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# NATIONAL FRAMEWORK REPORT

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Sweden



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12 May 2023

# National framework conditions report

## Sweden

### Aim of this report

This report aims to collect necessary national conditions that set the frames for the CommitClimate Simulator template model for each country. These framework conditions are essential for the model development so that the model can consider each country's national differences.

### Background

Sweden is one of the Nordic countries located on the Scandinavian Peninsula in Northern Europe. It shares border with Norway in North-West, Finland in North-East and also is connected with Denmark via a bridge-tunnel across the Öresund. It is the largest country in Nordic region, and 5th largest in the whole Europe. The three main cities are Stockholm which is the capital and the largest city of the country (984,748 population), Gothenburg 2nd largest city (596,841 population) and Malmö 3rd largest (357,377 population). Around 63% of Sweden's total land area is forest, and it has nearly 270000 islands.

### General data

Population: 10521556

Territory: 450,000 km<sup>2</sup>

Gross domestic product per capita: 53000 EUR

### References to sources:

1. <https://sweden.se/life/society/key-facts-about-sweden>
2. <https://www.ekonomifakta.se/fakta/ekonomi/tillvaxt/bnp-per-capita/>
3. <https://www.scb.se/en/finding-statistics/search/?query=island&lang=en>
4. <https://www.norden.org/en/information/facts-about-sweden>

### Natural conditions

Climograph (in case of different climatic conditions throughout the country, please provide one climograph per characteristic climatic conditions):

Climograph data:

Month	Average maximum temperature, °C	Average minimum temperature, °C	Average total precipitation, mm	Average amount of sunshine, h (Kiruna, North Sweden) Per Day	Average amount of sunshine, h (Malmö, South Sweden) Per Day
January	-3.6	-10.91	47.29	0.5	1.5
February	-2.85	-10.88	36.91	2.5	2
March	1.3	-7.73	34.23	5	5
April	6.7	-2.76	35.53	7	7.5
May	12.64	2.16	45.78	7.5	8.5
June	17.38	12.14	67.54	7.5	9
July	19.96	14.89	79.9	8	8.5
August	18.37	13.54	79.09	6	7.5
September	13.24	5	59.17	4	6.5
October	6.51	0.17	59.05	2.5	4
November	0.85	-4.98	55.95	0.5	1.5
December	-2.14	-9	53.22	0	1

#### Land cover

Woodland: 52, %	Water areas: 23, %	Land under buildings and roads: 2, %
Cropland: 6, %	Wetland: 6, %	
Grassland: Number, %	Shrubland: Number, %	Other lands: 11, %

