price components

The electricity price paid by an end consumer consists of three main components: the electricity trade price, network charges, and VAT and other taxes. Taxes are levied on the price of the product, electrical energy, and VAT is payable on the taxes, electricity and network charges. For a typical apartment-dwelling customer (2 000 KWh annual consumption) with a variable electricity price contract, the total electricity cost for 2018 was, on average, SEK 299 a month. Network charges account for the largest share (41%) of the electricity cost for apartment-dwelling customers. Figure 37 shows a breakdown of the electricity price components for customers with an annual consumption of 2 000 KWh.

Figure 37. Breakdown of electricity price components — apartment-dwelling customers (2 000 KWh annual consumption) with a variable electricity price contract during 2018.



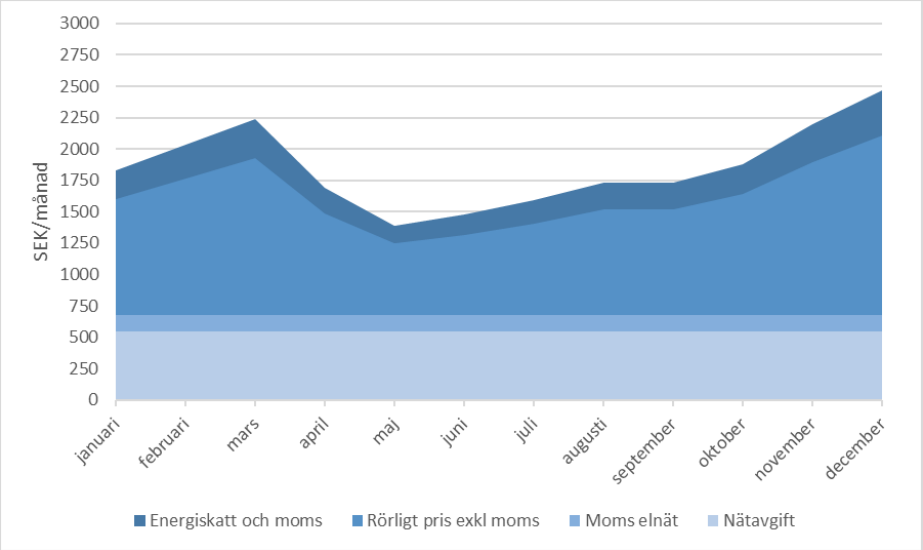
Source	Target
SEK/månad	SEK/month
januari	January
februari	February
mars	March
april	April
maj	May

juni	June
juli	July
augusti	August
september	September
oktober	October
november	November
december	December
Energiskatt och moms	Energy tax and VAT
Rörligt pris exkl moms	Variable price, excluding VAT
Moms elnät	VAT electricity network
Nätavgift	Network charges

Source: Swedish Energy Markets Inspectorate.

For a typical detached house-dwelling customer (20 000 KWh annual consumption) with a variable electricity price contract, the total electricity cost for 2018 was, on average, SEK 1 854 a month. For detached house-dwelling customers, the variable electricity price accounted for the largest share (51%) of the electricity cost. Figure 38 shows a breakdown of the electricity price components for customers with an annual consumption of 20 000 KWh.

Figure 38. Breakdown of electricity price components — detached house-dwelling customers (20 000 KWh annual consumption) with a variable electricity price contract during 2018.



Source	Target
SEK/månad	SEK/month
januari	January
februari	February
mars	March
april	April
maj	May
juni	June
juli	July
augusti	August
september	September
oktober	October
november	November
december	December
Energiskatt och moms	Energy tax and VAT
Rörligt pris exkl moms	Variable price, excluding VAT
Moms elnät	VAT electricity network
Nätavgift	Network charges

Source: Swedish Energy Markets Inspectorate.

4.6.4 Description of energy subsidies, including for fossil fuels

The special rules laid down by tax legislation, and their estimated effects on tax revenue, were detailed in a letter from the Swedish government (No 2018/19:98 on the accounting of tax expenditure). In line with the tax loss method, tax expenditure is calculated as the tax reduction multiplied by the base (tax base). The calculation of tax expenditure is based on accrual accounting, which means that tax implications relate to the year in which the underlying economic activities occur.

Table 34 shows reductions in energy tax and carbon tax and the calculated size of the tax shortfall. Tax expenditure relating to petrol and diesel of fossil origin resulting from the reduction obligation scheme has been omitted. The tax incentives for mining activities that were in force in 2018 have also been omitted, as these were abolished in August 2019.

Table 34. Energy subsidies for fossil fuels, billions of SEK.

Tax reductions relating to energy tax	**Calculated tax expenditure for 2018, billions of SEK**
Energy tax exemption for natural gas and liquefied petroleum gas for use as fuel	0.06
Energy tax exemption for biofuels not covered by the reduction obligation scheme	7.57
Energy tax exemption for electricity consumption relating to runway operations	1.32
Energy tax exemption for fuel consumption relating to runway operations	0.03
Energy tax exemption for fuels used in domestic shipping	0.24
Energy tax exemption for fuels used in domestic aviation	0.98
Energy tax exemption for biofuels, etc., for heating	5.43
Electricity (not taxable)	*Could not be quantified*
Reduced energy tax for fuels in cogeneration plants	0.16
Reduced energy tax for cogeneration suppliers for industry, etc.	0.02
Reduced energy tax for heating fuels in industry	0.67
Reduced energy tax for heating fuels in agricultural, forestry and aquaculture sectors	0.04
Reduced energy tax for electricity used in industry and in data centres	14.60
Reduced energy tax for electricity used in agricultural, forestry and aquaculture sectors	0.56
Tax reductions relating to carbon tax	
Reduced carbon tax for diesel for heavy machinery and shipping in agricultural, forestry and aquaculture sectors	0.72
Carbon tax exemption for fuels used in runway operations	0.02
Carbon tax exemption for fuels used in domestic shipping	0.18

5. IMPACT ASSESSMENT OF PLANNED INSTRUMENTS AND MEASURES

5.1 Effects of planned instruments and measures as described under Heading 3 on energy systems and emissions and removals of greenhouse gases, and comparison with projections on the basis of existing instruments and measures (according to the description under Heading 4).

5.1.1 Development forecasts relating to energy systems and emissions and removals of greenhouse gases and, if relevant, emissions of atmospheric pollutants in accordance with Directive (EU) 2016/2284 in line with planned instruments and measures, for at least the ten-year period following the period covered by the plan (including the last year of the period covered by the plan), including relevant instruments and measures at Union level.

The Swedish parliament has adopted a climate policy framework for Sweden, see Heading 1.2, in order to ensure that ambitious climate objectives are set, that the government will plan and take decisions to achieve the objectives, that the government and parliament follow up on adopted policies, and that independent experts evaluate the government's overall policies.[268] A climate action plan is to be submitted for each term of office. Accounting and follow-up is to be carried out annually and the development of instruments and measures is to take place on an ongoing basis. Sweden thus has a system in place for achieving the climate objectives set, but has yet to plan all of the instruments required to achieve those objectives.

For the purpose of following up and improving some of the most important instruments implemented, Sweden is also working on what are known as control stations at intervals of one or more years. The purpose of these control stations is to continuously evaluate these instruments and, if necessary, adjust them.

Fuel switching/reduction obligation scheme

On 28 June 2018, the government invited the Swedish Energy Agency to investigate and submit proposals on reduction levels for the period 2021 to 2030, whether a joint reduction level for petrol and diesel fuel should be introduced, and whether pure and high-blended liquid biofuels should be covered by the reduction obligation scheme or should continue to be promoted by way of a tax exemption. The Agency was also to investigate whether it was possible for the reduction obligation scheme to be made more cost-effective. The Agency reported on this issue on 4 June 2019 and supplemented the report on 25 October 2019. The process for establishing

[268] Bill No 2016/17:146, Report No 2016/17:MJU24, Parliamentary Letter No 296/17:320.

progressively higher reduction levels for the years following 2020 is currently under way before the Government Offices and is expected to be completed during 2020.

