



Brussels, 23.11.2017
SWD(2017) 411 final

COMMISSION STAFF WORKING DOCUMENT

Energy Union Factsheet Sweden

Accompanying the document

**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE, THE COMMITTEE OF THE REGIONS AND THE EUROPEAN
INVESTMENT BANK**

Third Report on the State of the Energy Union

{COM(2017) 688 final} - {SWD(2017) 384 final} - {SWD(2017) 385 final} -
{SWD(2017) 386 final} - {SWD(2017) 387 final} - {SWD(2017) 388 final} -
{SWD(2017) 389 final} - {SWD(2017) 390 final} - {SWD(2017) 391 final} -
{SWD(2017) 392 final} - {SWD(2017) 393 final} - {SWD(2017) 394 final} -
{SWD(2017) 395 final} - {SWD(2017) 396 final} - {SWD(2017) 397 final} -
{SWD(2017) 398 final} - {SWD(2017) 399 final} - {SWD(2017) 401 final} -
{SWD(2017) 402 final} - {SWD(2017) 404 final} - {SWD(2017) 405 final} -
{SWD(2017) 406 final} - {SWD(2017) 407 final} - {SWD(2017) 408 final} -
{SWD(2017) 409 final} - {SWD(2017) 412 final} - {SWD(2017) 413 final} -
{SWD(2017) 414 final}

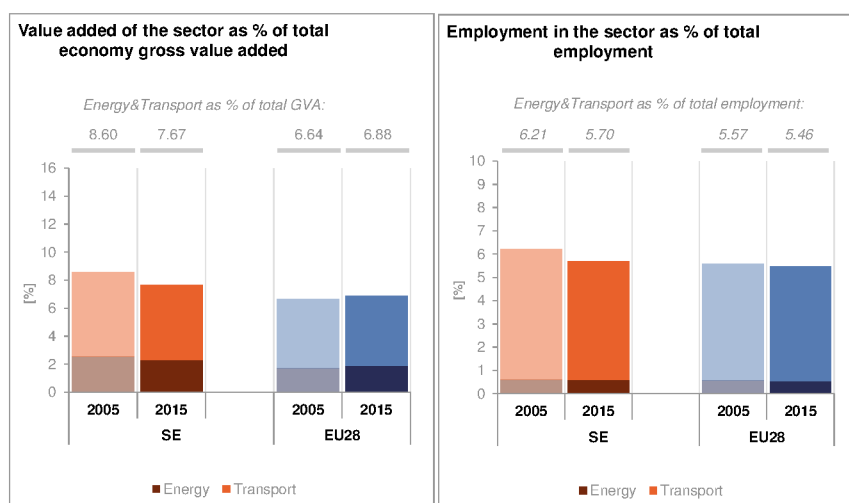


Sweden

Energy Union factsheet¹

1. Macro-economic implications of energy activities

Energy and transport are key sectors for the overall functioning of the economy as they provide an important input and service to the other sectors of the economy. Together the activity in these two sectors² accounted for 7.7% of Sweden's total value added in 2015. Their share in total employment³ was 5.7% in 2015, of which 5.1% in the transport and 0.6% in the energy sector.



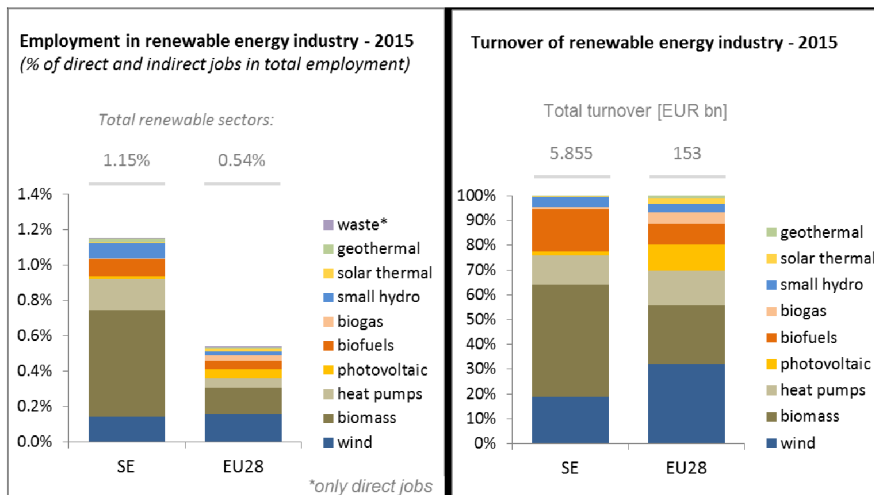
(source: Eurostat)

According to EurObserv'ER, in 2015, the share of direct and indirect renewable energy related employment in total employment of the economy in Sweden was at about 1.15%, above the EU average of 0.54%. The turnover of the renewable energy industry in the same year was estimated at around EUR 5.9 billion, the biggest part being attributed to the biomass (EUR 2.6 billion) followed by wind (EUR 1.1 billion), biofuels (EUR 1.0 billion) and heat pumps (EUR 700 million) industries.

¹ The indicators used in this country factsheet largely build on indicators developed for the Commission Staff Working Document "Monitoring progress towards the Energy Union objectives – key indicators" (SWD(2017) 32 final) https://ec.europa.eu/commission/sites/beta-political/files/swd-energy-union-key-indicators_en.pdf

² Gross value added and employment in NACE sectors D-Electricity, gas, steam and air conditioning supply and H-Transportation and storage

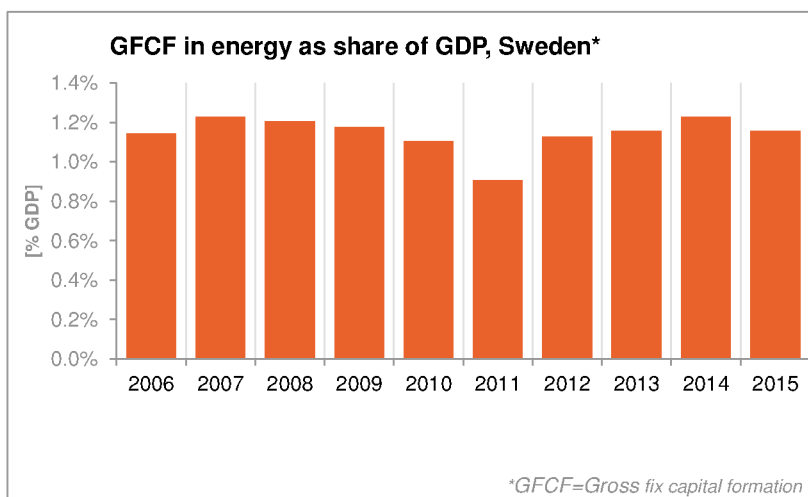
³ National accounts, Eurostat



(source: EC based on Euroserv'Er and Eurostat)

The decarbonisation of the energy and transport sectors will require significant investments and economic activity beyond the remit of these sectors themselves. The energy transition implies a structural shift in economic activity. Energy-related investment and jobs will in part migrate from traditional fossil fuel based activities towards construction, equipment manufacturing and other services related to the deployment of low carbon and clean energy technologies. At the moment, the efforts related to the low-carbon and clean energy transition in sectors beyond energy can only be partially quantified and are therefore not included in this analysis.