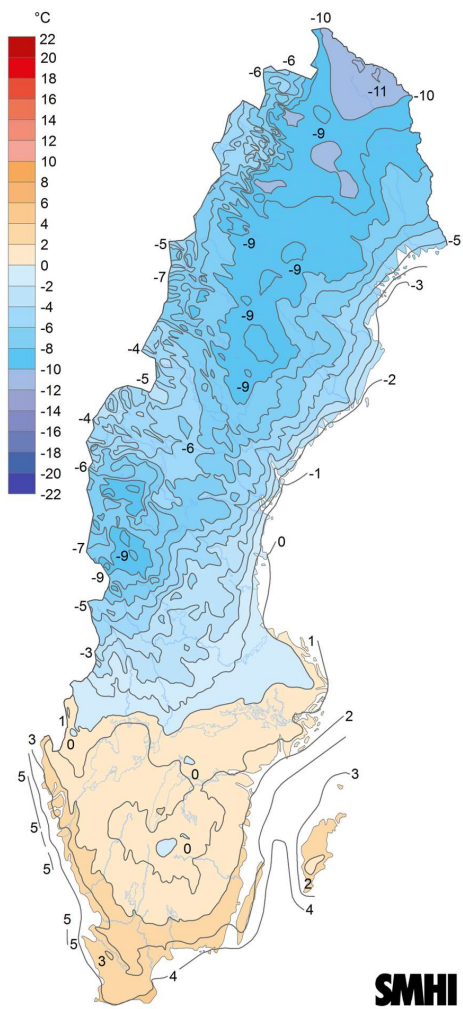


Figure 2 Average temperatures for January 2023

Source SMHI  
<https://www.smhi.se/data/meteorologi/temperatur>

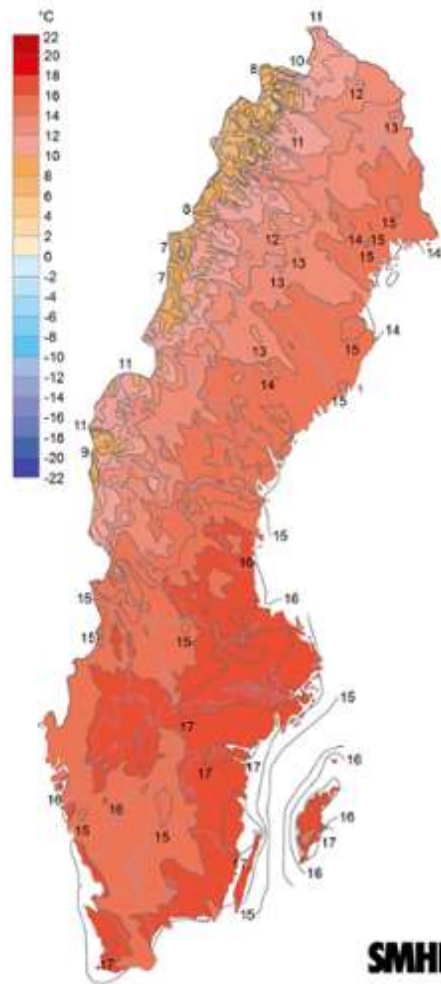


Figure 1 Average temperatures for June 2022

Source SMHI  
<https://www.smhi.se/data/meteorologi/temperatur>

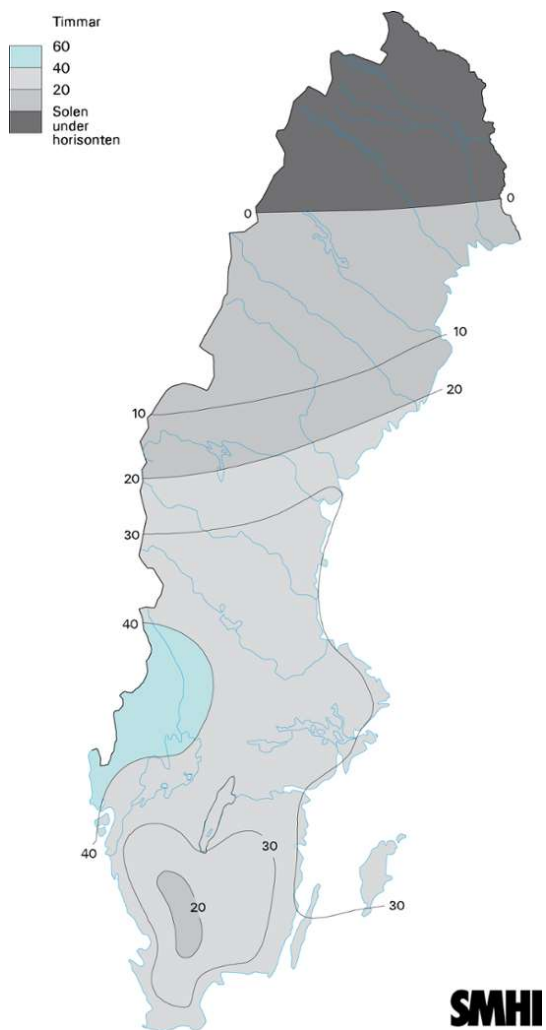


Figure 4 Sunshine hours in December  
<https://www.smhi.se/data/meteorologi/stralning>

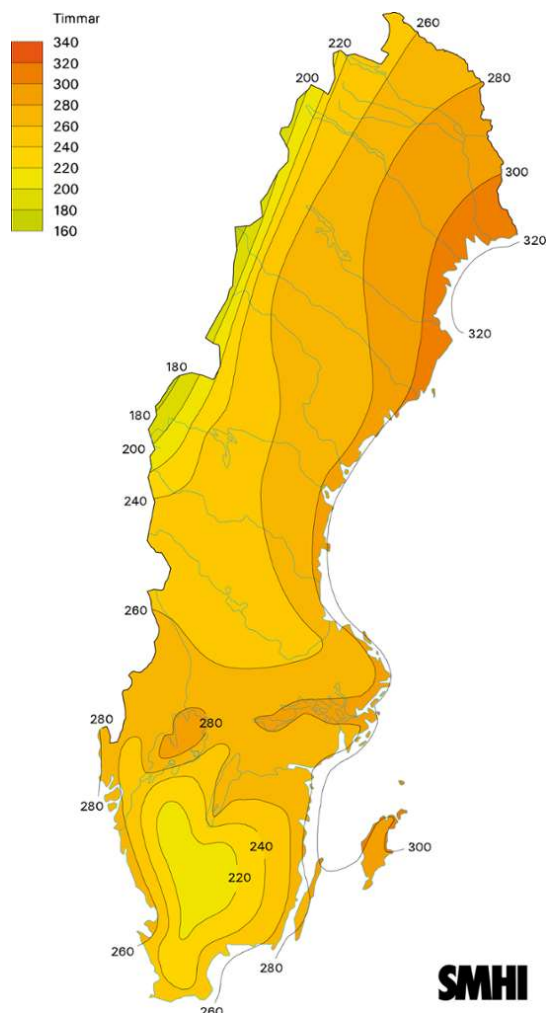


Figure 3 Sunshine hours in June,  
<https://www.smhi.se/data/meteorologi/stralning>

## National energy consumption and decarbonization strategy

### National energy consumption and energy mix (Ref. 7)

Sweden uses domestic renewable energy sources such as hydro, wind, solar, and biofuels. It also imports nuclear fuels, biofuels, and fossil fuels such as oil and natural gas. According to the latest data of year 2020, total supply of energy in 2020 was 508 TWh, out of which fossil fuel sources accounted for 136TWh, renewable source supplied 241 TWh and rest of the sources provided 131 TWh. Energy consumption in Sweden was 364 TWh, out of which industrial sector used 136 TWh, housing and service sector used 140 TWh and transport sector consumed 79 TWh, while losses and non-energy use accounted for 144 TWh.

Primary energy consumption: (Ref. 8)

Year	2010	2012	2014	2016	2018	2020	2021
Primary energy consumption, TWh	395	378	368	376	372	355	372

Primary energy consumption breakdown by sectors in 2022 (or latest data available): 2021 Ref. 9

Sector	Public Sector	Transport	Industry	Residential & Tertiary	Agriculture	Other
% of final energy consumption	4.44, %	21, %	41.9, %	20, %	1.4, %	11, %

National energy mix in 2022 (or latest data available): (Ref.8)

Source	Share in electricity consumption, %	Share in heat consumption, % (2021 – sheet 3.4)	Share in transport energy consumption, % (2021 – sheet 5.1)
Natural gas		1	0.60
Coal (and oil shale)			
Biomass	9	12	
Biogas			
Bioliquids			21.80
Oil (and other oil products) (Light & Heavy Fuel)		1	1.10
Nuclear	30		
Hydropower	44		
Solar	1		
Wind	16		
Geothermal			
Petrol			27
Diesel			43.7
Aviation fuel			0.96
Electricity			4.84
District Heating		58	
Electric Heating		28	

## References to sources:

5. <https://climateknowledgeportal.worldbank.org/country/sweden/climate-data-historicalhttps://tradingeconomics.com/sweden/real-gdp-per-capita-eurostat-data.html#:~:text=Sweden%20%2D%20Real%20GDP%20per%20capita%20was%20EUR45830.,EUROSTAT%20on%20April%20of%202023.>
6. [https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START\\_\\_MI\\_\\_MI0803\\_\\_MI0803A/MarkanvN/](https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__MI__MI0803__MI0803A/MarkanvN/)
7. <https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=208766>
8. <https://www.energimyndigheten.se/en/facts-and-figures/publications/>
9. [https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START\\_EN\\_EN0203\\_EN0203A/SlutAnvSektor/table/tableViewLayout1/](https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START_EN_EN0203_EN0203A/SlutAnvSektor/table/tableViewLayout1/)
10. <https://www.climatestotravel.com/climate/sweden/malmo>
11. <https://www.climatestotravel.com/climate/sweden/kiruna>

## Renewable energy

To understand what biomass and biofuel is, biomass refers to any organic matter derived from plants or animals, such as wood, crop residues, agricultural waste, or dedicated energy crops. It can be in the form of solid materials like wood chips or sawdust. Biofuel, on the other hand, refers to the renewable fuel produced from biomass. It is a type of energy derived from biological sources rather than fossil fuels. Biofuels can be used as a substitute for conventional fossil fuels in transportation, heating, and electricity generation. Common examples of biofuels include bioethanol, biodiesel, biogas, and woodchips. Renewable energy sources in Sweden are hydro, wind, solar, biofuels. In 2020 1 TWh of solar energy, 141 TWh of biofuels, 72 TWh of hydropower and 28 TWh of wind power were produced. Energy from solar, hydro and wind power was mainly supplied to industrial sector, and residential & service sectors. These sources of energy contributed to generating 63% of electricity i.e. About 101 TWh of the total 161 TWh of electricity was produced through solar, wind and hydro power. While biofuels contributed 59 TWh to industrial sector, 17 TWh to transport sector and 15 TWh to residential and service sector. The rest of biofuels are used for electricity and heating generation.