The aim of the reduction obligation scheme is to reduce petrol and diesel emissions by blending them with biofuels having low life-cycle emissions. The amount of energy from biofuels required to meet the obligation is determined by the life-cycle emissions of the biofuels used. The higher the life-cycle emissions, the greater the volume of biofuels required for blending, and vice versa. The extent to which the use of fossil fuels decreases as a result of this obligation scheme is therefore not just determined by the reduction levels set for each year, but also by the biofuels used.

The amount of energy from biofuels required to meet the obligation is also determined by the amount of energy from fossil fuels used. Measures relating to energy efficiency, a transport-efficient society, and the electrification of the transport sector reduce the amount of energy from fuels covered by the obligation scheme. The reduction obligation scheme interacts with other instruments in this way, such as the bonus-penalty system that contributes towards increased electrification of the transport sector.

5.1.2 Assessment of the interaction between instruments (between existing and planned instruments and measures with a political dimension and between existing and planned instruments and measures with various dimensions) until at least the last year of the period covered by the plan, particularly in order to provide a solid understanding of the effects of energy efficiency and energy saving measures on the size of the energy system and in order to reduce the risk of unnecessary energy supply investments.

The aim of sectoral energy efficiency strategies, see Heading 1.2, which are designed to help achieve the target of 50% more efficient energy use by 2030, is to establish dialogue at an early stage between the Swedish Energy Agency, various different sectors and relevant authorities on matters relating to appropriate indicative objectives and measures in each sector for contributing, in a cost-effective manner, towards achieving the national energy and climate targets. As a result of this work, carried out in association with relevant authorities and sectoral operators, a broad consensus can be reached, while also ensuring that those operators become increasingly engaged when implementing national policy. The key starting point for developing these sectoral strategies is the target of 50% more efficient energy use in Sweden in 2030 compared to 2005, but consideration is also to be given to the target of 100% renewable electricity production by 2040. These strategies must also take into account that Sweden is to have zero net emissions of greenhouse gases into the atmosphere by 2045 at the latest, in

order to subsequently achieve negative emissions, and that the target for the transport sector is a 70% reduction in greenhouse gas emissions compared to 2010.

5.1.3 iii) Assessment of the interaction between existing and planned national instruments and measures, and between those instruments and measures and the climate and energy policy measures of the European Union.

Interaction between instruments and measures for air and climate

Atmospheric pollutants and climate change are closely interlinked in many respects and represent a challenging area, due to their effects at both regional and global level. Future climate change will affect atmospheric pollutant concentrations, distribution patterns, depositions and exposure. The magnitude of these effects and the direction they take will depend on the evolution of climate change, amongst other things. In parallel with this, there are a number of atmospheric pollutants that have a climate-altering effect.

As emissions often come from the same societal activities, there is a strong incentive to coordinate strategies for air and climate measures and instruments in order to maximise environmental benefits. Ambitious action on climate change is crucially important in order to exploit synergies, avoid conflicts between objectives, and reduce costs for society as a whole. Air pollution control policy needs further development in a manner integrated with both climate policy and energy policy in order to be as effective as possible.

Energy efficiency and energy saving measures across various different sectors of society, including, for example, industry, transport, heating of premises and housing, and product performance, offer numerous opportunities for air and climate synergies. If Sweden achieves its target of increasing energy efficiency by 50% from 2005 to 2030, this may have positive effects on various different environmental areas.

Pursuant to the National Emissions Ceilings Directive[269], Sweden is committed to reducing emissions of certain atmospheric pollutants. According to the latest estimates, Sweden will need to implement further measures to reduce emissions of ammonia by 2020 and nitrogen oxides by 2030[270]. With regard to environmental quality standards for outdoor air[271]

[269] Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.
[270] Environmental Protection Agency – Air pollution control programme – Draft strategy for cleaner air in Sweden (NV-06767-17).
[271] Air Quality Regulation (2010:477).

and the EU's limit values for air quality[272], a number of measures are needed in order to cut concentrations of nitrogen dioxide and particulate matter (PM10) in congested areas. In order to be able to additionally meet the long-term generational goal of environmental policy, additional air pollution control measures to improve air quality[273] and reduce depositions of acidifying and eutrophifying air pollution will also be needed to protect human health and the environment. In March 2019, the Swedish government adopted a National air pollution control programme that describes how Sweden plans to implement measures and instruments to satisfy the emissions reduction requirement set out by the National Emissions Ceilings Directive. It is crucially important that the periodic revisions of Sweden's Air pollution control programme seek to exploit synergies with action on climate change.

The transport and use of bioenergy represent two areas of particular strategic importance in terms of potential synergies and conflicts between air pollution control and climate.

Developments within the transport sector will be crucial in terms of opportunities for achieving Sweden's 2030 emissions commitment in respect of nitrogen oxides, but this will also affect progress in respect of other atmospheric pollutants. The government's decision to adopt the National air pollution control programme identified measures for achieving the 2030 climate target for the transport sector, as part of the measures covered by the Air pollution control programme to reduce emissions of nitrogen oxides. Trends in emissions of nitrogen oxides will be strongly dependent on what proportion of the vehicle fleet is powered by internal combustion engines, particularly diesel engines, in the period to 2030. Positive measures for reducing emissions of both atmospheric pollutants and greenhouse gases include increased electrification of the vehicle fleet, a more transport-efficient society, and energy efficiency.

Future strengthening of common EU rules on the CO_2 requirement for light-duty vehicles and the introduction of corresponding requirements for heavy duty vehicles will also create positive synergistic effects on emissions of nitrogen oxides by 2025 and 2030. In practice, this requirement entails widespread introduction of electric vehicles.

Increased biomass consumption contributes towards reducing greenhouse gas emissions from fossil fuels, but may entail negative effects on air quality. During biomass combustion, emissions of atmospheric pollutants, including, but not limited to, particulate matter, black carbon, benzo(a)pyrene and

[272] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

[273] Here, particularly important atmospheric pollutants include particulate matter, black carbon, ground-level ozone and benzo(a)pyrene.

nitrogen oxides, may increase if they are not offset by exhaust gas cleaning.

A transition to biofuels in the vehicle fleet reduces greenhouse gas emissions but does not help reduce emissions of nitrogen oxides. Emissions of nitrogen oxides from diesel cars run on fossil diesel are approximately the same as from diesel cars run on biodiesel. Emissions of nitrogen oxides from cars run on biogas are slightly lower. Therefore, in order to satisfy Sweden's commitments under the National Emissions Ceilings Directive, it is important to have a more transport-efficient society and increased electrification of the vehicle fleet in Sweden's urban areas.

5.2 Macroeconomic and – as far as possible – health, environmental, educational, skills-related and social consequences, including with regard to fair transition (in terms of costs, benefits and cost efficiency) of planned instruments and measures as referred to under Heading 3, until at least the last year of the period covered by the plan, including a comparison with projections based on existing instruments and measures.

It has been highlighted in several reports that the costs of climate change for society may be very high. Perhaps the best known of these is called the Stern Review[274], which was published in 2006 and is named for its lead author, Sir Nicholas Stern. In his report, Stern notes that if the world does not take action, the overall long-term costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more. Stern also considers that 'the costs of not acting far outweigh the costs of action'; a finding he later repeated in a research article from 2015 and elsewhere. The negative effects would impact a wide range of stakeholders. From a global perspective, the Swedish government believes that meeting these targets is also a step towards equality, as, in many countries, women are generally more at risk from climate change, work in more exposed environments, and suffer to a greater extent than men from the disasters caused by climate change. Limiting global warming also contributes, in a positive way, towards achieving several other environmental quality targets. The environmental quality targets that are most affected by climate change, either directly or indirectly, are those relating to air, eutrophication and biodiversity.