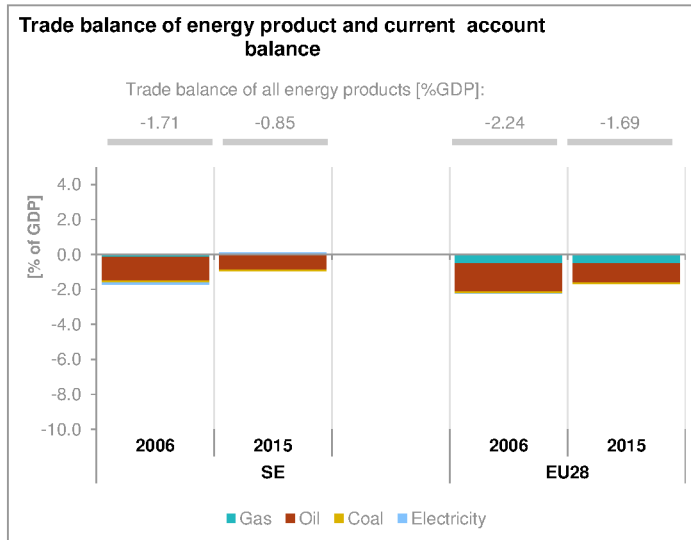
An indication of the level of efforts and challenges encountered by Sweden in the energy sector is provided by the gross fixed capital formation (GFCF)⁴. Investments in the electricity and gas sectors (much higher in electricity than in gas due to the difference in relative importance), which are taken as reference sectors, have overall been relatively stable. However, there was a dip in 2010–2011, but investments have since then recovered and are now at the levels recorded before the pre-crisis period. They represented around 1.15% of the country's GDP in 2015.



⁴ Gross fixed capital formation consists of resident producers' acquisitions, less disposals, of fixed tangible or intangible assets. This covers, in particular, machinery and equipment, vehicles, dwellings and other buildings. It also includes foreign direct investment (FDI). Steam and air conditioning supply are also included in the figures mentioned above as Eurostat reports electricity, gas, steam and air conditioning supply together.

(source: Eurostat)

In terms of trade, Sweden is a net importer of fossil fuels (it has no domestic production), while the trade position in electricity depends on the hydrological conditions that year. A trade deficit was recorded in the electricity trade in 2006, while there was a surplus in 2015. Overall, there is a trade deficit in energy products, which has fallen from about 1.7% of GDP in 2005 to 0.9% in 2015, influenced by the export of electricity, lower fossil fuels prices and decarbonisation and energy efficiency efforts. Gas experienced the largest relative decrease of more than 50%. The trade deficits for both coal and petroleum products have also been significantly reduced, the later from 1.3% of GDP in 2005 to 0.8% of GDP in 2015.

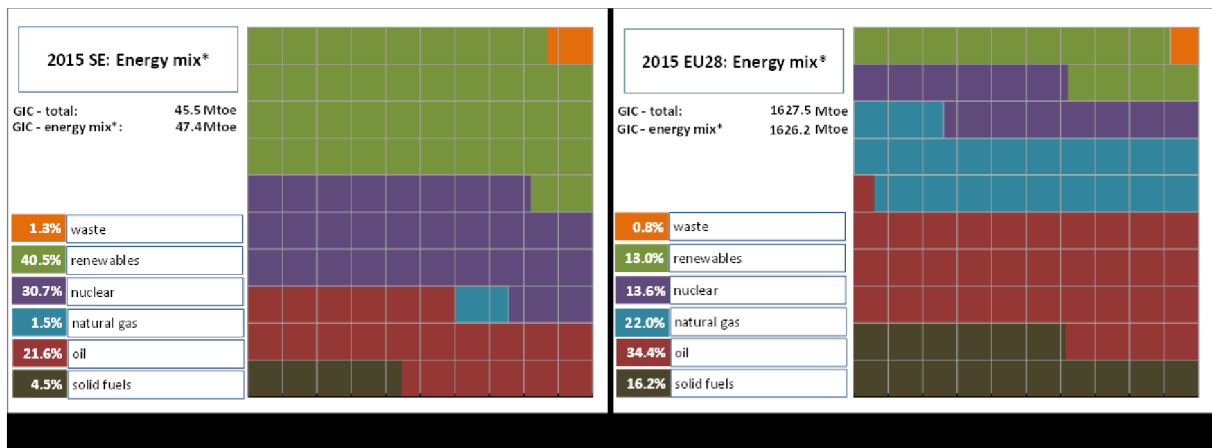


(source: Eurostat)

2. Energy security, solidarity and trust

2.1. Energy Mix

Compared with the EU average, Sweden's energy mix of primary energy products has a much higher share of renewable energy in gross inland consumption (40.5% vs 13%) and nuclear energy (30.7% vs 13.6%) in gross inland consumption. Conversely, natural gas has a much lower importance in Sweden (1.5% vs 22.0%). To a somewhat lesser extent, this applies as well for oil (21.6% vs 34.4%) and solid fuels (4.5% vs 16.2%).



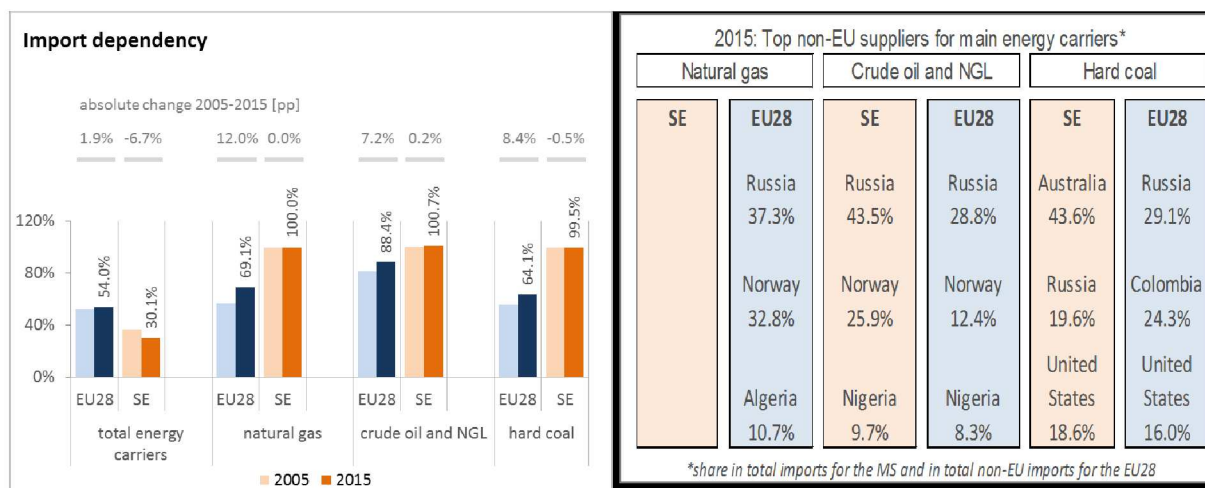
(source: Eurostat)

2.2. Import dependency and security of supply

30% of Sweden's energy consumption is covered by imports, significantly less than the EU average. This is due to the high degree of renewables and nuclear energy in the energy mix, which together accounts for about three quarters of the country's energy needs (measured in gross inland consumption).

The overall import dependency of Sweden demonstrated a decrease of about 7 percentage points (p.p.) between 2005 and 2015, whilst at the EU level, import dependency increased by 1.9 p.p. over the same period.

Sweden imported all natural gas, oil and hard coal needed to meet demand in 2015 due to the lack of domestic fossil fuel resources. All imports of natural gas in Sweden came through Denmark. The associated risk of concentrated supply is partly alleviated by the very low share of natural gas in the country's energy mix. Russia (43.5%) followed by Norway (25.9%) were the dominant suppliers of crude oil. Sweden has significant refining capacity, contributing to net exports of oil products.