### Current RES share (in 2021):

Sector	RES share, % of final energy consumption
Electricity	76
Heat	69
Transport	30
Total	63



#### Renewable energy production:

Renewable energy source	Current annual production, TWh	Maximum annual production potential, TWh
Solar	1	50
Wind	27	160
Geothermal		
Hydropower	73	95
Biomass	13	50
Bioliquids		
Biogas	2	10
Other, please specify		

#### Indicative RES targets and timescale:

Sector	RES share, % of final energy consumption		
	2030	2040	2050
Electricity	85	100	
Heat	69	71	
Transport	46	48	
Total	65		

\* Above figures are projection and not the target, kindly see reference no. 6.

#### References to sources:

1. <https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=208766>
2. <http://energimyndigheten.se/en/facts-and-figures/publications/>
3. <https://smartcitysweden.com/focus-areas/mobility/biofuels/>
4. <https://www.ri.se/sites/default/files/2021-11/Power%20Distribution%20SE.pdf>
5. <https://www.svebio.se/wp-content/uploads/2020/03/Roadmap-Bioenergy-2020.pdf>
6. <https://www.government.se/contentassets/e731726022cd4e0b8ffa0f8229893115/swedens-draft-integrated-national-energy-and-climate-plan/>

#### National goals and strategies

Sweden's energy and climate goals are aligned according to energy policies of EU. Based on that the aims and goals for 2030 and beyond are as follows

- Sweden aims to achieve net zero emission by 2045 out of which 85% of emission reduction should happen domestically within Sweden. Milestones to achieve are

- 63% lower emission in 2030 compared to 1990
- 75% lower emission in 2040 compared to 1990
- Emission from domestic transport, excluding domestic flight, is aimed to be reduced by 70% by 2030 as compared to 2010
- 50% more efficient energy use by 2030 as compared to 2005, in relation to the GDP
- 100% electricity production through renewable sources by 2040

Sweden's strategy towards decarbonization includes plans for increased energy efficiency and to increase consumption from renewable sources. Swedish Energy Agency aims to have 65% of gross consumption of energy from renewable source by 2030. It has further adopted policies for CO2 taxation, emission trading, emission performance for new vehicles, building regulations and many more, to combat greenhouse emission and contribute towards decarbonization efforts.

Energy security is also part of Sweden's energy policies indicating policies for emergency preparedness and civil defense. Some key points for maintain energy security are as below

- Sweden has diversified energy source and also aims to increase supply of electricity through renewable sources
- For oil stock pile Sweden follows guidelines laid down by 2009/119/EC
- Policy to ensure at least 30 days of gas supply to consumers in the event supply disruptions

With respect to electricity interconnectivity, Sweden doesn't have any specific target, however, Swedish TSO Svensk Kraftnät aims to have 27% of connectivity by 2030.

Sweden has increased its public funding in the energy area for public research and innovation from SEK 1.3 billion in 2017 to SEK 1.6 billion in 2020 annually. The key objectives areas:

- Transition towards sustainable energy system in Sweden through new technologies and services
- Commercialization of new developed technologies and services to achieve sustainable growth and energy system with Sweden as well as other markets
- Contribute to and leverage international cooperation in energy sector

References to sources:

1. <https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=208766>
2. <https://www.energimyndigheten.se/klimat--miljo/sveriges-energi--och-klimatmal/det-klimatpolitiska-ramverket/>
3. <https://www.government.se/contentassets/e731726022cd4e0b8ffa0f8229893115/swedens-draft-integrated-national-energy-and-climate-plan/>

## Energy sector

### Electricity market regulation

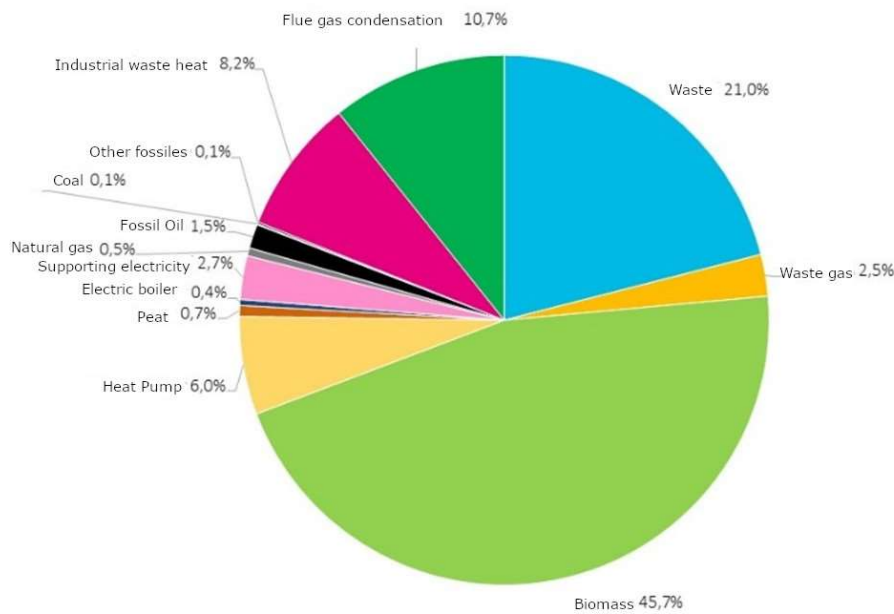
Electricity trade in Sweden has been deregulated since 1996, while electricity distribution throughout the country is partly done via a common network. Sweden is a part of European electricity market and

electricity is both produced in Sweden and imported from abroad. Electricity is a competitive market with around 120 electricity suppliers and 170 electricity grid operators. Each grid operator works in a specific geographical region and their prices are regulated by Swedish Energy Markets Inspectorate (EI). A grid is a monopoly market where grid owners have the exclusivity for the distribution. EI also monitors the electricity market in Sweden to prevent any market abuse maintain transparency and promote energy efficiency.