However, many of the consequences of Sweden's long-term climate objectives primarily depend on how the objectives are achieved and under what conditions. The ease or difficulty with which targets are achieved depends on factors such as technological development and behavioural changes, which are difficult to predict. For example, digitalisation may

[274] Stern, Nicholas – Review on the Economics of Climate Change (2006).

accelerate and facilitate development that helps achieve climate targets. If the rest of the world does not adapt, the cost of achieving Swedish climate targets increases. The positive consequences of climate change adaptation in Sweden may also be diminished if the rest of the world does not adapt, for example the possibility of exporting Swedish climate solutions and environmental technologies may be restricted.

In its two reports A climate policy framework for Sweden (SOU 2016:21) and A climate and air pollution control strategy for Sweden (SOU 2016:47), the Environmental Objectives Council, see Heading 1.3, compiled a number of estimates of the socio-economic consequences of achieving the milestone targets for 2030 and 2040, the milestone target for the transport sector, and the long-term emissions target. Many of these estimates were obtained using different models, which, in turn, have different points of focus and are based on different assumptions relating, amongst other things, to the structure of the instruments and global developments, as well as links between different parts of the economy. This means that, although the results of the model calculations are not directly comparable with one another, they can help create an overall picture of the socio-economic consequences.

With regard to the milestone target for 2030, the Environmental Objectives Council entrusted the task of calculating the socio-economic costs[275] to the National Institute of Economic Research based on a number of assumptions identified by the Council. The assumptions mainly relate to the transport sector, for example future energy efficiency. On the basis of these assumptions, calculations show that a cost-effective climate policy for the milestone target, compared with a less ambitious climate target, may result in a GDP in 2030 that is 0.2 to 1.5% lower than the baseline scenario. However, the National Institute of Economic Research stresses that there is a great deal of uncertainty associated with the calculations and that some costs are not represented in the results. Moreover, the National Institute of Economic Research considers that a more accurate cost estimate cannot be provided until an instruments package has been developed. The Environmental Objectives Council considers that the possibility of using complementary measures may help reduce the costs of achieving the milestone target, as well as other climate targets. Furthermore, the possibility of using complementary measures should also help reduce the costs of achieving other milestone targets.

The consequences of achieving the milestone target in the transport sector are comparable to the consequences of the milestone target for 2030, as the instruments and measures used to meet those targets are substantially the same. There is an even greater degree of uncertainty in the calculations surrounding the milestone target for 2040 and the long-term emissions

[275] SOU 2016:47

target. How those consequences will affect various different stakeholders depends on the structure of future instruments and on global developments. Greenhouse gas emissions from the transport sector must be reduced considerably. The stakeholders that are most dependent on the transport sector today may be affected to a relatively greater degree, unless this is offset by technological developments that make climate-smart transport cheaper and more accessible. Therefore, research and innovation are required in order to facilitate the development of climate-smart transport, in parallel with a policy to help make alternatives available. For example, continued digitalisation may provide an alternative to physical resources and also contribute to efficiency gains within the transport sector, due, for example, to improved logistical solutions and more efficient traffic management.

With regard to industry in general, climate change adaptation in Sweden and worldwide will result in benefits for certain sectors, while others may be negatively affected. Services and products that are more climate-friendly will provide advantages over more emissions-intensive competitors. Similarly, climate change adaptation will affect the labour market by creating new jobs in companies and sectors with low emissions intensity or that offer sustainable solutions, for example as a result of an increased production of bio-based fuels and agricultural materials to replace products made from fossil raw materials. Since the long-term target covers greenhouse gas emissions from all activities in Sweden, this may also have an impact on industries currently operating under the European Union Emissions Trading System (EU ETS). Milestone targets do not cover the trading sector, however, meaning that the medium-term consequences for industry primarily concern developments within the trading system. The long-term emissions target, which also includes emissions falling under the EU ETS, requires a more ambitious approach in the EU ETS. The strengthening of this system must be carried out in such a way as to avoid increasing the risk of carbon leakage. While a policy for achieving climate targets may have a positive effect on attaining several other environmental quality targets, for example with regard to *Clean air* and *A good built environment*, there may also be conflicts between targets based on the manner in which climate change adaptation occurs.

5.3 Overview of investment needs

5.3.1 Existing investment flows and assumptions on future investment with regard to planned instruments and measures.

Investments in electricity production

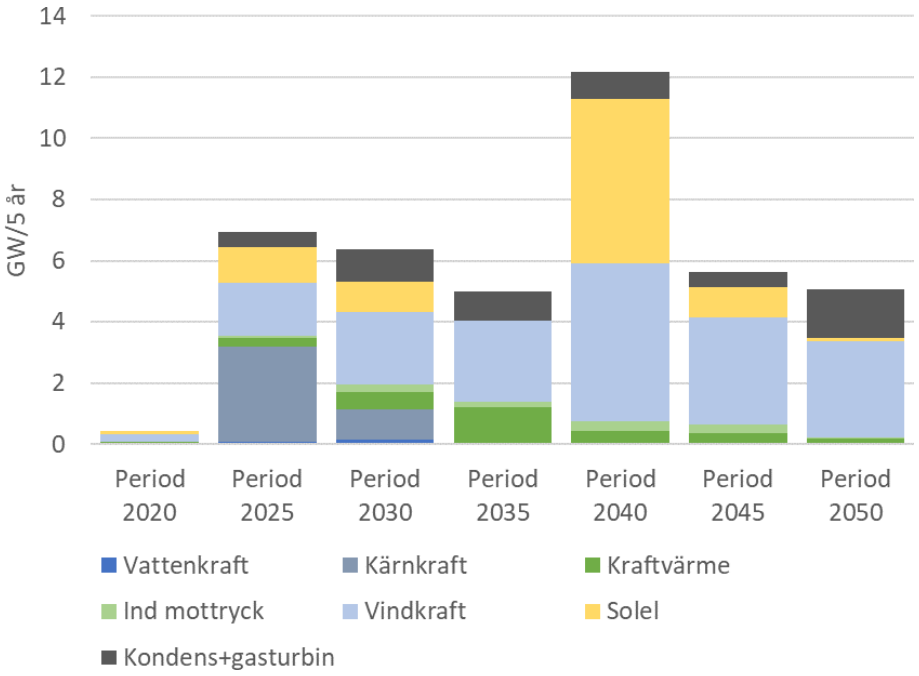
The results of the calculation under this heading are based on the EU baseline scenario from the Swedish Energy Agency's report on long-term

scenarios[276]. The outcome will be different if a similar analysis is carried out for any of the other scenarios in the report.

In the model calculations, investments are made in a large number of electricity production technologies (for example various different classes of wind power technology). The respective production technologies were first evaluated individually and then in the following main groups: hydroelectric power, nuclear power, cogeneration (within district heating systems), industrial back pressure, wind power, solar electricity, condensate production and gas turbines. The model only covers investments in electricity production. Any capital costs for existing production facilities that have yet to be written off are not included in the model.

Figure 39 shows new investments in production capacity for each model year[277].

Figure 39. Investments in capacity (additional GW per five-year period).



Source	Target
GW/5 år	GW/five-year period
Period	2020
2020	period
Vattenkraft	Hydroelectric power
Ind mottryck	Ind. back pressure
Kondens+gasturbin	Condens.+gas turbines
Kärnkraft	Nuclear power
Vindkraft	Wind power
Kraftvärme	Cogeneration
Solel	Solar electricity

[276] Swedish Energy Agency – Scenarios of Sweden's energy system 2018 (ER2019:7).

