

THE ENERC

IN SWEDEN

OR

**Flanders** State of the Art



# THE ENERGY SECTOR IN SWEDEN

# Introduction to the market March 2020



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# 1. INTRODUCTION

Sweden's energy sector is known to be very green. It is one of the only countries in the world that has a high energy consumption, but also low carbon emissions. Already 54% of all the energy produced comes from renewable energy sources. The country mainly depends on hydropower and bioenergy to maintain its reputation of being climate friendly.

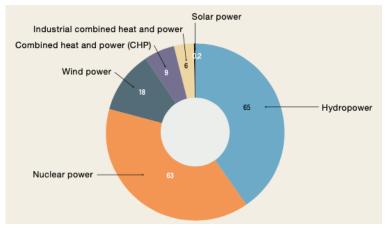
The progress of Sweden is partly thanks to the support of the government that is helping with the search for alternatives by investing huge amounts of money. Sweden is already an example for the world, and it is heading towards an even greener future (Sweden.se, 2019).



# 2. THE SWEDISH ENERGY MARKET

Sweden gets 80% of its electricity from nuclear, hydroelectric power and a growing share of

wind power. This last option is due to its massive supply of moving water. Nuclear power was chosen due to its relatively low carbon emission, although the political opinions are divided about the future use of nuclear power. At this moment Sweden is phasing out the use of nuclear power. From 2020, Sweden will have 3 nuclear plants with 6 operating nuclear reactors providing 40% of the country's electricity (World Nuclear Association, 2019).



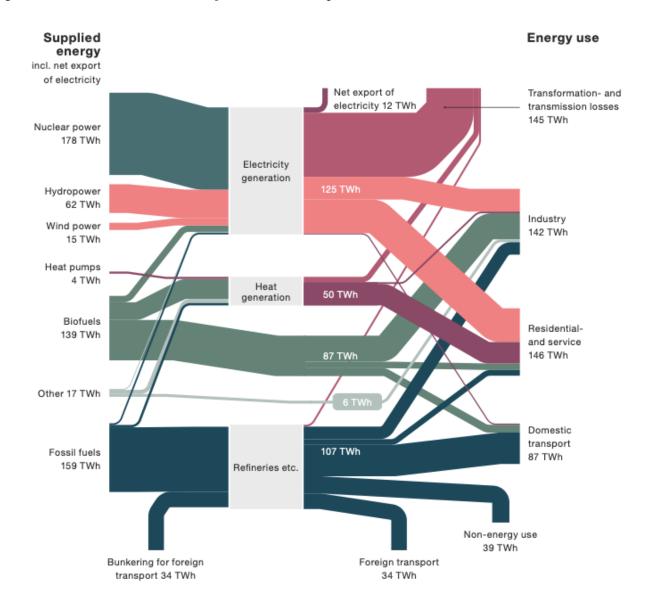
Hydropower and bioenergy are currently the dominating renewable sources that the country is relying on. Sweden can therefore count on its rich supply of fast-moving water and biomass to provide the renewable energy. Hydropower is especially used to generate electricity and bioenergy is primarily used for heating (Sweden.se, 2019).

54% of its total energy consumption is currently coming from renewable sources. In 2012, they already had met the 2020 goal by surpassing 50% energy use from renewable sources. A great example of how Sweden is running ahead in the energy sector.

Sweden has one of the highest energy per capita consumptions in the world according to the International Energy Agency (IEA). In 2017, Sweden's average was remarkably higher than that of the world and Europe. On the other hand, it has also one of the lowest carbon emissions of the world. This can be explained by looking at the sources of electricity. 80% is coming from nuclear and hydroelectric power, 11% from wind power and 9% from combined heat and power plants which are powered by biofuels (Sweden.se, 2019).

The final energy use in Sweden can be divided in three main consumers. The main consumer is the residential and the service sector, being households that consume electricity and heating. The second largest consumer is the industrial sector by using huge amounts of electricity and biofuels. The third largest consumer is the transportation sector. They mainly use petroleum product such as gasoline and diesel, although the use of biofuels is increasing (The Swedish Energy Agency, 2019).

The transportation sector in Sweden – as mentioned above - is a sector that requires some more attention if Sweden wants to obtain its long-term targets. At this moment, the transportation sector accounts for a little less than a quarter of Sweden's energy consumption. Although, it is also responsible for over half of its energy-related  $CO_2$  emissions. This can be explained by looking at the picture below where it is clear that the transportation sector is heavily relying on fossil fuels instead of on renewable energy sources (The Swedish Energy Agency, 2019). Sweden has set a goal to reduce 70% of its transport emissions by 2030.