**References to sources:**

1. <https://ei.se/ei-in-english/electricity/the-electricity-market>.
2. <https://www.government.se/government-policy/energy/>
3. Add source here

**District heating energy mix 2021**



**District heat market regulation**

Sweden’s district heating infrastructure is well developed, and renewable energy is the main source for heating and cooling sector. District heating is the most common form of heating used for residential and commercial buildings. The infrastructure for district heating was put in place between 1950-1990. District heating is mainly produced through renewable sources such as solid biofuels while the use of heat pumps for district heating has decreased overtime amounting to only 6% share by 2021. The share of renewables in the heating and cooling sector has increased from 51.8% in 2005 to 69.1% in 2017 and is expected to grow up to 72% by 2030 and 74% by 2040. Heat pumps run on electricity. Oil use in this sector is heavily taxed and hence uses of oil have been in decline over the years. Sustainable biofuels are exempted from

energy and carbon tax, while other fuel sources for heating have both energy and carbon tax applicable as per EU's energy tax directives. In 2019, Sweden Government budgeted SEK 1.5 billion as investment for reducing GHG emission in areas such as charging infrastructure for EVs, switching from fossil fuel to biofuels or district heating, expansion of district heating network and others. Since May 2019 a support of max 20% is provided for installation of photovoltaic cell system or solar electricity/heating system. Private individuals can also obtain a deduction of 9% on investment cost towards such changes.

#### References to sources:

1. [https://energy.ec.europa.eu/system/files/2021-10/se\\_ca\\_2020\\_en.pdf](https://energy.ec.europa.eu/system/files/2021-10/se_ca_2020_en.pdf)
2. <https://norden.diva-portal.org/smash/get/diva2:1098961/FULLTEXT01.pdf>
3. <https://ei.se/ei-in-english/district-heating>
4. [https://energy.ec.europa.eu/system/files/2020-03/se\\_final\\_necp\\_main\\_en\\_0.pdf](https://energy.ec.europa.eu/system/files/2020-03/se_final_necp_main_en_0.pdf)

### Energy infrastructure

Sweden has three types of power grid, national grid, regional grids, local grids. The national grid is used for power transmission while the other two are used for power distribution. Svenska Kraftnät is responsible for maintaining the national power grid. The national power grid consists of aprx. 17000 KM of power lines, about 200 substations and switching stations and 16 connections to other countries. The development and expansion of the national grid is overseen by Svenska Kraftnät. Various projects are ongoing or planned for development of national grid to secure the supply of electricity and enable expansion of renewable electricity production. Project details can be found in reference 5. Regional grids are owned by three companies, Vattenfall Eldistribution, Ellevio and E.On Elnät Sverige. Local grids are owned and operated mostly by companies with municipal ownership. There are a total of 170 local power grid companies out of which 129 are municipal companies. Hydro and Nuclear power supply 80% of total electric power demand and the remaining 20% is split between wind power, bioenergy, and solar energy. Development in power grids depends on various factors such as development of old grind lines, trade opportunities and specific needs of renewable and nuclear power sources. Details of these development plans can be found in the reference five.

#### References to sources:

1. <https://www.ri.se/sites/default/files/2021-11/Power%20Distribution%20SE.pdf>
2. [https://inis.iaea.org/collection/NCLCollectionStore/\\_Public/42/022/42022239.pdf](https://inis.iaea.org/collection/NCLCollectionStore/_Public/42/022/42022239.pdf)
3. <https://www.svk.se/en/national-grid/>
4. <https://www.svk.se/en/grid-development/driving-forces/>
5. <https://www.svk.se/en/grid-development/grid-projects/>

### Local authority powers and duties in the energy sector

Sweden's law 1977:439 requires each municipality to have an energy action plan for their region. They are also obliged to carry out risks and vulnerability analysis to prepare for exceptional situations. Support is provided in the form of advisory services for private person and SMEs for energy mapping, capacity development, transition towards energy efficiency and others. Possible financial support for disaster preparedness, climate coach, improving energy efficiency and others are also provided. According to the above-mentioned law, local municipalities must cooperate with other municipalities, power companies and other stakeholders for energy management. They should have an up-to-date plan for supply, distribution, and use of energy. The plan should also include analysis of the impact of the plan on the environment and health and management of land and water resources. Regional authorities should also aim to promote energy efficiency and renewable energy sources and in cooperation with companies, organizations, residents, and other operators should drive local developments aim at reaching national and local climate targets. One good example is for Gothenburg region that supplies 30% of district heat from water heat generated from industry. The cooperation between Preem and Göteborg Energi started in 1996. Preem produces 475 GWh of waste heat which is used as a source for district heating in Gothenburg district. Another example is of Helsingborg district, whose climate and energy action plans aim to increase energy usage effectiveness to 50% by 20230 as compared to 2005, 100% district heating from recycled or renewable energy source by 2024, increase biogas production by 15% before 2024 and others. Land and water use planning plays an important role for municipalities providing them with guidelines for sustainable development of land and water areas. According to planning and building act (2010:900), the overview plan must consider natural and cultural values, environment and climate aspects as well as inter-municipal and regional conditions. National interests of the environment code mentioned in Ch. 3 and 4 of the aforementioned ordinances must be reported in the plans. The plan should also consider public and private interests promoting a good living environment for all social groups. Buildings and constructions that require supply of energy must be located to facilitate management of energy supply. Hence, both overview plan and detailed plans should be drawn out keeping national, social, and environmental interests in scope. For reducing climate impact, the overview plan can therefore include developments that favor resource efficient transport, minimize emission of pollutants and greenhouse gases and reduced energy use. The regulation also provides guidance for detailed plan that incorporates natural solutions for regulating local climate of built area. For example, use of vegetation for creating shades and wind protection, water evaporation from plants for controlling temperature and others. Planning and building act provides documents as guidelines for local municipality for designing that promotes efficient energy use and reduction in climate impact. Municipalities also have legal power controlling and limiting environment impact of buildings through use of permits with certain exceptions as mentioned in Ch. 9 of the planning and building act. Municipalities also have power over supply, distribution, and usage of energy as they often own and operate both housing companies and district heating. In 2021, 469 municipally owned companies operated in energy, and water sector.