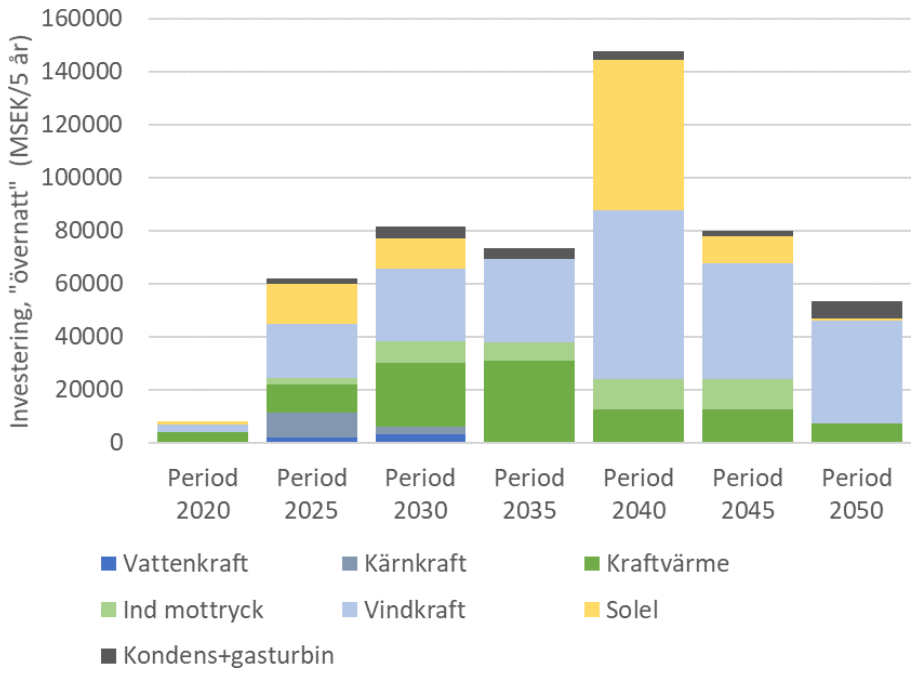
[277] In practice, each model year relates to a period of five years, i.e. the model year 2030 covers, for example, years 2027.5-2032.5. The investments shown in the figure are thus made during a five-year period, rather than in each year covered by the five-year period in question. For example, this means that, between 2037.5 and 2042.5, investments corresponding to approximately 12 GW are made in electricity production.

Source: Swedish Energy Agency.

It should be noted that no indication as to total installed capacity can be inferred from investments in capacity. The sum of new investments over a longer period may exceed the installed capacity. Some investments are in fact made in order to replace previous investments that have expired as a result of the age limit (the technical lifespan) and that have different utilisation timeframes (i.e. different energy-to-capacity ratios). Nuclear power investments are made in order to extend that lifespan, from a technical lifespan of 35 years to 60 years.

Figure 40 shows investments in monetary terms. It is assumed that the entire investment is charged to the model year in which it is made. This refers to the immediate investment cost, i.e. the investment costs excluding interest costs during the construction period. As in Figure 39, each model year actually represents a five-year period. The investment is charged during this period. In order to obtain the annual investment during a certain year, divide the five-year period (model year) that includes the year in question by five.

Figure 40. Investments in millions of SEK per five-year period, charged to the model years (five-year period) during which the investment is made ('overnight' cost).



Source	Target
Investering, "övernatt" (MSEK/5 år)	Investment, 'overnight' (MSEK/5-year period)
Period	2020
2020	period
Vattenkraft	Hydroelectric power
Ind mottryck	Ind. back pressure
Kondens+gasturbin	Condens.+gas turbines
Kärnkraft	Nuclear power
Vindkraft	Wind power
Kraftvärme	Cogeneration
Solel	Solar electricity

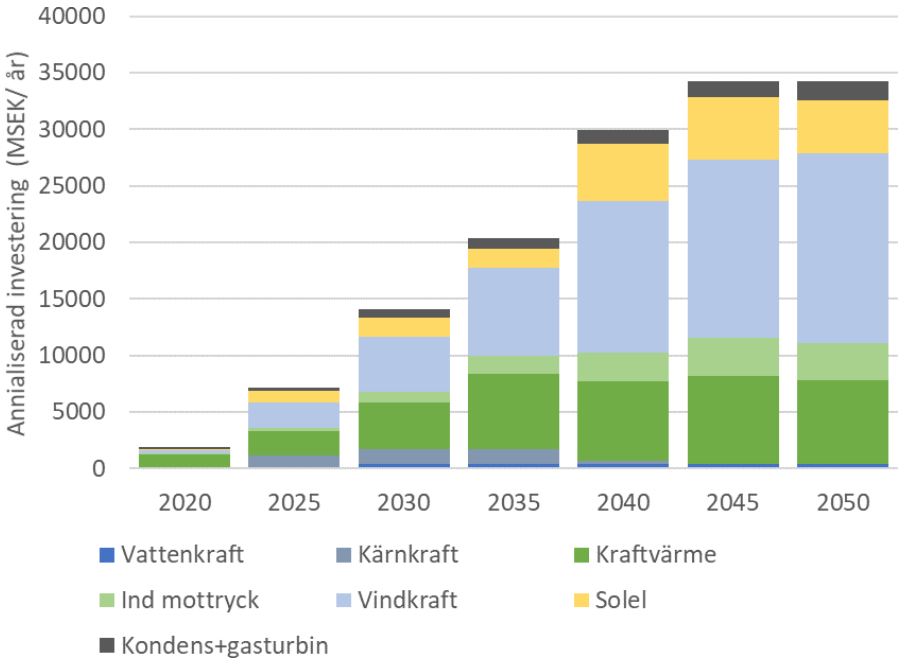
Source: Swedish Energy Agency.

Despite the fact that investments in cogeneration capacity, expressed in GW, are lower than investments in wind power, for example (see Figure 39), the difference calculated in terms of monetary investment, in SEK, between wind power and cogeneration is much smaller. This is because the entire cogeneration investment is allocated to electricity production, including investments for district heating production. For waste-based cogeneration, for example, the specific investment cost is thus very high per unit of electricity. If some of the investment cost is allocated to heat production, which may be reasonable, then, naturally, a reduced cost is allocated to electricity production. However, there is no clear, objective answer as to how such allocation is to be carried out.

An alternative method of calculating investments is to annualise[278] them over the economic lifecycle of each investment and according to its imputed interest. This is shown in Figure 41, where each individual investment is annualised and allocated to its respective technology group. In other words, the annualised investment cost is the same as the annual capital cost. It is the individual calendar year that is relevant here, rather than the five-year periods given in Figure 40. The costs associated with historical investments, where parts of the economic lifecycle remain to be charged, are not included here. It is thus not a total capital cost for electricity production that is shown, but merely new investments from 2020 onwards, albeit not those in respect of which a decision to adopt has already been made. Therefore, it is not possible on the basis of Figure 41 to establish whether the total capital costs associated with electricity production will increase or decrease in the long term.

[278] An annualised cost is an annual cost (payment) that includes both an interest cost (based on the imputed interest) and an amortisation. As a result of this annualisation, the investment is thus repaid in equal instalments each year (the annual cost) over the economic lifecycle of the investment.

Figure 41. Investments in millions of SEK/year annualised over the economic lifecycle and based on the imputed interest of the investment in question. (Capital costs relating to 'historic' investments are not included here).



Source	Target
Annialiserad investering (MSEK/ år)	Annualised investment (MSEK/year)
Vattenkraft	Hydroelectric power
Ind mottryck	Ind. back pressure
Kondens+gasturbin	Condens.+gas turbines
Kärnkraft	Nuclear power
Vindkraft	Wind power
Kraftvärme	Cogeneration
Solel	Solar electricity

Source: Swedish Energy Agency.

The annualised investments increase over time, as investments are made on an ongoing basis (but to varying degrees in accordance with Figure 39) over the calculation period. This means that the annualisations accumulate, that is to say that the annualisation of new investments during model year x is added to the annualisations resulting from investments made during the preceding model years (x-1, x-2, etc). Written-off investments that no longer contribute to the sum of annualised investments serve to counteract an increase over time. The fact that the growth rate of the annualised investments decreases towards the end of the calculation period, for example with regard to solar electricity and wind power, may be interpreted as meaning that new investments are largely offset by written-off investments that no longer entail any capital cost.