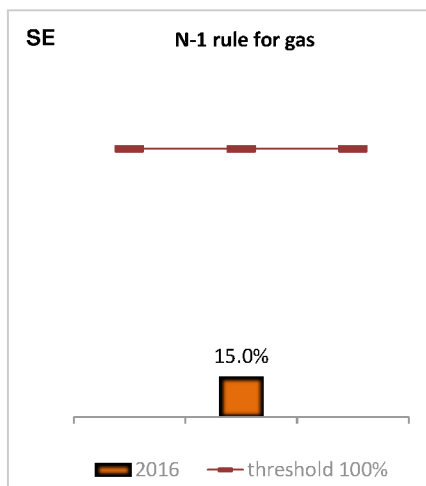


(source: Eurostat)

Imports of uranium and nuclear fuels are not included in Eurostat's energy balances and import dependency can therefore not be illustrated in the same way as for the main fossil fuels. Some nuclear fuel is fabricated in Sweden, but there are also imports from e.g. France and Russia.

The European security of gas supply regulation requires that, if the single largest gas infrastructure fails in one Member State, the capacity of the remaining infrastructure is able to satisfy total gas demand during a day of exceptionally high gas demand. This condition is met if the value of the N-1 indicator is equal to or above 100 %.

Sweden is exempted from this requirement EU28 primarily due to the relatively modest role of natural gas in the energy mix. Yet, gas is important for heat generation and for industrial processes along the south west coast, which makes the system vulnerable in case of a disruption of imports from Denmark. Sweden has only 15% of N-1 capacity, coming from storage resources mostly within the transmission and distribution system itself. Several new LNG terminals are planned, including one in Gothenburg (labelled as a Project of Common Interest) which would contribute to flexibility of the Swedish gas market.

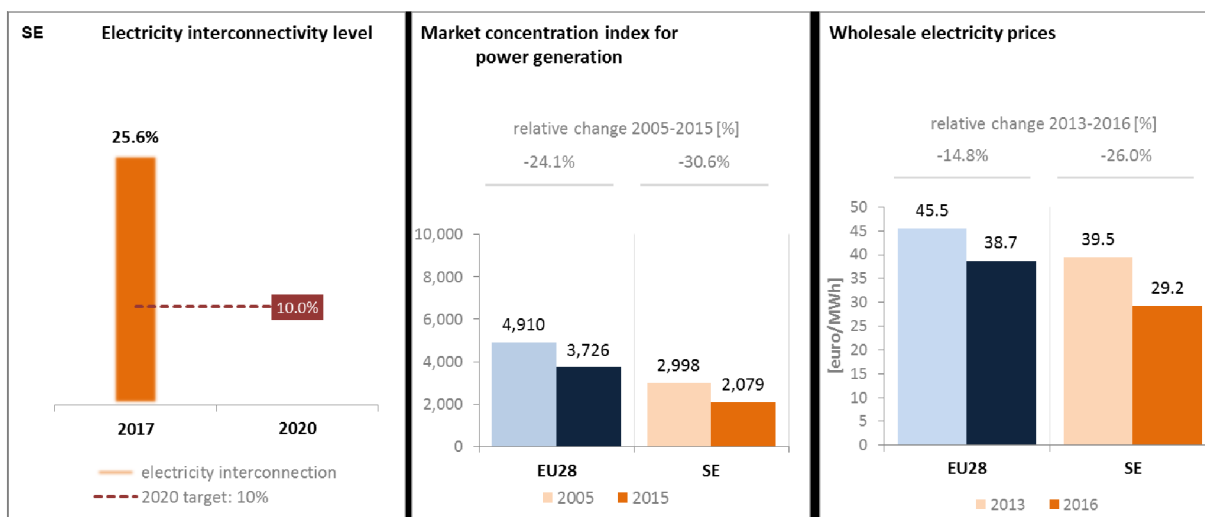


(source: gas coordination group)

3. Internal market

3.1. Interconnections and wholesale market functioning

3.1.1. Electricity



(source: EC services based on ENTSOE)

(source: EC services based on Eurostat)

(source: EC services based on Platts and European power exchanges)

Sweden is a central part of the Nordic and Baltic wholesale electricity market. The Swedish electricity system is directly connected to the Norwegian, Danish, Finnish, German, Lithuanian and Polish systems and indirectly through these to the wider continental Europe and other Baltic States. In 2017, the electricity interconnection level⁵ of Sweden was 25.6%, well above the 2020 target of 10%. The recent commissioning of a DC cable with Lithuania (NordBalt) has added to Sweden's interconnectivity, while rapid expansion of new renewable electricity capacity in Sweden has resulted in a slightly lower share compared to 2014.

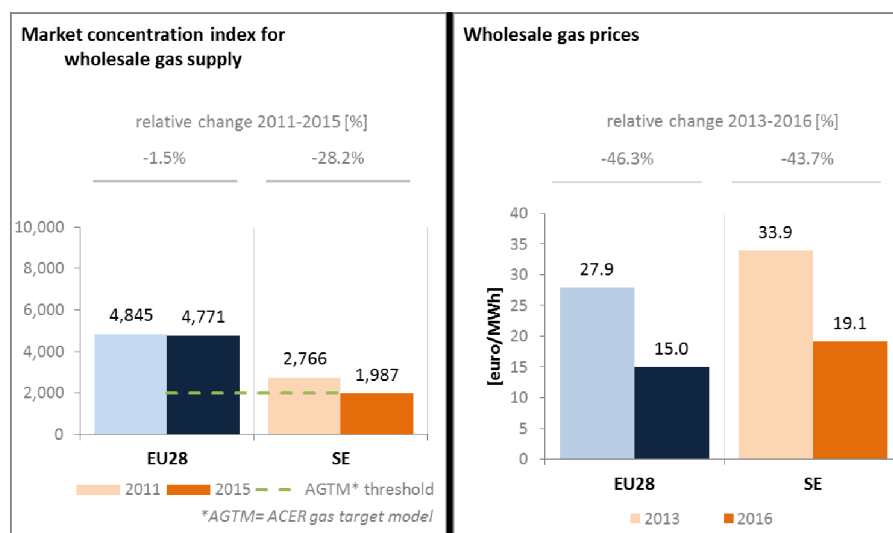
⁵ The interconnectivity level is calculated as a ratio between import interconnection and net generation capacities of the country (i.e. the 2017 value is the ratio between simultaneous import interconnection capacity [GW] and net generating capacity [GW] in the country at 11 January 2017, 19:00 pm as resulted from ENTSO-E Winter Outlook 2016/2017)

There is a recognised need for additional transmission capacity across the border with Finland. Swedish and Finnish Transmission System Operators (Svenska kraftnät and Fingrid) are carrying out a joint study on a possible third AC-line and on the future replacement of the older HVDC-link, Fenno-Skan I between Sweden and Finland. The third AC-line is included in the 2016 ten year national development plan as a long-term project (estimated commissioning in 2025) and has also been discussed in the context of BEMIP.

Concentration of power generation is much below EU average and falling in the 2005 to 2015 perspective. The good electricity connectivity to the Nordic electricity market and other European States together with full liberalisation has led to a very dynamic electricity wholesale market with good competition and comparably low and decreasing wholesale prices. Wholesale electricity prices are among the lowest in the EU, and between 2013 and 2015 recorded a higher decrease than the EU average (almost 44% in Sweden, vs 10.8% in EU). Wholesale electricity prices are impacted by the hydrologic situation due to the importance of hydro power.