#### References to sources:

1. [https://energy.ec.europa.eu/system/files/2020-03/se\\_final\\_necp\\_main\\_en\\_0.pdf](https://energy.ec.europa.eu/system/files/2020-03/se_final_necp_main_en_0.pdf)
2. [https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-1977439-om-kommunal-energiplanering\\_sfs-1977-439](https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-1977439-om-kommunal-energiplanering_sfs-1977-439)

3. <https://norden.diva-portal.org/smash/get/diva2:1098961/FULLTEXT01.pdf>
4. <https://helsingborg.se/wp-content/uploads/2020/03/helsingborg-climate-and-energy-plan-2018-2024-final.pdf>
5. [https://www.boverket.se/sv/PBL-kunskapsbanken/planering/oversiktsplan/allmannaintressen/hansyn/miljo\\_klimat/klimatpaverkan/](https://www.boverket.se/sv/PBL-kunskapsbanken/planering/oversiktsplan/allmannaintressen/hansyn/miljo_klimat/klimatpaverkan/)
6. <https://www.boverket.se/sv/samhallsplanering/sa-planeras-sverige/planeringsfragor/klimat/klimatanpassning/>

## Building sector

### Energy performance certificate evaluation methodology

According to Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 the European Union member states are obliged to develop a methodology to evaluate the building's energy performance. The methodology may be differentiated at national and regional levels. According to the directive, it is the sole responsibility of Member States to set minimum requirements for the energy performance of buildings and building elements.

The Swedish National Board of Housing, Building and Planning, named Boverket, is a central government authority who oversees developments within housing, building, town and country planning, and other building management related tasks in Sweden. Boverket is also responsible for issuing building regulations and are aligned with EU regulations. Energy performance certificate (EPC) system is administered by Boverket and it is required by law for new buildings and buildings that can be sold to have an EPC. All EPC can be found in Boverket database and the information that can be obtained are ID number of EPC, date of issue, energy performance rating, radon check and ventilation control information. EPCs are issued by building or energy experts and the organization that carries out certification of these experts are accredited by Swedish Board for Accreditation and Conformity Assessment (SWEDAC). These experts inspect the building for its energy performance and identify cost-effective measures of improvements.

References to sources:

1. <https://www.boverket.se/en/start/building-in-sweden/contractor/inspection-delivery/energy-performance-certificate/>
2. <https://www.boverket.se/en/start/about/about-boverket/>
3. [https://energy.ec.europa.eu/system/files/2020-03/se\\_final\\_necp\\_main\\_en\\_0.pdf](https://energy.ec.europa.eu/system/files/2020-03/se_final_necp_main_en_0.pdf)
4. [http://bpie.eu/wp-content/uploads/2018/01/iBROAD\\_CountryFactsheet\\_SWEDEN-2018.pdf](http://bpie.eu/wp-content/uploads/2018/01/iBROAD_CountryFactsheet_SWEDEN-2018.pdf)

### Space heating

Share of total energy consumption for space heating: 22%

Share of heating energy provided by district heating: 58%

Electric heating including heat pumps are the most common form of heat sources for detached houses and around 60% of these houses used a heat pump in 2019. The sales of heat pumps have experienced minor fluctuations from year to year, however an overall upward trend has been observed since 2004. Notably, between 2018 and 2022, there was an increase in the quantity of heat pumps sold, with a notable rise of 24%.

#### Reference:

1. <https://skvp.se/statistik/varmepumpsforsaljning>
2. <https://www.energimyndigheten.se/nyhetsarkiv/2020/ny-statistik-over-energianvandningen-i-smahus-flerbostadshus-och-lokaler/>

#### Building stock renovation goals

According to the report submitted in 2020, there are over 8 million buildings in Sweden, of which 37% are residential buildings. Complementary buildings are small in size and are of type free-standing outbuildings, garage, storage buildings etc. and account for 58% of building stock. Remaining 5% are other non-residential buildings. A study carried to analyse improvements made showed marked improvements in energy class of buildings between 2008 and 2018. An ordinance (2014:348) later amended by 2022:336 was introduced, requiring measurement of individual energy consumption to motivate renovations for apartment buildings with worst energy performance and to upgrade those for energy efficiency. However, the building stock accounts for a high proportion of Sweden's energy consumption and hence, there is potential for improvements for energy efficiency in this sector. Instruments such as taxes, information and research are contributing to achieve the long-term goals and efforts are being made with relevant stakeholder under "Resource-efficient development" to achieve energy efficiency in building stock. Also, a lot of networks and projects initiatives are going on. The goal is to achieve lower energy consumption per m<sup>2</sup> and building type. Another goal is to increase the portion of near-zero buildings by achieving higher portion of buildings with energy class rating of A-C. Both these goals have milestones set for 2030, 2040, and 2050. The plan also includes phasing out use of fossil fuels amongst building stock.

#### References to sources:

1. [https://energy.ec.europa.eu/system/files/2020-05/se\\_2020\\_ltrs\\_official\\_translation\\_0.pdf](https://energy.ec.europa.eu/system/files/2020-05/se_2020_ltrs_official_translation_0.pdf)
2. [https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/forordning-2022336-om-energimatning-i-byggnader\\_sfs-2022-336/](https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/forordning-2022336-om-energimatning-i-byggnader_sfs-2022-336/)

Add source here

#### National level restrictions

Carbon and energy tax is levied on use of non-renewable energy sources, for instance fuels for heating. Fuel used for electricity is not taxed, however tax is applied on electricity supply. Households also pay 25% VAT which is calculated on energy price including tax. In 2022 a directive was introduced for building

owners to submit a climate declaration for the whole life cycle of building, to aid in knowledge improvement for reducing climate impact of building stocks. This proposal also aims to impose limits on emission on buildings that is planned to be introduced by 2027. The aim is to achieve net-zero climate impact from construction activities, required for achieving national target for 2045.

References to sources:

1. [https://energy.ec.europa.eu/system/files/2020-05/se\\_2020\\_ltrs\\_official\\_translation\\_0.pdf](https://energy.ec.europa.eu/system/files/2020-05/se_2020_ltrs_official_translation_0.pdf)
2. <https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=206547>
3. <https://www.boverket.se/globalassets/publikationer/dokument/2020/regulation-on-climate-declarations-for-buildings.pdf>
4. <https://www.boverket.se/sv/klimatdeklaration/om-klimatdeklaration/>

### Building stock renovation support mechanisms and subsidies

Halvera Mera initiative has been carried out to provide information on renovation method for increasing energy efficiency of buildings stocks, in a cost-effective manner. Tax deductions are provided for improvements such as repairs, conversion, and extensions. In Sweden, heating and hot water costs are included in rent, so property owners have incentive to carry out energy efficiency improvements. Only through improving the standard of the building can property owners increase the rent which motivates them further to make improvements. Banks and other financial institutions are also encouraged through Energy Efficiency Directive, to participate in financing of energy efficiency improvement measures. Financial aids are also provided to stimulate renovation and energy efficiency improvements in rental housing sector. Owners of detached house that is heated through electricity or gas can also apply for grants to achieve energy efficiency of their houses.