# **3. DIFFERENT TYPES OF RENEWABLE SOURCES**

One of the reasons of Sweden's advancements is the use of a lot of different kinds of renewable resources. The country is therefore primarily counting on its widely spread nature. The following is a list of the different resources Sweden is relying on.

### 3.1 HYDROPOWER

Hydropower is making use of the power of flowing water to generate energy, usually electricity. The energy can come from falling water because of the difference in height – by using a dam – or from the power of fast-running water (Muise, sd).



The main application – electricity - is the top renewable resource Sweden is using. For this, the country can count on the rich supply of moving water. Nuclear power and hydropower are together responsible for around 80% of the electricity generated in Sweden where hydropower has a share of 45%. The main advantage is the fact that hydropower is inexhaustible. nearly Flowing water in rivers and lakes will keep

flowing, making this a source that's been used for decades already and will be used for upcoming centuries. Electricity generation depends on the weather conditions during that year, especially the amount of rain or snow. Altogether, it still gives Sweden security on their electricity supply for the upcoming years.

### 3.2 **BIOENERGY**

Bioenergy is a type of energy that is extracted from materials that come from biological sources, called biomass. Most biomass is coming from wood, followed by agricultural biomass, and the top three is closed by biowaste. It is commonly used – in order of importance – for heating, electricity, and transport fuel (Bioenergy Europe).

Sweden can count on its 63% of land that is covered in forests to get biomass, the main resource to generate bioenergy. It is together with hydropower the top renewable resource in Sweden. The bioenergy is primarily used for heating, to provide households as well for industrial purposes. 56% of the final energy use in the industrial sector comes from biofuels. In the transport sector

this percentage accounts for 19%. Yet, this is a remarkable increase compared to previous years. The residential and services sector has 14% of its final energy use coming from biofuels.

### 3.3 NUCLEAR POWER

Nuclear energy is the process of generating electricity by splitting atoms. During this process, water is heated into steam. This steam activates a turbine, resulting in generating electricity. Using uranium instead of fossil fuels makes nuclear power an energy source that has a low carbon footprint as during the whole process, a small amount of carbon emissions are emitted (Nuclear Energy Institute, sd).

Yet, nuclear power is a topic that is subject to divided opinions in Sweden. On one hand it is an environmentally friendly option because of the low carbon footprint. This is an important advantage to some Swedish political parties. On the other hand, managing uranium is a very delicate process that involves a lot of risks. One accident can have disastrous consequences. This argument is causing opposition from other political parties.

Sweden is phasing out the use of nuclear power. To accomplish this, Sweden once implemented a tax against nuclear energy to discourage the use of nuclear power. However, this tax was withdrawn in 2019 (World Nuclear Association, 2019). The phasing out of nuclear power brings uncertainty to some as there needs to maintain stability in electricity supply while new renewable sources are replacing the nuclear power. From 2020, Sweden will have 3 nuclear power plants with 6 operating nuclear reactors. Most of these plants are located near the sea to use the sea water for cooling.

### 3.4 SOLAR POWER

Solar power is using the sun to generate electric or thermal energy. The most common application is the use of solar panels to generate electricity. It can be used for industrial or residential purposes (Solar, sd).

The Swedish government is doing a lot of efforts on the development and improvement of solar power. They're doing this by means of funding, investment support, and investments in innovation and research regarding solar power (Sweden.se, 2019).



Solar power use in Sweden is increasing each year, but it's still only providing a very small portion of the yearly generated electricity. Sweden has 2 advantages for its use of solar panels. The first is its more extensive rainfall to clean the solar panels so that no dirt and dust can cover the panels. The second is the fact that solar panels produce more electricity at lower temperatures, which turns out better for Sweden (Byman, 2016).