3.1.2. Gas

Gas prices are, on the contrary, higher than the EU average despite a relatively low market concentration index. In 2015, Sweden was one of only five Member States that had a concentration index below ACER's gas target model threshold indicating a well-functioning market (the other ones are Belgium, Ireland, Luxembourg and the UK). However, the facts that there is only one supply route and that the market is relatively small impacts gas prices in Sweden. The planned LNG terminal in Gothenburg is expected to contribute, once operational (currently foreseen for 2020), to diversification and add security and dynamism to the Swedish gas market. The terminal has the status of a Project of Common Interest and is part of the Baltic Energy Market Interconnection Plan in gas but has not been granted funding for works by the Connecting Europe Facility.



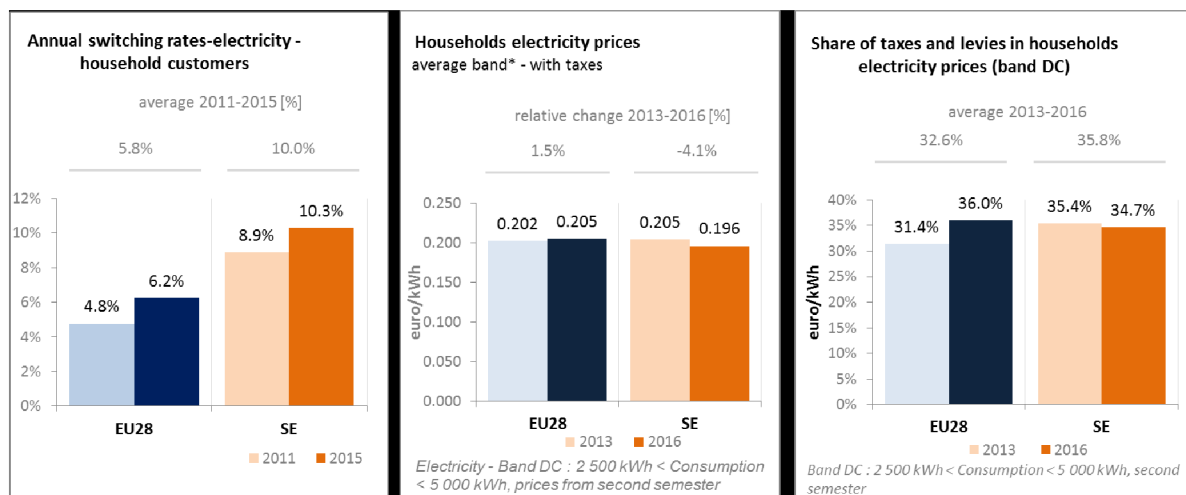
(source: ACER for the left graph and EC services based on Platts, gas hubs, Eurostat for the right graph)

3.2. Retail electricity and gas markets

3.2.1. Electricity

In 2015, households' electricity prices in Sweden were slightly lower than the EU average. Between 2013 and 2016, average retail electricity prices for households decreased, but to a lesser extent than the wholesale prices. This decrease is partially explained by the role of taxes and levies, representing more than a third of average household prices. Sweden has a very high number of nation-wide electricity retail companies and the market is generally speaking competitive.

There is also a widespread deployment of smart meters, and high annual switching rates by consumers from one electricity supplier to another. Swedish consumers are also opting for more innovative offers. 49% of Swedish households had an electricity contract linked to spot market prices in 2016, up from 37% in 2013. This included variable monthly tariffs and dynamic price contracts for consumers with hourly metering. 29% opted for a fixed price contract, while only 13% remained on the default contract.



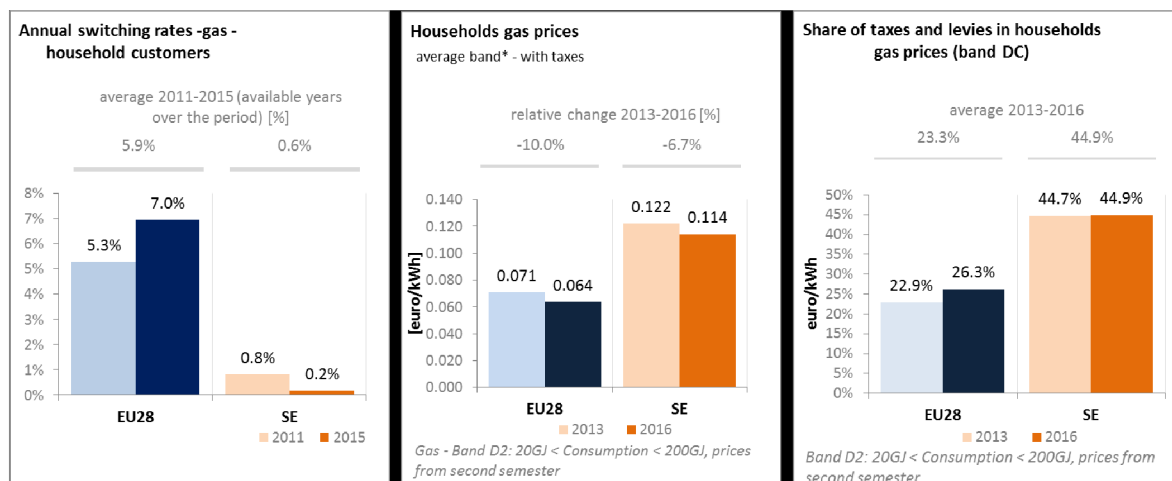
(source: ACER)

(source: Eurostat)

(source: Eurostat)

3.2.2. Gas

Gas represents a negligible share of households' energy consumption. Therefore, household gas retail markets are not yet fully developed. Household prices are significantly above EU average, significantly impacted by taxes which amount to no less than 45% of the final price.



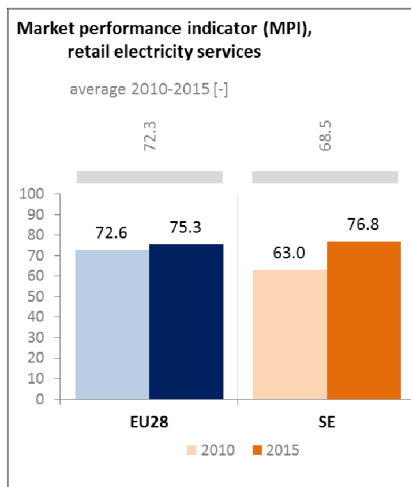
(source: ACER)

(source: Eurostat)

(source: Eurostat)

3.2.3. Market performance indicators

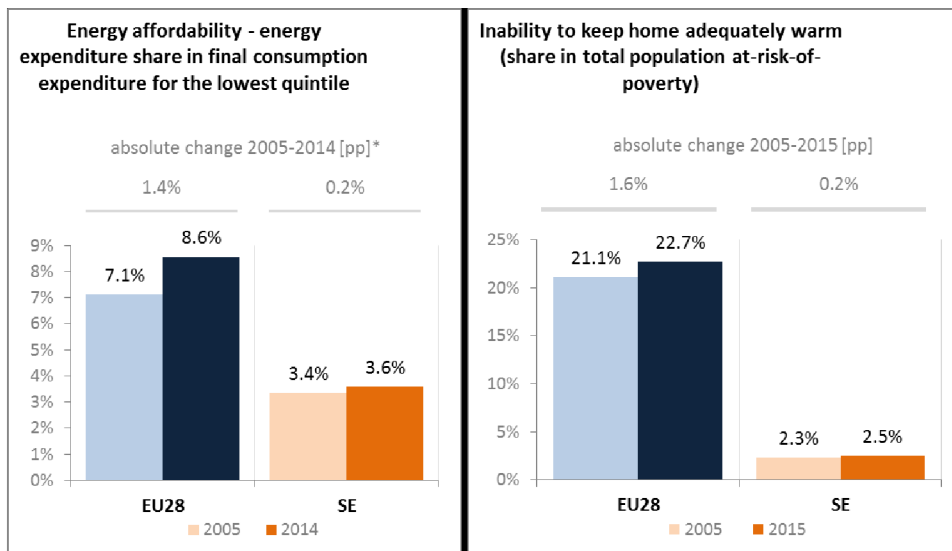
According to the periodical survey of DG JUST, the satisfaction of Swedish electricity consumers is increasing and is slightly above the EU average.