References to sources:

1. [https://energy.ec.europa.eu/system/files/2020-05/se\\_2020\\_ltrs\\_official\\_translation\\_0.pdf](https://energy.ec.europa.eu/system/files/2020-05/se_2020_ltrs_official_translation_0.pdf)
2. <https://www.boverket.se/sv/bidrag--garantier/bidrag-for-energieffektivisering-i-smahus/>
3. Add source here

### Local authority powers and duties in the buildings sector

When a private person or a company will build a new building, they will need to get a permit from the local authority to carry out the construction within this process the local authority will check the energy calculation is valid.

Reference to source:

1. PBL, the Swedish Planning and Building Act

## Transport sector

### Passenger transport characteristics

Annual passenger transport volume: 120 mil. passenger-kilometres



### Modal split of inland passenger transport (% of transport volume)

Domestic flights	Ships and ferries	Passenger cars	Trains	Buses, trolleybuses
3, %	1, %	88, %	8, %	Incl. in Passengers cars, %

#### References to sources:

1. <http://www.trafa.se/globalassets/statistik/transportarbete/transportarbete-2021-2022-10-04.pdf>
2. Add source here
3. Add source here

### Freight transport characteristics

Annual freight transport volume: 106063 mil. ton-kilometres

#### Modal split of inland freight transport (% of transport volume)

Domestic flights	Inland waterways	Road	Rail
0, %	26, %	54, %	20, %

#### References to sources:

1. <http://www.trafa.se/globalassets/statistik/transportarbete/transportarbete-2021-2022-10-04.pdf>
2. Add source here
3. Add source here

### Energy consumption in the transport sector

#### Energy consumption in transport sector, TWh

Year	2010	2012	2014	2016	2018	2020	2021
Diesel, TWh	41.0	40.6	38.9	36.9	36.7	35.7	36.1
Gasoline, TWh							
Biofuels, TWh	5.0	6.9	11.0	16.9	17.5	16.8	18.0
LPG, TWh							
Natural gas, TWh	0.3	0.6	0.6	0.4	0.1	0.4	0.5
Biomethane, TWh							
LPG, TWh							
Hydrogen, TWh							

Electricity, TWh	2.4	2.4	2.6	2.6	2.8	2.9	4.0
Heavy fuel oil, TWh	1.7	0.5	0.5	0.0	1.1	0.8	0.6
Petrol	38.8	32.9	29.9	28.0	23.7	21.1	22.2
Light fuel oil	0.2	0.2	0.3	0.4	0.5	0.3	0.3
Aviation fuel	1.9	2.1	2.1	2.2	2.1	0.7	0.8

#### References to sources:

1. <http://www.energimyndigheten.se/en/facts-and-figures/publications/>
2. Add source here
3. Add source here

#### Cars and road transport

Average number of private cars per 1000 people: 474

#### Registered vehicles by technology (fuel used)

	Diesel	Gasoline (Petrol)	Biofuels (Electric Hybrid)	LPG (Plug-in Hybrid)	Natural gas (Gas)	Bio-methane (Same as Gas)	Hydrogen (Ethanol)	Electricity	Other
Private cars	1,667,176	2,485,975	173,476	239,531	38,086		178,316	197,709	274
Trucks, <3.5 tons	539,156	43,117	62	421	8,604		4,255	13,217	39
Trucks, <12 tons									
Trucks, >3.5 tons	82,932	900	38		1836		81	231	15
Buses, <5 tons	10,437	34	147		2,641		65	915	
Buses, >5 tons									
Motorcycles		313,889							

	Diesel	Gasoline (Petrol)	Biofuels (Electric Hybrid)	LPG (Plug-in Hybrid)	Natural gas (Gas)	Bio-methane (Same as Gas)	Hydrogen (Ethanol)	Electricity	Other
Mopeds		104,136							
Tricycles and other									

Average age of vehicles: 10.2 years

Share of mandatory bio additive in total motor fuels: 30.5 % for diesel, 7.8 % for petrol

References to sources:

1. [https://www.aut.fi/en/statistics/international\\_statistics/average\\_age\\_of\\_passenger\\_cars\\_in\\_european\\_countries](https://www.aut.fi/en/statistics/international_statistics/average_age_of_passenger_cars_in_european_countries)
2. Fordon 2022 PDF
3. <https://www.ekonomifakta.se/Fakta/Energi/Styrmedel/reduktionsplikt/>

#### Alternative fuel vehicle infrastructure

Number of public electric vehicle recharging points: 16,697

Share of fast chargers (% of public charging points): 1165 (7%)

Number of public compressed natural gas refueling points: 212

Number of public hydrogen refueling points: 5

References to sources:

1. <https://www.elbilsstatistik.se/laddinfrastatistik>
2. <https://www.energigas.se/media/wm1osxcb/biomethane-in-sweden-230112.pdf>
3. <https://www.glpautogas.info/en/hydrogen-stations-sweden.html>

#### Sustainable transport policy

Sweden's goal is achieving fossil fuel free transport and has created an intermediate target for GHG emission from national transport for reducing it by 70% by 2030 as compared to 2010. Several steps have been taken to achieve this goal. Sweden aims to phase out use of fossil fuels in transport sector and towards that an ordinance was introduced in 2018 to reduce consumption of petrol and diesel and switch towards biofuels. Electric bus incentive payment has been introduced to transition toward electric buses

in different regions. The goal is also to increase the share of transport by public transport, cycling and walking through urban development. In 2015 the government introduced a special grant for sustainable urban environment, under which municipality and county councils can receive up to 50% government funding infrastructure development for public transport and cycling. Under the eco-bonus system funding is allocated from transferring goods transport from roads to shipping. In 2018 Government has also decided on a national intermodal transport infrastructure plan. To promote the use of electric vehicles funding is also provided for electrification of the transport sector. With the aim of reducing climate impact of aviation, a tax was introduced in 2018 on air travel. Aviation industry is also required to reduce emission from Kerosene, every calendar year with a target of 27% by 2030 as compared to 0.8% in 2021. Under reduction obligation scheme, similar targets are also set for other fuels used in transport industry and is planned for reduction of 28% for petrol and 66% for diesel by 2030.