Investments in the national grid

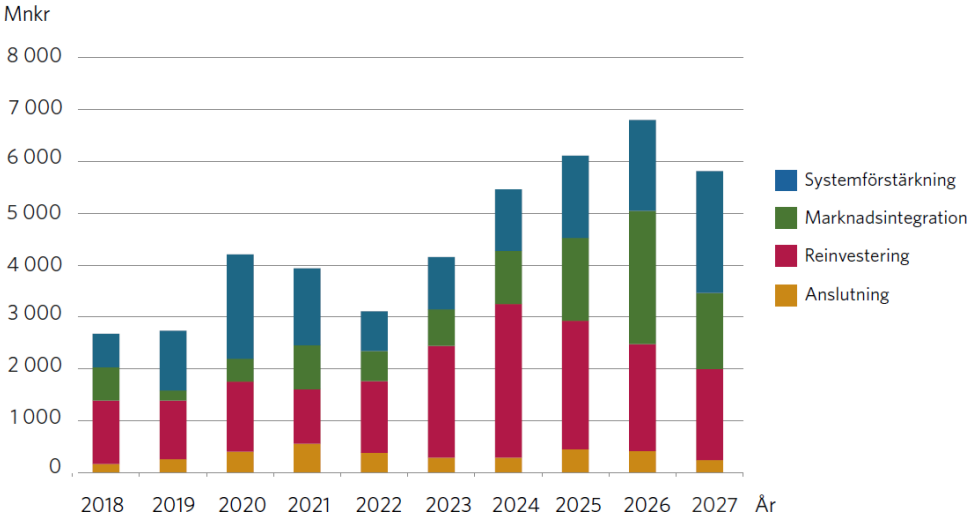
There are four main driving forces behind network (national grid) investments:

- Connection of new electricity production, with the majority

consisting of new wind power. The greatest volume of wind power is expected to be connected in the north of Sweden.
- The increased need for connections between the Nordic countries and between the Nordic countries and continental Europe.
- Considerable increases in consumption in metropolitan areas result in substantial network investments in order to secure the supply of electricity to these areas. Together with the expected phase-out of nuclear power in the south of Sweden, this also increases the national grid's need for transmission capacity from north to south.
- Network development is also driven by the need for reinvestments. The oldest parts of the Swedish national grid will need to be renewed over the coming decades.

The network investments reported in the System Development Plan[279] during the planning period for the years 2018-2027 amount to SEK 60 billion, of which SEK 45 billion is expected to be paid out during the planning period for the years 2018-2027. Of this sum, SEK 22 billion is made up of reinvestments in existing stations and lines, with the remaining SEK 23 billion consisting of new investments, see Figure 42 and Figure 43.

Figure 42 Investment levels for the years 2018-2027 broken down according to the main driving forces for network investments.

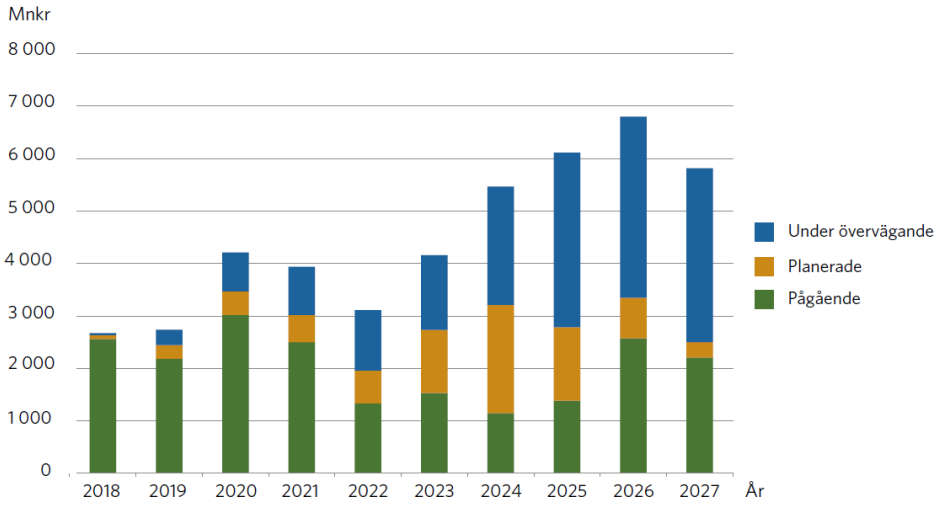


Source	Target
Mnkr	MSEK
Systemförstärkning	System reinforcement
Marknadsintegration	Market integration
Reinvestering	Reinvestment
Anslutning	Connection

Source: Svenska kraftnät.

[279] Svenska kraftnät – System Development Plan 2018-2027.

Figure 43 Annual levels of network investments broken down by stage.[280]



Source	Target
Mnkr	MSEK
Under övervägande	Under consideration
Planerade	Planned
Pågående	Ongoing
År	Year

Source: Svenska kraftnät.

5.3.2 Sector-specific or market-related risk factors or obstacles at national or regional level.

No risk factors have been identified.

5.3.3 Analysis of complementary public financial support or resources capable of bridging the gaps identified in Part ii.

No risk factors have been identified.

5.4 The effects of planned instruments and measures as described under Heading 3 on other Member States and on regional cooperation, until at least the last year of the period covered by the plan, including a comparison with projections based on existing instruments and measures

5.4.1 Consequences for the energy system in neighbouring countries and other Member States in the region, insofar as can be established.

See Heading 5.4.3.

5.4.2 Effects on energy prices, public service obligations and integration of the energy market.

See Heading 5.4.3.

[280] Svenska kraftnät – System Development Plan 2018-2027.

5.4.3 If relevant, consequences for regional cooperation.

In 2016, Nordic Energy Research, the platform for joint energy research and policy development under the Nordic Council of Ministers and financed jointly by the Nordic governments, published the report Nordic Energy Technology Perspectives 2016[281] in collaboration with the International Energy Agency, and a report into regional long-term, cost-effective, low-carbon emissions technology roadmaps for the Nordic countries. The study provides a detailed scenario-based analysis into how the Nordic countries can achieve a near carbon-neutral energy system in 2050 (Carbon Neutral Scenario, CNS), and compares this with a Nordic 4°C Scenario (4DS) that reflects the Nordic contribution to the IEA's global 4°C Scenario.

The analysis carried out in Nordic Energy Technology Perspectives 2016 is centred on a scenario where Nordic energy-related CO_2 emissions drop by 85% by 2050. The name – the Carbon Neutral Scenario (CNS) – reflects wording used in official targets, although carbon neutrality requires offsets to be used for the remaining 15%. The roadmap for CO_2 reduction established in the CNS scenario should therefore be seen as a minimum requirement. In order to limit global warming to 1.5°C, in line with the Declaration on Nordic Carbon Neutrality from January 2019[282], it is likely that additional measures will be needed in order to reduce emissions.

Nordic Energy Research has also drafted a follow-up report on progress towards carbon neutrality in the Nordic countries: Tracking Nordic Clean Energy Progress 2019[283]. The report tracks Nordic progress towards a carbon-neutral society by highlighting major trends and examples where Nordic solutions may have a global impact. The report was launched in October 2019. Some of the most important results from the report include:

- For the period 2013 to 2016, the Nordic countries are on track to achieve carbon neutrality, even with higher than expected GDP growth, but it is likely that further measures will be needed to continue this trend.

- The positive trend is seen mainly in the power and heating sectors, which contribute with significant reductions in CO_2 emissions, from 60.7 $MtCO_2$ in 2007 to 37.4 $MtCO_2$ in 2016, in line with the intermediate CNS target of 19.2 $MtCO_2$ in 2030.

[281] https://www.nordicenergy.org/project/nordic-energy-technology-perspectives/.

[282] https://www.regeringen.se/48febb/contentassets/afd1e82263dc4fbba6a1b0c15357faee/declaration-on-nordic-climate-neutrality.

[283] https://www.nordicenergy.org/publications/tracking-nordic-clean-energy-progress/

- The share of renewable energy in total energy input for the Nordic countries combined increased from 29% in 2006 to 39% in 2016.

- The share of electric vehicles in the light-duty vehicle fleet is on track for the 2020 level of 4.1%, in line with the Carbon Neutral Scenario (CNS).

- For particularly challenging sectors, it is noted that:

    - Energy consumption and emissions in the industry sector have decreased, but it is difficult to reduce process emissions.

- Bioenergy should be used primarily in 'high-value sectors' (transport), and sustainability remains a challenge.