(source: DG JUST survey)

3.3. Energy affordability

In Sweden, the climate conditions imply significant heating needs in comparison to the EU average, but the share of energy in total household expenditures of the quintile of the population with the lowest income is very low. Only a small part (2.5%) of citizens below the at-risk-of poverty threshold considers that they are unable to keep their home adequately warm. This is explained by comparably competitive prices together with higher-than-EU-average disposable income, comparably low spread of disposable income around the national mean, and well-developed social policies.

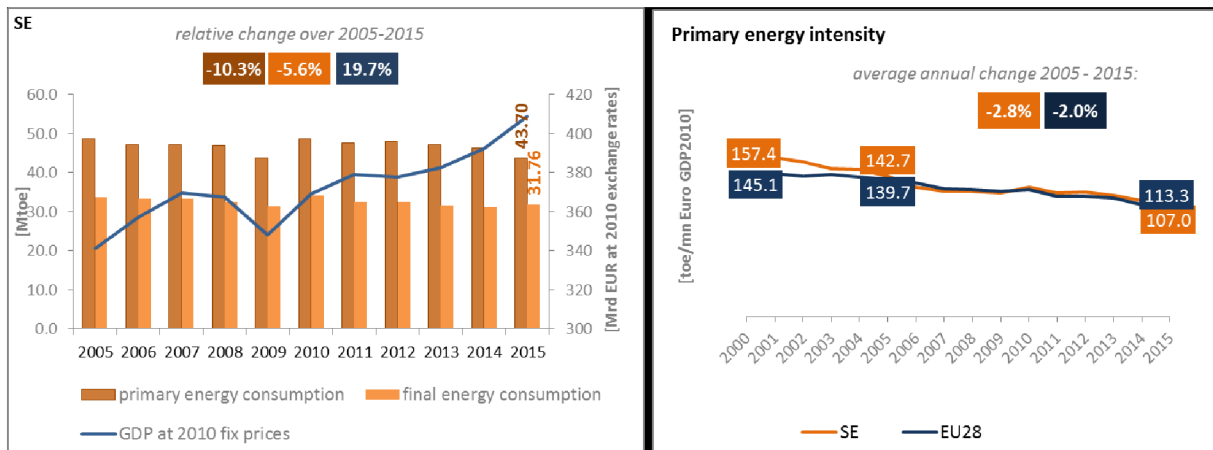


(source: ad-hoc data collection of DG ENER based on HBS with the support of Eurostat and national statistics)

4. Energy efficiency and moderation of demand

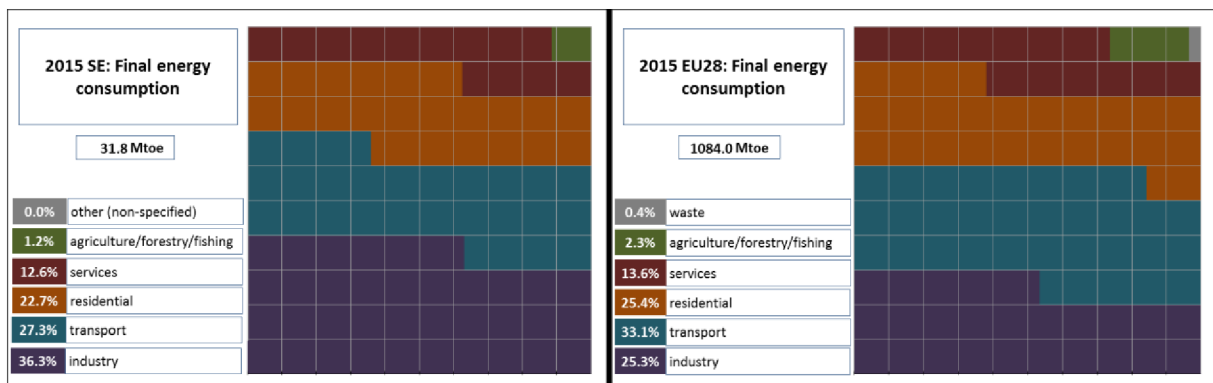
Since 2005, Sweden decreased its primary energy consumption by 10.3% to 44 Mtoe in 2015. Over the same period, final energy consumption decreased by 5.6% to 32 Mtoe in 2015. Sweden has set a 2020 target of 20 % less primary energy intensity (TPES/GDP) 2008–2020.

While the latest available data demonstrated that primary energy consumption, in particular, is decreasing, Sweden has to continue the efforts to reach its targets. Primary energy intensity decreased at an annual rate of 2.8% over the 2005–2015 period, and is below EU average.



(source: Eurostat)

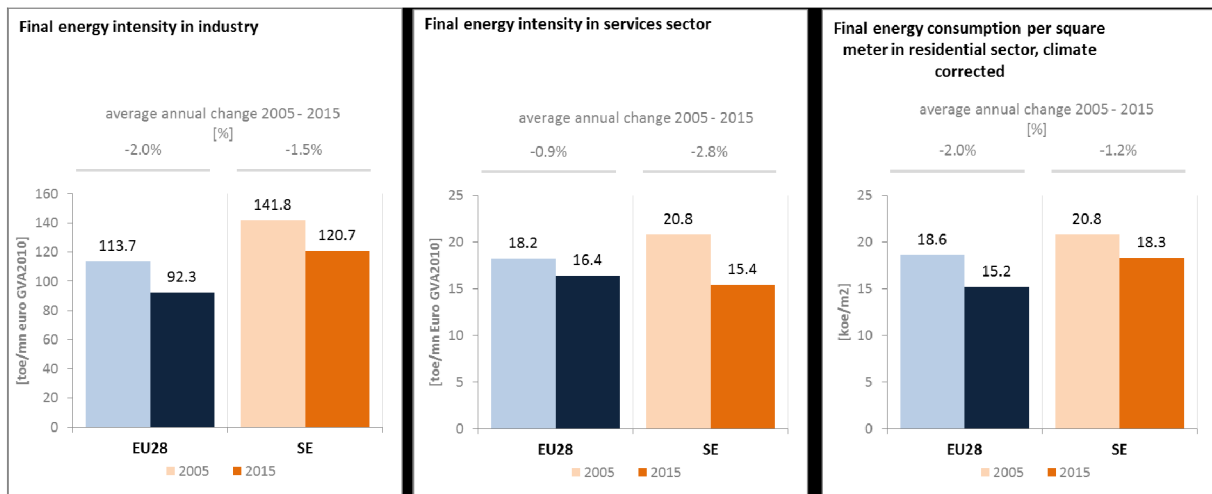
In 2015, industry was the largest energy consuming sector representing 36.3% of total final energy consumption. On contrary, the relative importance of energy consumption in the transport and residential sectors is well below EU average at 27 and 23% respectively.