#### References to sources:

1. [https://energy.ec.europa.eu/system/files/2020-03/se\\_final\\_necp\\_main\\_en\\_0.pdf](https://energy.ec.europa.eu/system/files/2020-03/se_final_necp_main_en_0.pdf)
2. [https://www.government.se/globalassets/government/dokument/regeringskansliet/agenda-2030-och-de-globala-malen-for-hallbar-utveckling/voluntary-national-review-vnr/voluntary\\_national\\_review\\_2021\\_sweden\\_report\\_on\\_the\\_implementation\\_of\\_the\\_2030\\_agenda\\_web.pdf](https://www.government.se/globalassets/government/dokument/regeringskansliet/agenda-2030-och-de-globala-malen-for-hallbar-utveckling/voluntary-national-review-vnr/voluntary_national_review_2021_sweden_report_on_the_implementation_of_the_2030_agenda_web.pdf)
3. <https://www.naturvardsverket.se/contentassets/caf14fb0008a41d29b9d51228f874fcb/report-sweden-march-2021.pdf>
4. <https://www.energimyndigheten.se/en/sustainability/sustainable-fuels/greenhouse-gas-reduction-mandate/>

#### Local authority powers and duties in the transport sector

Most municipalities will have mobility plan, in some cases this work can be connected to the law of local energy planning. Sweden's greatest challenge is to reduce greenhouse gas emission in transport sector, agriculture, and basic industry. Comprehensive land use planning can help influence transport sector's emission by reducing distances between home and workplaces, community services, leisure facilities and others so that people can choose to walk, cycle or commute through public transport instead of taking car, since personal car have significant impact on climate. Through land use planning municipalities has tools to control availability of parking spaces, speed limits, prioritization for pedestrian and bicycle traffic, development of efficient public transport and such that can impact the overall emission from this sector.

#### References to sources:

5. <https://ext-geoportal.lansstyrelsen.se/arcgis/apps/storymaps/collections/759463f685a442e48af78ff8e1e51d58?item=8>
6. [https://www.boverket.se/sv/PBL-kunskapsbanken/planering/oversiktsplan/allmanna-intressen/hansyn/miljo\\_klimat/klimatpaverkan/](https://www.boverket.se/sv/PBL-kunskapsbanken/planering/oversiktsplan/allmanna-intressen/hansyn/miljo_klimat/klimatpaverkan/)

7. [https://www.boverket.se/sv/PBL-kunskapsbanken/planering/oversiktsplan/allmannaintressen/hansyn/miljo\\_klimat/klimatpaverkan/transport/](https://www.boverket.se/sv/PBL-kunskapsbanken/planering/oversiktsplan/allmannaintressen/hansyn/miljo_klimat/klimatpaverkan/transport/)

## Other emission sources and mitigation measures

Greenhouse gas emissions and air pollution in municipalities are formed not only from the energy production, buildings and transport sectors, which were discussed above. Other sources are, for example, waste management, the agricultural sector, the industrial sector, forestry and fisheries. Depending on the specifics of each country, these sectors may be higher or lower than the EU average level and, accordingly, have an impact on the greenhouse gases emissions balance. The capture of CO<sub>2</sub> emissions in soils and biomass must also be considered. Please briefly describe the main trends in each of the sectors to give a general overview.

### Waste management sector

Sweden has introduced national instruments aimed at waste emission reduction. A tax of 25 EUR per ton was introduced in 2000 on landfill waster and gradually increased to 55 EUR in 2019. Under ordinance (SFS 2001:512) a ban was imposed on landfill combustible material in 2002 and on organic material in 2005. This ordinance also regulates collection and disposal of methane gas from landfills. Extended producer responsibility promotes sorting, collection and recycling of certain waste products and incentivizes producer to create resource-efficient products for reducing waste, facilitate easier recycle and reduce consumption of hazardous substances. All municipalities in Sweden are required to have their own waste management plan and EPA regulation (NFS 2006:6) provides minimum requirements for waste plan such as description of current situation, recycling plants and landfills, environment assessment, measures, and monitoring. Recycling in Sweden is rather high and in 2020, waste recycling was done for 449 kilos per person per year, 54% of waste was turned in energy, 86% of PET bottles and 87% of aluminum cans were recycled through deposit return system, and 61% of all packaging materials were recycled. Sweden aims to reduce food waste at least by 20% compared between 2020 and 2025. However, Sweden aims to reach to zero waste and is moving from recycling to reusing wherever applicable. The target is to increase reuse of products by 55% by weight until 2025 and increase it further to 60% by 2030 and 65% by 2035.

References to sources:

1. <https://www.naturvardsverket.se/contentassets/caf14fb0008a41d29b9d51228f874fcb/report-sweden-march-2021.pdf>
2. <https://sweden.se/climate/sustainability/swedish-recycling-and-beyond>
3. <https://www.naturvardsverket.se/en/topics/waste>

### Industry sector

In 2018, Sweden implemented a long-term reform measure through “The Industrial Leap” scheme which is an investment program. It is planned to continue until 2040. Through this scheme, support is provided

for technological and process developments for reducing GHG emission in the industry sector. Financial support is provided for research, pilot, and feasibility studies as well as for full-scale investment for mitigation of GHG emission. One such example is HYBRIT, “Hydrogen Breakthrough Iron-making Technology” that aims to replace coal usage in steel making plants with hydrogen fuel. The plan is also to produce hydrogen using fossil free electricity and expected gains is 10% reduction of emission in Sweden. In 2021 another company called H2 Green Steel, also started a project in Northern Sweden for production of green steel with the aim to reduce 95% of CO2 emission from steel production by replacing coal with green energy solutions. Such development projects will have significant demand on electricity supply with an estimated increased requirement of 100 TWh of electricity per annum. Energy audits are carried out in large enterprises under SFS 2014:226, aimed at promoting and increasing energy efficiency. This audit must be done every fourth year and the organization who has conducted this audit are also eligible to receive further assistance for energy efficiency through the Energy Step Program. Advisory services are also provided to small and medium-sized enterprises aimed at increasing energy efficiency, solutions for cost-effective measures, increase competitiveness and generating new opportunities. Regulation 2016:1128 in Sweden complements EU regulation on fluorinated gases. This regulation imposes requirements for leak checks, periodic inspection, notification to supervisory authority about equipment containing more than 10 KG of refrigerants, restrictions on the sale of f-gases and others. Total emission from industrial sector amounted to 7.9 million tons of CO2 equivalent in 2019 and this is aimed to be reduced to 22% below the levels of 1990 by 2040. This decrease is expected due to reduction in hydrofluorocarbons (HFC) and perfluorocarbons (PFC). CO2 emission is also expected to decrease due to transition towards fossil-free technology in iron and steel industries. However, CO2 emission is expected to rise in mineral industry until 2040 compared to 1990, due to increased construction of new buildings. Emission from chemical industry is expected to remain same as compared to 2019 levels. The total projected estimates for emission reductions between 1990-2030 is -20% and -22% by 2040.