    - CCS must be demonstrated on a large scale.

Regeringen

Ministry of Infrastructure

Annex 1 to Sweden's Integrated National Energy and Climate Plan

Compilation of national consultation documents on Sweden's Integrated National Energy and Climate Plan

Overview

Below are some impacts based on stakeholders' more comprehensive overview of the plan. Generally speaking, stakeholders view the development of the National Energy and Climate Plan positively, as a summary of Swedish energy and climate policy. Only one stakeholder considers that the plan should be completely revised.

However, several stakeholders, including the Swedish Gas Association, the Swedish Bioenergy Association, the WWF and the Swedish Public Transport Association, express doubts about the fact that the plan only covers adopted instruments and measures.

A number of stakeholders view the plan as an opportunity to influence and raise the profile of Swedish viewpoints and requirements.

Meeting the plan's targets

The WWF considers that greater importance should have been attached in the plan as to how Swedish targets and instruments can be translated into contributions/forecast outcomes that the Commission can directly add to contributions from other countries, in particular the energy efficiency target.

It also notes that the plan sends the message that Sweden will not achieve its national climate targets (milestone target for 2030 and the target for the transport sector), nor the national target for 100% renewable electricity production by 2030. Therefore, it considers that the plan should reflect on how these targets are to be achieved, even if adopted instruments are not in place.

The Swedish Society for Nature Conservation observes that the plan does not include any instruments for achieving the national target on net-zero emissions and that the plan should include ways to close the gap.

100% Förnybart (100% Renewable – a non-profit organisation) is critical of the fact that the plan does not reflect the long-term climate strategy and does not address the ways in which the national target for net-zero emissions by 2045 is to be achieved.

The Swedish Public Transport Association believes that the plan should be supplemented with conclusions and analyses as to whether, taken together, existing and planned instruments will result in the stated targets being achieved.

Greenpeace considers that the plan should be supplemented to include the risks that Sweden will not achieve its targets and to report on the conclusions of the Swedish Climate Policy Council, according to which current policies are insufficient to achieve the targets.

The Swedish Bioenergy Association believes that the plan should be coordinated with all Swedish climate targets and should indicate developments needed to achieve those targets in the period to 2030.

Sweden's contribution to renewable energy by 2030

A number of stakeholders (100% Förnybart, WWF, the Swedish Society for Nature Conservation, Västra Götaland Regional Council and the Swedish Wind Energy Association) consider the contribution to be too low.

100% Förnybart, WWF, the Swedish Wind Energy Association and the Swedish Windpower Association believe that the contribution should be 80% by 2030. For example, the Swedish Wind Energy Association points out that Sweden's target of 100% renewable electricity by 2040 will require well over 80% renewable electricity in 2030.

The Swedish Windpower Association considers that the plan should indicate 80% renewable electricity in 2030, in order to meet the national target of 100% renewable energy by 2040. The importance of network expansion is also highlighted in this respect.

100% Förnybart does not believe the scenario reflects the strong performance of wind power.

The Swedish Bioenergy Association notes that the development trajectory should begin with the expected share of renewables in 2020, rather than the national target for Sweden of 50%.

The Swedish Society for Nature Conservation believes that the contribution is too low in light of the development of wind power, the national target of 100% renewable electricity by 2040 and the 63% reduction in emissions in the non-trading sector by 2030. The Swedish Wind Energy Association considers that the rapid development of wind power should be visible in the scenario and notes that Swedish wind power is expected to double by 2022, thus accounting for 25% of electricity consumption: 40 TWh wind power. Approx. 60 TWh onshore and offshore wind power by 2030 is reasonable.

The Swedish Bioenergy Association believes that the development of bioenergy has been underestimated and would almost result in stagnation of this renewable energy source after 2020. Its own assessment is a 30 TWh higher contribution by 2030, by which time the total share of renewables would amount to 74.5% (66.5% + 8%). It also believes that it is not the EU baseline scenario that should be used, but rather the scenario in which the reduction obligation scheme quotas are taken into account.

The Swedish Association of Energy Companies believes that the national contribution to renewables is reasonable, on the basis of the decisions taken and the recommended criteria.

The Swedish Petroleum and Biofuels Institute believes the plan will result in huge demand for biofuels during the transition, and that the sector's role in satisfying Swedish and EU ambitions is growing ever more relevant. The long-term validity and stability of regulations and forecasts are prerequisites for the fuel industry to invest and take a leading role in implementing the plan.

It also believes that, before entering into any binding commitments under the plan, it should be ensured that any ambitious goals set by Sweden are not used by other countries to reduce their targets, thus ensuring Sweden's ambitious goals continue to make a net positive contribution to EU targets. Moreover, it points out that any revised plan may only include more ambitious goals and that this should be a cause for restraint, due to changing environmental factors over time. It also considers that Sweden should incorporate a caveat that the plan applies to currently established regulations.

The Swedish Gas Association believes that the plan should be supplemented with an assessment/scenario showing how Sweden's future developments/contributions may appear if further measures and

instruments are put in place.

Sweden's contribution to energy efficiency by 2030

The Swedish Society for Nature Conservation considers that there is a higher potential for energy efficiency and finds it striking that a more ambitious contribution to energy efficiency is not included in the plan.

WWF believes that the plan should respond to the Commission's recommendation on energy efficiency, and should reflect on the potential for and include a more ambitious contribution to energy efficiency. It also believes that consideration should be given to the ongoing work involving instruments in the form of, for example, white certificates, and processes to revise energy requirements in building regulations.

100% Förnybart considers that the plan should include a more ambitious contribution to energy efficiency.

Bioenergy and gas

The Swedish Gas Association believes that the role of biogas and gas should be given greater prominence, and notes the lack of information concerning gas oil and hydrogen in the energy system.

100% Förnybart considers that the role of biogas in replacing natural gas should be highlighted.

The Swedish Petroleum and Biofuels Institute considers that the plan results in an overwhelming demand for biofuels during the transition, and that the forecast relating to electric cars is understated.

Greenpeace believes that some parts of the plan take a seemingly positive view on natural gas and biofuels, highlighting, by way of example, the description of the LNG terminal in Gothenburg.

The Swedish Steel Producers' Association considers that the plan should be supplemented with a strategy for expanding the gas network and its role in the future energy system, and that the plan should describe the future demand for bioenergy.

Transport

The Swedish Car, Truck and Bus Manufacturers and Importers' Association (Bil Sweden) has doubts as to the forecast development of vehicles (of all fuel types), as it believes that growth in chargeable vehicles will be considerably faster.

The Swedish Petroleum and Biofuels Institute believes that the targets identified in the plan with regard to the 70% reduction in emissions in the transport sector should give consideration to the restrictions set out in Article 26 of the Renewable Energy Directive. It also believes that the plan should be supplemented by a description of how the commitment set out in Article 25 is to be met.

KTH considers that the plan should be expanded with regard to the environmental effects of the electrification of transport.

Power issues and the lack of security of supply targets

In light of the current shortage of capacity and the forecast power situation, the Swedish Association of Energy Companies believes that the section of the plan covering security of supply has serious shortcomings in terms of concrete measures.

The Swedish Steel Producers' Association considers that the plan should clarify the strategies to be used to guarantee climate-neutral energy and long-term power and transmission capacity in the electricity system, as well as necessary measures for guaranteed security of electricity supply.

KTH believes that the section on security of supply should be expanded, in particular with regard to issues on responsibility for security of supply.

The Swedish Wind Energy Association considers that wind power's contribution to an electricity production system with better geographical distribution should be taken into account.

The role of regional and local stakeholders

Klimatkommunerna (an association of cities, towns and regions in Sweden) asks that the role of communities be clarified and highlighted in the plan.

Like SKR (the Swedish Association of Local Authorities and Regions), Klimatkommunerna wishes the plan to be used as an opportunity to highlight key Swedish requirements and on EU legislation, in order for these to be promoted in terms of implementation at both national and local level.

SKR believes that the plan should highlight stakeholder engagement, efforts and opportunities.