(source: Eurostat)

The final energy intensity of Sweden's industry is well above EU average, notably due to the strong presence of e.g. steel, pulp and paper industries. Sweden has proposed an energy efficiency programme for the industry sector in the budget bill for 2018. 125 million SEK have been proposed to be allocated over three years. The government has also proposed a separate programme to reduce emissions from the industry sector. It is a long term programme that is planned to allocate, to research, project studies and investments, SEK 300 million per year to 2040.

The residential sector demonstrates energy consumption per square meter well above EU average, even after a correction for climate conditions.⁶ At the same time, Sweden has decreased the use of fossil fuels for heating purposes drastically over the last decades, resulting in very low CO₂ emissions from the building sector. Projections show that CO₂ emissions will be phased out by 2020.

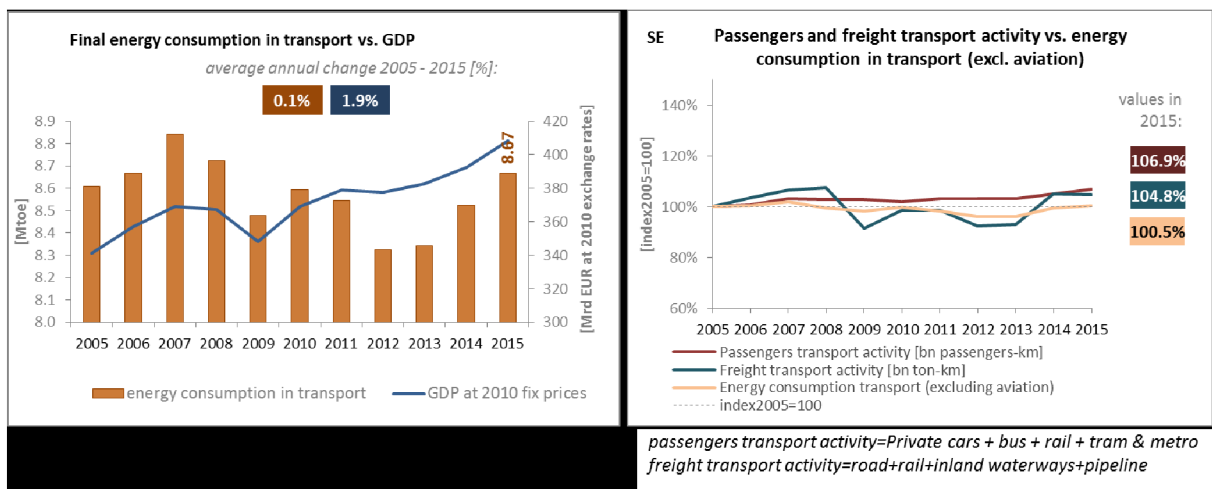


(source: Eurostat)

(source: Eurostat)

(source: Odyssee database)

Between 2005 and 2015 in Sweden, the final energy consumption in transport recorded an average annual increase of 0.1%, lower than the 1.9% average annual increase of GDP. Passenger activity over the same period has been steadily increasing, while freight transport activity registered some fluctuations due to economic trends.



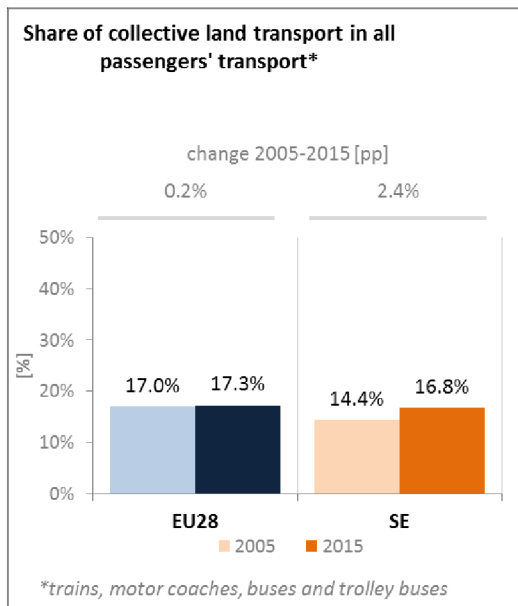
(source: Eurostat)

(source: Eurostat and DG MOVE pocketbook)

The share of collective passengers land transport in total passengers' transport⁷ increased by 2.4 percentage points between 2005 and 2015 and is, overall, slightly lower than the EU average.

⁶ This may partially be due to the fact that Sweden has a methodology for calculating the of residential housing surface leading to lower surface values than in some other Member States. This can have an impact on the figure for energy consumption per m².

⁷ The share is measured using the ratio between the passenger-kilometers of rail and buses, over the amount of passenger-kilometers (which includes cars as well).



(source: Eurostat)

Despite overall good macroeconomic performance, the infrastructure investment situation is quite low by international standards, where railroad infrastructure presents the biggest challenge. The railway system requires continued attention and investment, in particular for network maintenance and for removing bottlenecks to cross-border traffic. Given Sweden's geographical location, all transport modes are important to support future exports performance, and potential capacity bottlenecks need careful consideration. The government has recognised these infrastructure-related challenges in recent budget proposals and in specific assessments and negotiations for high-speed railways.

The importance of the transport system is reflected in the national Transport Plan in which the whole transport system investment for 2018-2029 is planned to increase by 20% compared to the previous planning period 2014-2025 (from SEK 515bn to SEK 622.5bn). Furthermore, in 2016, after years of discussions and investigations, Sweden announced plans for a first high-speed railway. The goal is to complete high-speed railways between major metropolitan regions. The expansion is to take place at a pace allowed by the economy.

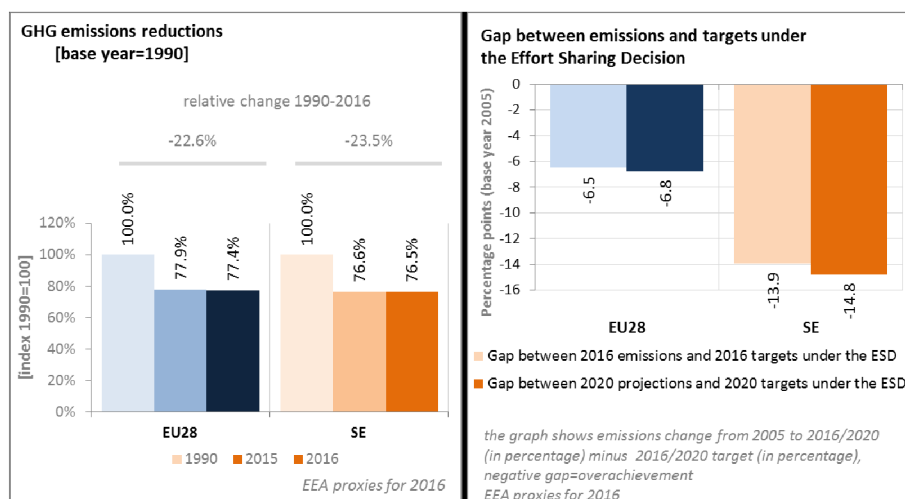
An aviation strategy was presented in January 2017 which treats the role of aviation in the total transport system. The Government has the intention to introduce a tax on air travel taking effect on 1 April 2018. The government has also in close dialogue with stakeholders developed a national cycling strategy which was presented in May 2017.

5. Decarbonisation of economy

5.1. GHG emissions

Sweden has recently adopted a climate policy framework. This framework legislation includes the following long term climate targets: Sweden shall have, at the latest by 2045, net-zero emissions; to achieve negative emissions thereafter. Emissions from activities on the Swedish territory shall be 85% lower than emissions than in 1990. Interim targets are set for 2030 and 2040. Furthermore, a sector specific target for transport is set, according to which emissions shall be reduced by 70 % until 2030, compared to 2010.