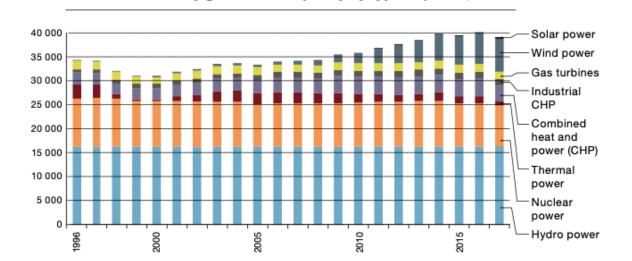
### 3.5 WIND POWER

Wind power uses, as stated in the name, wind as primary source to drive turbines which generate electricity or perform other tasks like milling for example (Wikipedia, 2020). It is also a renewable source without carbon emissions, at least when operative. The installation on the other hand requires heavy, polluting machinery and the use of land and other resources. When in operation, windmills also cause disturbance to humans, animals, and the environment that are in close proximity of the turbines.

Sweden has a yearly increasing share of wind power. This is mainly caused by Sweden's goal to have a 100% renewable electricity production by 2040. The conditions in Sweden are ideal to generate electricity from wind power with their long coastline and high annual average wind speeds. Although, potential for wind power in the north his high, the cold weather opposes new challenges with ice and snow being the most important ones. Sweden has around 3,600 wind turbines producing 18 TWh, or 11% of the nation's electricity (The Swedish Energy Agency, 2019).

Below is a chart that show the electricity generation. It is clear to see how the share of wind power is rapidly increasing.

Installed electricity generation capacity by type of power, MW



### 3.6 OTHER SOURCES

#### 3.6.1 Wave power

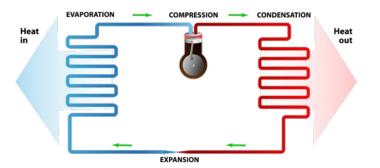
Wave power is extracting energy out of waves crashing into a device called a wave energy converter (WEC) to generate electricity (Wikipedia, 2020).

This technology is still undeveloped in the world, but it offers great possibilities. Sweden is involved in this development with the Lysekil Project. It's a project set up by the Upssala University with the purpose of evaluating the concept of wave power. They're testing and optimizing different models and options to get the most out of the system (Wikipedia, 2019).

Seabased is a company that has performed several tests in the Swedish coast. In 2009 there was a project to test generators and in 2015 there was the start of a second test where they installed the first wave park that actually supplied electricity to the Nordic power grid (Seabased, sd).

#### 3.6.2 Heat pumps

A heat pump absorbs heat energy from one place, such as the ground or the air, and transfers it to another (Sweden.se, 2019).



Sweden is a leader when it comes to heat pumps per capita. In 2018, the total number of heat pumps reached 1,7 million. The heat pumps are used in all kinds of building going from residential, to hospitals, to universities, etc. This number resulted in less energy being used for heating all across Sweden (Heat pumping technologies, 2018).

#### 3.6.3 Body heat

Using body heat as an energy source: a thermoelectric device is using the difference in temperature between its two sides to generate electricity (Ozcanli, 2010).

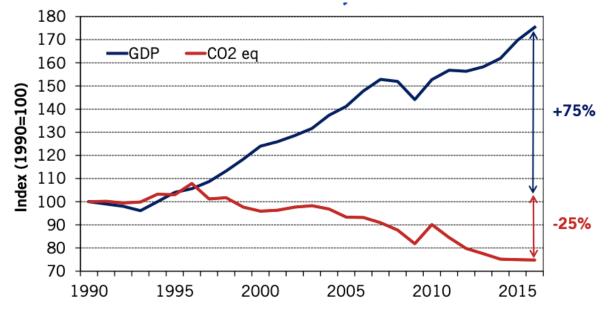
Sweden has implemented this concept by using passive houses. These are buildings that are far more energy-aware by consuming less energy. This is achieved by making sure the building is insulated in a proper way. Furthermore, the buildings are known to use energy sources inside the building like body heat (cblagojevic, 2019). Sweden has a few of these passive buildings.

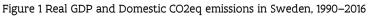
Another application of body heat can be found in Stockholm. In the Central Station, body heat from commuters is used to heat a nearby building (Sweden.se, 2019).

# 4. ROLE OF THE GOVERNMENT

*"In its energy market policy, the government aims to promote efficient and competitive markets that ensure a reliable energy supply at internationally competitive prices* (Sweden, 2020)."

Being a world leader in using renewable resources is achieved with the help of the government who has offered a lot of help, such as investments and funding, in this domain (as mentioned in previous topics). Sweden is one of the countries that shows that it's possible to have environmental taxes and still achieving economic growth and welfare. The picture below shows an increase in GDP from 1990 until 2016 while also having a decrease in  $CO_2$  emissions.