Fossil energy

The Swedish Society for Nature Conservation considers that the plan should justify the need for complete phasing-out of fossil fuels in Sweden, and methods to do so.

100% Förnybart believes that a prohibition on the use of fossil fuels should be introduced.

Other

KTH considers it important that the plan tie in to the work towards a national strategy for wind power and highlight authorisation problems associated with establishing new wind farms.

Greenpeace believes that Heading 5 is underdeveloped and should be supplemented by comprehensive impact assessments, for example the Environmental Protection Agency's input to the government's climate policy action plan, the Swedish Climate Policy Council's annual report, and the government's two climate reports for the 2019 and 2020 Finance Acts.

SKR believes that the plan should highlight global climate benefits rather than territorial emissions.

Shadow analysis AB considers that the plan is too nationalistic, given that Sweden is part of a wider context involving the electricity market and EU-ETS.

The Swedish Meteorological and Hydrological Institute (SMHI) proposes that information relating to the National Expert Council for Climate Adaptation be added.

The Swedish Bioenergy Association believes that the plan should be strongly

supported in parliament. The Swedish Association of Energy Companies considers that there are sections of the plan that lack explicit targets and policies for achieving same, such as the internal market and security of supply, and that these sections should be further developed within the plan.

Research institutes of Sweden AB believes that the roadmaps developed as part of the Fossilfritt Sverige (Fossil-Free Sweden) initiative may be more clearly integrated into the plan. It also observes that there is a general lack of objectives for timeframes of less than 10 years (2030) and considers that the plan should be supplemented to include ways of streamlining authorisation processes.

The Swedish Agency for Economic and Regional Growth believes that the entire range of actions under Thematic Objective 4 of the regional fund should be shown.

Shadow analysis AB has been critical of the short consultation timeframes for gathering observations on the plan.

The Swedish University of Agricultural Sciences considers it unfortunate for a research policy objective to be based on a current political objective.

The Swedish Concrete Association believes that competition should be clarified in the plan, including with regard to the roadmaps developed as part of the Fossilfritt Sverige initiative.

Research institutes of Sweden AB believes that the roadmaps developed as part of the Fossilfritt Sverige initiative can be more clearly integrated into the plan. It also observes that objectives for timeframes shorter than from now until 2030 are lacking within the plan.

KTH considers that the plan should be developed in terms of a circular economy, including with regard to extending the lifecycle of electricity production, for example wind power and recycling of batteries from the transport sector for energy storage.

The Swedish Wood Fuel Association takes the view that the EU baseline scenario should give consideration to changes in taxation on cogeneration.

Regeringen

Ministry of Infrastructure

Annex 2 to Sweden's Integrated National Energy and Climate Plan

Calculation of annual and cumulative energy savings pursuant to Article 7, 7(a) and 7(b) of the Energy Efficiency Directive.

Energy savings in housing and services (buildings)

Electricity savings alone are reported in the housing and services sector. This is because current levels of direct oil consumption for heating purposes in housing and services is very low, whereas the price elasticity information available is based on conditions when oil consumption was significantly higher. The potential of switching from direct electric heating, which is the most common heating method in smaller buildings, to air-to-air heat pumps is great. It is also true that, at present, a large proportion of heating, particularly in multi-dwelling buildings, takes place through district heating, where technical lock-in effects reduce the potential of switching to other heating sources, for example geothermal heat pumps.

In order to estimate the relationship between electricity consumption and electricity prices in the housing and services sector, a dynamic model[284][284] is used, which consists of two parts. This model consists, on the one hand, of a long-term linear relationship between electricity consumption and the independent variables of price, income and heat demand and, on the other hand, a more short-term, dynamic relationship based on deviations in energy consumption from the long-term relationship and/or changes in any of the underlying variables (price or income) between the preceding and current time period.

Those selected parts of the model description that are used to estimate long- and short-term price elasticity are shown in Annex 1 to Sweden's plan for implementing Article 7 of the Energy Efficiency Directive[285] for the period 2014-2020[286]. The memorandum of the Swedish Energy Agency[287] provides data and estimated results and discusses new elasticities for housing and services.

The price elasticity estimates provided by the Swedish Energy Agency show that a higher electricity price reduces electricity consumption in the housing and services sector. A price increase of 10% indicates a long-term reduction in electricity consumption of approximately 5.2%. In the short term, electricity consumption decreases by 1.1% with a price increase of 10%. It

[284] The model was developed by professor Runar Brännlund at the Centre for Environmental and Resource Economics – CERE, Umeå University (www.cere.se). It is described in more detail in the report *Electricity demand in the Swedish housing sector*.

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

[286] Memorandum of the Ministry of Enterprise, Energy and Communications, N2013/5035/E: Notification of Sweden's plan for implementing Article 7 of the Energy Efficiency Directive. Annex 1 Estimation of price elasticity for electricity consumption in the housing and services sector, 2013.

[287] Memorandum of the Swedish Energy Agency, 2019: *Method for calculating the effects of energy and carbon taxes on energy consumption*. Reference number: 2018–12739.

takes a long time for households and the services sector to fully adjust to changes in prices and income. Buildings, heating systems and other apparatus do not change greatly from year to year, meaning that one can only make small adjustments to electricity consumption from one year to another as a result of, for example, a change in electricity price. However, this does not mean that long-term changes can be disregarded when calculating cumulative energy savings. Certain households and companies adjust faster than others.

The aforementioned elasticities have been used to calculate electricity savings resulting from the fact that the Swedish electricity tax in the housing and services sector is higher than the minimum taxation levels set by the EU and that, in combination with other complementary instruments, this triggers a reduction in electricity consumption compared with the situation if these instruments were not in place.

The only difference between the reference scenario (EUmin) and alternative scenario (SE) is the final consumer price of electricity (including excise duties and VAT). The calculations start from a price difference of approximately 50%, which is based on 2015 prices. These calculations also account for the fact that the Swedish VAT rate is higher than the minimum taxation level set by the EU (25% compared with 15%). In practice, however, VAT is only paid by households and companies that do not have a right to deduct. The calculations are based on the latest available data, with that year then being used for the subsequent year. The difference in electricity consumption between the alternative and reference scenario is calculated in line with this.

Table 1 shows an estimate of the annual and total cumulative electricity saving in the housing and services sector during the period 2014-2030.

Table 1. Annual and cumulative energy saving in the housing and services sector

	ΔEl TWh/year	ΔEl cum. TWh
2014	-10.8	-10.8
2015	-11.6	-22.4
2016	-11.4	-33.8
2017	-11.3	-45.1
2018	-11.7	-56.7
2019	-11.7	-68.4
2020	-11.7	-80.1

2021	-11.7	-91.7
2022	-11.7	-103.4
2023	-11.7	-115.1
2024	-11.7	-126.7
2025	-11.7	-138.4
2026	-11.76	-150.1
2027	-11.7	-161.7
2028	-11.7	-173.4
2029	-11.7	-185.0
2030	-11.7	-196.7

The calculations carried out by Sweden in 2013 are based on available statistics prior to 2014 and price elasticities for the period 1975-2010. The results in Table 1 are based on the latest available statistics prior to 2019 and price elasticities for the period 1975-2017[288]. The revised calculations account for differences in VAT between Sweden and the EU. In addition, certain simplifying assumptions are made regarding input data as compared to the 2013 calculations[289].

Table 1 shows a conservative estimate that Swedish instruments will contribute a cumulative energy saving of approx. 197 TWh in the housing and services sector during the period 2014-2030. A conservative estimate of the cumulative energy saving for the period 2021-2030 is approx. 117 TWh. All data are updated on an annual basis by the Swedish Energy Agency in conjunction with the publication of new official statistics. The Swedish Energy Agency will also work to develop the calculation methods further, as they underestimate the effects of taxation at present. In connection with the reporting of energy savings achieved pursuant to the EU's Governance Regulation[290], the calculations may be updated.

Energy saving in the transport sector

A reduced consumption of petrol and diesel is reported overall in the transport sector. Savings of pure biofuels and electricity are not reported.