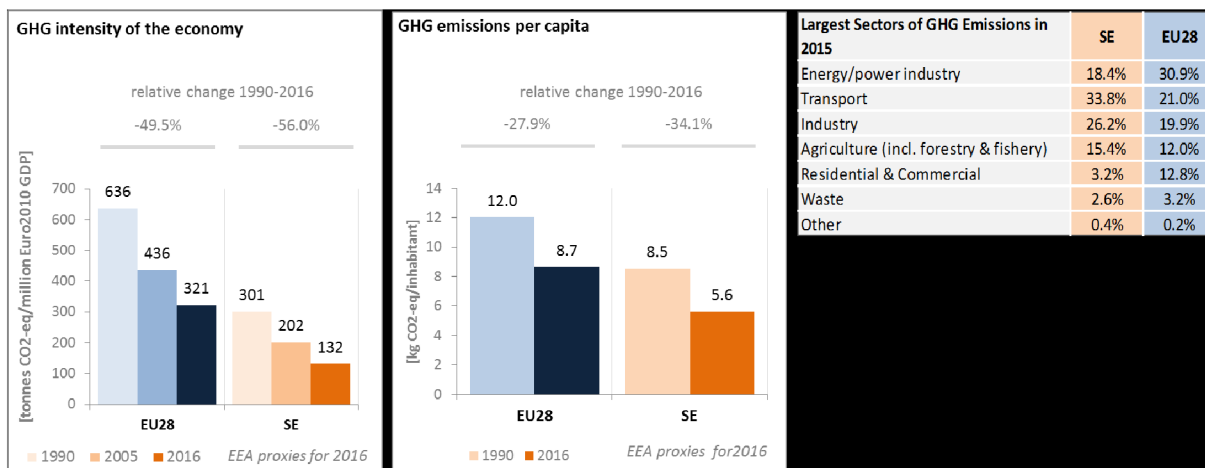
In 2016, GHG emissions in Sweden were 23.5% below the 1990 levels (based on 2016 proxy data), slightly below the EU average of -22.6%. According to national projections, the reduction in Sweden's non-ETS greenhouse gas emissions by 2020 is projected to exceed its 2020 target with some 14.8 p.p., implying that the target with all likelihood will continue to be met by 2020. Sweden has so far canceled - as a measure of environmental integrity - any excess annual emission allocations (AEAs) under the Effort sharing Decision, and does thus not use the banking or trading of AEAs.



(source: EC and EEA)

According to European Environment Agency (EEA) estimates, the greenhouse gas intensity of Sweden's economy was the lowest in the EU and less than half of what it was in 1990. Also greenhouse gas emissions per capita in Sweden were 36% lower than the EU average. Both factors are impacted by the higher than average share of renewable and nuclear energy in the energy mix.

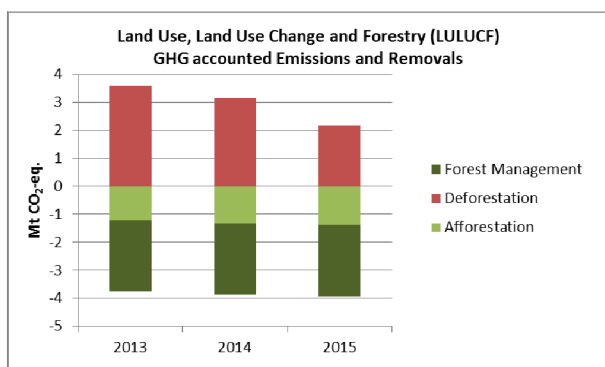
In 2015, the largest sectors in terms of GHG emissions were transport (1/3 of the total greenhouse gas emissions) followed by industry (26%) and the energy / power sector (18%). In relative terms, the greenhouse gas emissions from the residential sector in Sweden were well below the EU average, primarily due to the very limited direct use of fossil fuels.



(source: EC and EEA)

Preliminary accounts under the Kyoto Protocol for Sweden show overall removals of 0.9 Mt CO₂eq. as an annual average in the period 2013-2015. For comparison, the annual average of the EU-28 accounted for removals of 119.0 Mt CO₂eq. It should be noted that in this preliminary simulated accounting exercise, removals from Forest Management were capped to 2.5 Mt CO₂eq per year, due to significantly exceeding the limit of the difference between the reported sink and the accounting forest management reference level.

Emissions by Deforestation are notably higher than removals by Afforestation. Removals by Forest Management are higher than by Afforestation and gained relative importance over time. Overall, there is an increasing trend in removals mainly due to a decline in emissions by Deforestation. Removals by Afforestation show a slight increase over the course of the three-year period.



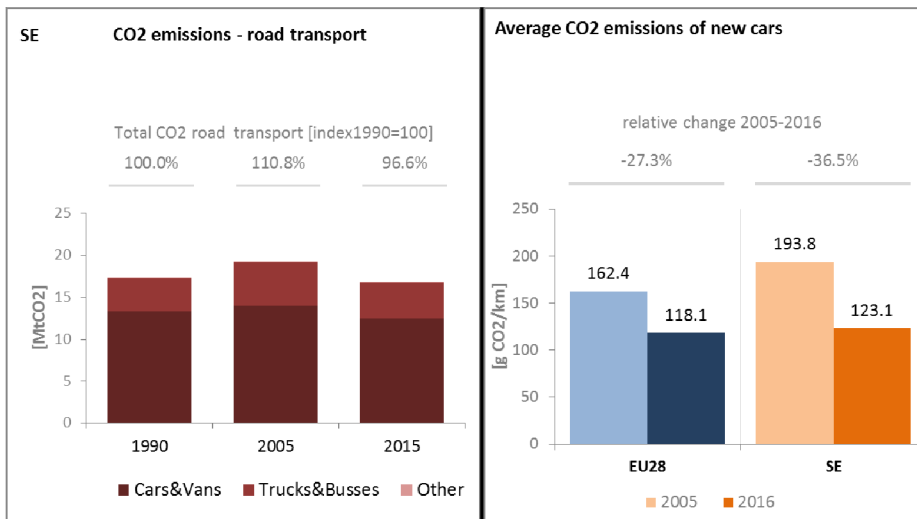
Note: Forest Management credits are capped and presented as yearly averages when the total Forest Management credits of the considered period exceed the simulated cap over the same period.

(source: EC and EEA)