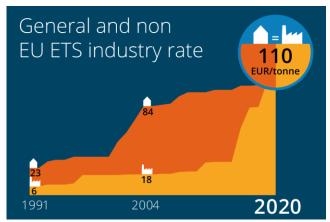




Below is a list of government initiatives that promote the use of renewable sources.

### 4.1 CARBON TAXATION

Sweden was one of the first countries to implement the carbon tax in 1991 and has the highest rate in the world. This measure contributes to the energy transition Sweden is working on to meet its ambitious long-term targets as well as the Paris agreements conditions. Levying a carbon tax results in extra revenues for the government to spend on climate enhancing measures. The tax money can for example be used to grant subsidies to companies



using green energy sources. Sweden's approach over the years have made them successful in levying the carbon tax. By gradually increasing the tax rate, households and companies had the time to adapt. The current tax rate is SEK 1,190 (approximately EUR 110) per ton fossil carbon dioxide emitted. Sweden encourages every state to levy the carbon tax as it is easy to manage, implement, and it has a lot of advantages (Government offices of Sweden, 2020):

- There are low administration costs
- -Set a price according to Polluters Pay Principle
- Extra revenues to spend on climate enhancing measures
- Helps obtain national targets and targets set by the Paris Agreements -

### 4.2 GREEN ELECTRICITY CERTIFICATION

One of the ways the Swedish government promotes the use of green energy sources is by giving green electricity certifications. This is given to electricity retailers that buy a proportion of electricity that comes from a renewable source as part of their normal supply. The certificates are also awarded to power producers that generate electricity coming from a renewable source. The certificates are linked to a quota obligation which means that the electricity supplier holds certificates corresponding to the electricity production of the previous year. Power producers can on their turn sell these certificates to generate extra income which is stimulating to invest more in renewable electricity production. (Sweden.se, 2019).

The system was implemented in 2003 and replaced the previous use of grants and subsidies. From 2012, Sweden collaborated with Norway to join a common electricity certificate market. In 2017, the Swedish parliament set a new target for 2030 to increase the electricity production from renewable sources by 18 TWh (Swedish Energy Agency, 2017).

### 4.3 THE SWEDISH ENERGY AGENCY



**Swedish Energy Agency** regulated by the Swedish government which also decides on the tasks and budget. It is a subordinate of the Ministry of Infrastructure. The Swedish energy agency is an organization

Their main task is leading the energy transition in Sweden to make it a fossil-free and sustainable country. The Agency also provides funding to different causes that stimulate the transition. Thirdly, they issue the annual report with the official statistics regarding energy. Lastly, the Swedish energy agency manages important instruments such as the Electricity Certificate System and the EU Emission Trading System (Swedish Energy Agency, 2020).

# 5. LONG TERM GOALS

Sweden has set ambitious climate goals to achieve in the next decades. The ultimate goal and ideology to pursue is to reduce emissions in the most effective, cost-efficient way. The country's electricity generation is already largely decarbonized due the access and use of nuclear power, hydropower, and many other renewable energy sources. Also heating has a low carbon footprint by using bioenergy and heat pumps. There are three important goals they want to achieve in the long run. The first is having a zero-carbon economy by 2045. The second goal is achieving the target of using 100% renewable energy sources for the generation of its electricity. The last goal is reducing the emissions in the transport sector by 75% between 2010 and 2030.

Other goals set by Sweden include reducing greenhouse gas emissions and a more efficient energy use. The EU has set goals as well for its member states. These are roughly in line with the goals Sweden has set for itself.

# 6. LIST OF ENERGY-RELATED COMPANIES

Company name	Description	Specialization
Vattenfall AB https://www.vattenfall.se/english/	Swedish state-owned energy producer, leader in Scandinavia	Electricity Heating
Fortum www.fortum.se	Finnish energy supplier with major presence in Sweden	Electricity from hydropower
E.ON www.eon.se	Energy supplier	Electricity
AB Vindkraft http://www.vindkraft.com/	Contractor for wind power plant construction	Wind power
InnoVentum https://www.innoventum.se/	Company focused on the installation of renewable energy solution	Wind power Solar power
S-Solar AB http://www.ssolar.com/	Swedish company specialized in solar power applications	Solar power
Soltech Energy https://soltechenergy.com/	Supplier of energy and solar solutions	Solar power
Svebio https://www.svebio.se/en/	Swedish bioenergy association	Bioenergy
Swedenergy https://www.energiforetagen.se/	Swedish energy organisation	Energy

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