As is the case for buildings, the relationship between energy consumption and energy price for petrol and diesel in the transport sector is estimated

[288] Memorandum of the Swedish Energy Agency, 2019: *Method for calculating the effects of energy and carbon taxes on energy consumption*. Reference number: 2018–12739.

[289] A summary statement of assumptions and prerequisites for the 2013 calculations is provided in Annex 1 to the Memorandum of the Ministry of Enterprise, Energy and Communications, N2013/5035/E: *Notification of Sweden's plan for implementing Article 7 of the Energy Efficiency Directive*, 2013.

[290] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

using a dynamic model[291], which consists of a long-term relationship between total fuel consumption and the independent variables of price and income and a more short-term dynamic relationship based on deviations in fuel consumption from the long-term relationship and/or changes in any of the underlying variables between the preceding and current time period (short-term dynamics). Annex 2 to Sweden's 2013 notification relating to Article 7[292] provides a detailed description of the model, which is used to estimate both long- and short-term price elasticity, and of the simulations carried out in 2013 relating to energy saving as a result of higher rates of taxation in Sweden compared to the minimum levels of taxation set by the EU. In 2019, the Swedish Energy Agency estimated new elasticities for petrol and diesel in the transport sector. The present effect calculations are based on these elasticities. The Swedish Energy Agency's 2019 memorandum[293] includes data, the results of the estimates, discussions and possible applications for the new elasticities.

The 2019 estimates of price elasticity show that a higher petrol price reduces petrol consumption, and that a higher diesel price reduces diesel consumption. The results also show that – as expected – petrol and diesel are substitutes in the long term. This means that, everything else being equal, higher petrol prices result in increased diesel consumption. Naturally, this is interpreted as meaning that some substitution occurs from petrol cars to diesel cars. The reverse is true with regard to high diesel prices. In this respect, it is particularly relevant to consider cross-price elasticity for petrol and diesel when calculating the cumulative energy saving of high petrol and diesel prices.

The estimated and processed elasticities from 2019 have been used to calculate the energy saving resulting from the fact that VAT and energy and carbon taxation levels in Sweden are higher than the minimum levels of taxation set by the EU and that, in combination with other complementary instruments, this triggers a reduction in energy consumption compared with the situation if these instruments were not in place. These calculations also account for the fact that the Swedish VAT rate is higher than the minimum taxation level set by the EU (25% compared with 15%).

The only difference between the reference scenario (EU) and alternative

[291] The model was developed by professor Runar Brännlund at the Centre for Environmental and Resource Economics, CERE, Umeå University (www.cere.se), and is described in more detail in the report *The effects on energy saving from taxes on motor fuels: The Swedish case*, CERE Working Paper 2013:6.
[292] The Ministry of Enterprise, Energy and Communications, *Plan for implementing Article 7 of the Energy Efficiency Directive,* 5 December 2013, Ref. N2013/5035/E (in part).
[293] Memorandum of the Swedish Energy Agency, 2019: *Method for calculating the effects of energy and carbon taxes on energy consumption*. Reference number: 2018–12739.

scenario (SE) for energy saving simulations is the final consumer price of petrol and diesel (including excise duties and VAT). The calculations are based on an average price difference of 50% for petrol and 42% for diesel, which is based on 2015 price levels. The calculations are based on the latest available data, with that year then being used for the subsequent year. The difference in fuel and energy consumption between the alternative and reference scenario is calculated in line with this.

Table 2 (petrol) and Table 3 (diesel) show an estimate of the annual and total cumulative fuel and energy saving in the transport sector during the period 2014-2030.

Table 2. Annual and cumulative energy saving for petrol in the transport sector.

	ΔP TWh/year	ΔP cum. TWh
2014	-4.5	-4.5
2015	-5.1	-9.6
2016	-5.9	-15.5
2017	-5.4	-21.0
2018	-5.2	-26.2
2019	-5.2	-31.5
2020	-5.2	-36.7
2021	-5.2	-41.9
2022	-5.2	-47.2
2023	-5.2	-52.4
2024	-5.2	-57.7
2025	-5.2	-62.9
2026	-5.2	-68.2
2027	-5.2	-73.4
2028	-5.2	-78.6
2029	-5.2	-83.9
2030	-5.2	-89.1

Table 3. Annual and cumulative energy saving for diesel in the transport sector.

	ΔD TWh/year	ΔD cum. TWh
2014	-0.2	-0.2
2015	-0.3	-0.5
2016	-0.3	-0.9
2017	-0.3	-1.2
2018	-0.3	-1.5
2019	-0.3	-1.9
2020	-0.3	-2.2

2021	-0.3	-2.5
2022	-0.3	-2.8
2023	-0.3	-3.1
2024	-0.3	-3.4
2025	-0.3	-3.7
2026	-0.3	-4.1
2027	-0.3	-4.4
2028	-0.3	-4.7
2029	-0.3	-5.0
2030	-0.3	-5.3

The calculations carried out by Sweden in 2013 are based on available statistics prior to 2014. The results in Table 2 and 3 are based on the latest available statistics prior to 2019[294]. The price elasticities used relate to the period 1976-2017[295].Certain simplifying assumptions are made regarding input data as compared with the 2013 calculations[296].

A conservative estimate of the cumulative energy saving for petrol and diesel in the transport sector as a result of Swedish instruments for the period 2014-2030 of approx. 95 TWh can be obtained from the sum of the results in Table 2 and Table 3. A conservative estimate of the cumulative energy saving for the period 2021-2030 is approx. 56 TWh. It should be noted that the calculations do not currently give consideration to the reduction obligation scheme. This scheme increases fuel price at the pump, which may therefore be relevant to a future analysis of the effects of this instrument, in the same way as for taxation. The estimated energy saving reported for the transport sector is thus to be regarded as low. All data are updated on an annual basis by the Swedish Energy Agency in conjunction with the publication of new official statistics. The Swedish Energy Agency will also work to develop the calculation methods further, as they underestimate the effects of taxation at present. In connection with the reporting of energy savings achieved pursuant to the EU's Governance Regulation[297], the calculations may be updated.

Energy saving in other sectors

The energy saving in industry and agricultural sectors was calculated in

[294] Calculation data are available at the Government Offices, Ref. I2019/00931/E.

[295] Memorandum of the Swedish Energy Agency, 2019: *Method for calculating the effects of energy and carbon taxes on energy consumption*. Reference number: 2018–12739.

[296] The assumptions and requirements for the 2013 calculations are described in Annex 1 to the Memorandum of the Ministry of Enterprise, Energy and Communications, N2013/5035/E: *Notification of Sweden's plan for implementing Article 7 of the Energy Efficiency Directive*, 2013.

[297] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

Sweden's 2013 notification. A simpler linear model is used, where the price difference resulting from the higher levels of taxation in Sweden is multiplied by the long-term own-price elasticities for various fuels in order to determine the long-term decrease in demand. By assuming a linear increase in effect across the seven years of the period up to full effect in 2020, the long-term annual and cumulative energy saving during the period 2014-2020 is estimated to be approximately 3 TWh (cumulative 12 TWh) for the sector of industry forming part of the EU ETS and 0.34 TWh (cumulative 1.4 TWh) for the sector of industry not forming part of the EU ETS. For agricultural sectors, the long-term saving is estimated to be 0.54 TWh (cumulative approx. 2 TWh). The effects are calculated for different sectors and activities. The price elasticities used represented an average value for various sectors and were based on data relating to the period 1990-2004.

Effects in industry and agricultural sectors have not been calculated for 2021-2030, as previous calculations resulted in relatively small effects compared with the housing and services and transport sectors. Agricultural sectors have relatively low energy consumption and are subject to both tax deductions and exemptions. Industry also continues to be subject to relatively large tax deductions and exemptions, but there are industries that do pay tax and carbon tax deductions and exemptions have also decreased in recent years.

The fact that the effects of taxation in the aforementioned sectors has not been calculated is another reason why estimates of energy-saving effects as a result of energy and carbon taxes in Sweden are conservative ones.