#### References to sources:

1. <https://www.naturvardsverket.se/contentassets/caf14fb0008a41d29b9d51228f874fcb/report-sweden-march-2021.pdf>
2. <https://energikontornorr.se/kartlaggning-norrbottnens-framtida-elbehov/>
3. <https://www.h2greensteel.com/about-us>
4. <https://www.iva.se/publicerat/iva-fokuserar-pa-jakten-pa-det-grona-stalet/>

#### Forestry & Fisheries

Swedish forest-based industry contributes significantly to Swedish economy. As reported in 2022, 10% of Sweden’s goods export is of forest-based products, while goods import contributes 3% creating a positive net trade balance for Sweden. It has also generated about 70k jobs and including subcontractors this number rises to 115k. Swedish Forest Industry reported that forest sector in Sweden has contributed to reducing on an average 94 MtCO2 through direct and indirect measures. Carbon sink created through increasing timber volume contributed to 46 MtCO2e/yr, while replacing fossil fuel based product by products from forest contributed to 52 MtCO2e/yr. Through sustainable forest management, Swedish forest land has grown twice as much as compared to 100 years ago. At least two new trees are planted for every tree that is harvested every year about 380 million trees are planted in Sweden. 70% of area in

Sweden is covered in forest, with 120 million cubic meters of forest growth every year, while only 1% of forest is harvested annually. In fishery sector, Sweden produced around 0.2 million tons of fish in 2018, however, the quantity produced decreased by 4% as compared to 2008. Sweden adheres to SDG14 to end overfishing by 2020 and regulate fishing activities based on science. The top 5 Swedish fish species are within Total Allowable Catches (TAC) limits. In 2018 Swedish government and companies in the fisheries sector. Fish stocks are regularly assessed, and limits are set to ensure sustainable fisheries management. Policies are also in place to fight against illegal, unreported and unregulated (IUU) fishing.

References to sources:

1. <https://www.forestindustries.se/siteassets/dokument/fakta-nyckeltal/fact-and-key-figures-2022-.pdf>
2. [https://www.oecd.org/agriculture/topics/fisheries-and-aquaculture/documents/report\\_cn\\_fish\\_swe.pdf](https://www.oecd.org/agriculture/topics/fisheries-and-aquaculture/documents/report_cn_fish_swe.pdf)
3. Add source here

## CO<sub>2</sub> sequestration

Sweden has incorporated demand of KP-LULUCF into Swedish national system. KP-LULUCF Inventory reporting is done on several categories through Forest management, Afforestation/Reforestation, Deforestation and Harvested wood products. All land areas are inventoried except high mountains, military impediments, and urban land as significance of these are considered relatively small compared to the other areas. LULUCF contributes to total net removal of 40 Mt CO<sub>2</sub>-eq. in 2020. Sweden also invests in tools for Carbon Capture and Storage (CCS) to reach to climate goals. Carbon is separated from other gases and then compressed to change its state to liquid which is then transported through pipelines to its permanent storage location which are located hundreds to thousands of meters below the sea bed.

References to sources:

1. [https://unfccc.int/documents/461776?gclid=EAlaIqobChMI6ffO0djj\\_gIVnAWiAx0iWgTyEAAAYASA AEgIlevD\\_BwE](https://unfccc.int/documents/461776?gclid=EAlaIqobChMI6ffO0djj_gIVnAWiAx0iWgTyEAAAYASA AEgIlevD_BwE)
2. <https://www.energimyndigheten.se/en/sustainability/carbon-capture-and-storage/>
3. Add source here

## General modelling assumptions

### Macro-economic indicators

#### Population projections

	2025	2030	2035	2040	2045	2050
Population		10.92		11.32		11.84

#### GDP projections

	2025	2030	2035	2040	2045	2050

GDP, billion EUR		550		700		800
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References to sources:

1. [https://www.scb.se/contentassets/e99a33e517a343488cd1fd73362167c8/be0401\\_2023i70\\_br\\_be51br2302.pdf](https://www.scb.se/contentassets/e99a33e517a343488cd1fd73362167c8/be0401_2023i70_br_be51br2302.pdf)
2. <https://www.regeringen.se/contentassets/f5552245cfac4ac2bd57f6aee30458d0/sveriges-ekonomi--scenarier-fram-till-ar-2060-sou-2015106>
3. Add source here

Average energy and fuel prices

Year	2010	2012	2014	2016	2018	2020	2022
Electricity, EUR/MWh	54.25	28.19	28.78	27.28	45.78	22.10	137.87
Diesel, EUR/l	124	148	142	128	155	145	244
Gasoline, EUR/l	130	150	143	132	154	142	205
Biofuel, EUR/l	85	103	95	110	108	121	175
Natural gas, EUR/kg							
Biomethane, EUR/kg	117	137	153	163	187	177	275
Hydrogen, EUR/kg							
LPG, EUR/l							
Wood logs, EUR/t	200				300		1000
Wood chips, EUR/t	197	209	192	181	189	199	208
Wood pellets, EUR/t	200	200	200	200			
Coal, EUR/t							

References to sources:

1. <https://www.circlek.se/drivmedel/drivmedelspriser>
2. Add source here
3. Add source here



## Emission factors

National electricity emission factor: [In 2021 10gCO<sub>2</sub>/KWh](#) tCO<sub>2</sub>/MWh

Nordic electricity emission factor: 90gCO<sub>2</sub>/KWh

### References to sources:

1. <https://www.statista.com/statistics/1290491/carbon-intensity-power-sector-sweden/#:~:text=In%202021%2C%20Sweden's%20power%20sector,levels%20reached%2037%20gCO%E2%82%82%2FKWh>.
2. <https://www.naturvardsverket.se/contentassets/9db319015c994a9d88f64ffae725765/vagledning-berakna-utslappsminskning-2022-05-06.pdf>
3. Add source here