CO2 emissions in transport and alternative fuelled vehicles

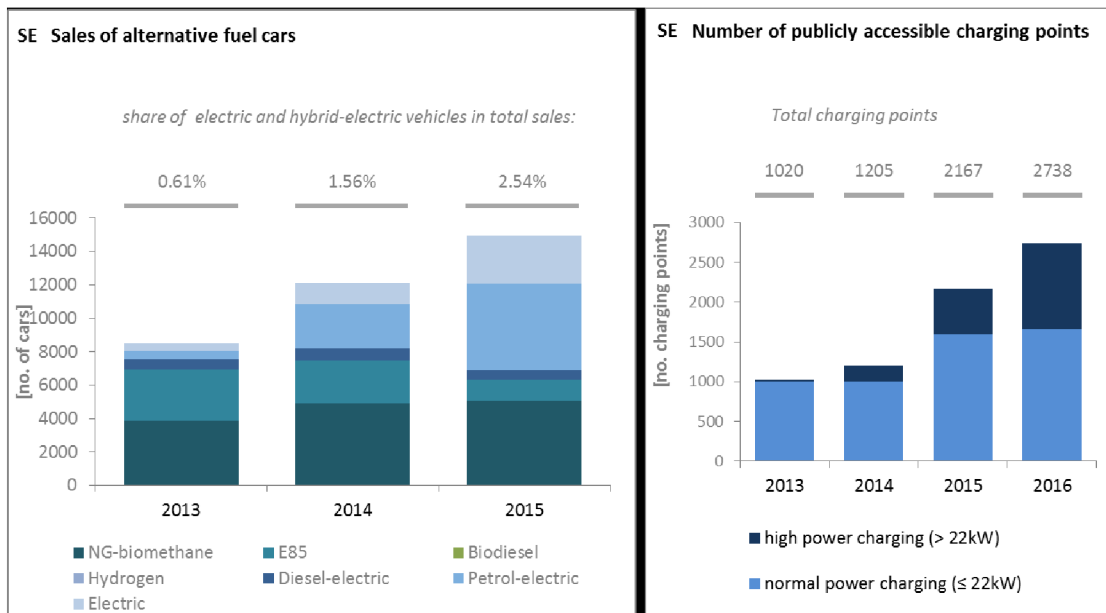
Sweden has set a new and ambitious national target to reduce emissions in the transport sector by 70 % until 2030, compared to 2010. In line with this, Sweden will be implementing two major reforms which aim at reducing greenhouse gas emissions from the transport sector.

From 2018 and onwards, Sweden’s main instrument to decrease emissions from fuels, will be a greenhouse gas reduction obligation imposed on fuel suppliers. Fuel suppliers will have to reduce emissions from the fuels they sell, typically by increasing the share of sustainable biofuels, by a set amount, increasing over time. For vehicles, Sweden will implement a bonus/malus system as of 2018. More environmentally friendly vehicles will be taxed advantageously, while more polluting vehicles will have a heavier tax burden. The average CO₂ emissions of new cars in Sweden were, in 2016, still above the EU average, but decreased between 2005 and 2016 more than the EU average. CO₂ emissions from transport are positively impacted by a high share of renewable energy (see below).



(source: European Environment Agency)

The number of electric charging points in Sweden has more than doubled in the period from 2013 to 2016, from 1 020 to 2 738 units.



(European Environment Agency)

(European Alternative Fuels Observatory)

National Policy Frameworks under Directive 2014/94/EU on alternative fuels infrastructure have to establish targets, objective and measures for the development of the market of alternative fuels in

the transport sector and the deployment of the relevant infrastructure. Sweden has submitted its National Policy Framework as requested under article 3 of the Directive 2014/94/EU.

A detailed assessment of the Swedish National Policy Framework in terms of its compliance with the requirements of Directive 2014/94/EU on alternative fuels infrastructure, its contribution to achievement of long-term energy and climate objectives of the Union and coherence of its targets and objectives in terms of cross-border continuity has been published as part of the Communication on Alternative Fuels Action Plans (COM(2017)652) and the related staff working document SWD(2017)365.

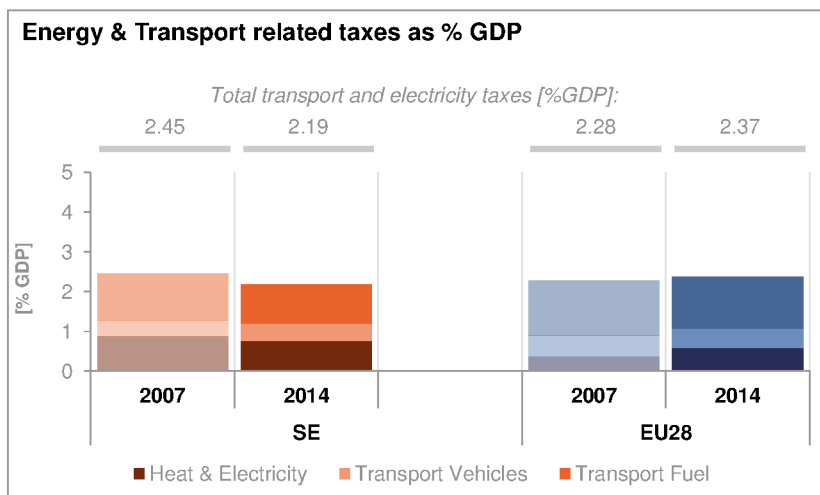
5.2. Adaptation to climate change

The Swedish policy for adapting to climate change is laid out in the 2008 bill 'An Integrated Climate and Energy Policy'. Adaptation policy efforts are supported by a range of strategic documents and action plans that are implemented at national, regional and local levels. Several government agencies/national authorities have developed action plans of their own. The sectors that are pointed out in the Swedish strategies are related to critical societal functions: biodiversity and ecosystem services, fresh water supply, health, infrastructure, rural businesses, technical supply systems, and urban areas. An assessment report on the Swedish climate change adaptation strategy and the actions being taken since 2007 was completed in 2015. Work is currently ongoing to further develop strategic planning at the national level, including possible systems for evaluation and monitoring of adaptation work and progress in Sweden.

5.3. Taxes on energy and transport and fossil fuel subsidies

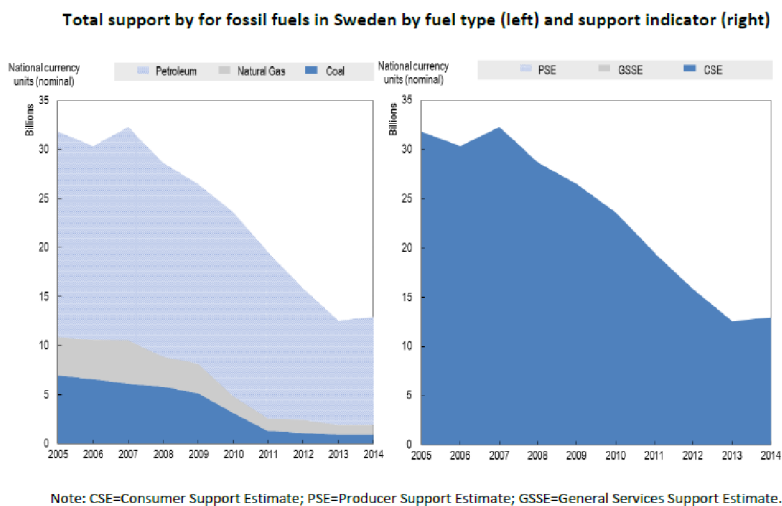
Sweden uses taxation as part of the climate policy, and has a carbon tax in place. It currently, in 2017, amounts to EUR 118/tCO₂ (SEK 1130/tCO₂). It is applied on all fossil fuels, including heating oil fuels (light and heavy), natural gas and coal. A reduced rate is applicable for industry (outside the ETS), agriculture, forestry and fishery. In addition, the circulation tax on vehicles is partly based on CO₂ emissions.

The overall tax burden on energy and transport (including carbon taxation) in Sweden amounts to 2.2 % in 2014, 0.2 percentage points lower than in 2007. This is also below the EU average, while the opposite was true in 2007. The tax burden on heat and electricity is considerably above the EU-average, but has fallen slightly since 2007. The tax burden on transport fuels has also fallen since 2007 (0.2 p.p.). The tax burden on transport vehicles is lower than the EU-average, but has increased slightly during the period.



(source: Eurostat)

Sweden has put substantial effort into phasing out fossil-fuel support throughout the last decade. Today, the CO₂ tax rate reduction for diesel used as fuel for machinery in agriculture and forestry represents the most significant tax expenditure. This is despite the fact the reduction has been decreasing over time — from 77% when the scheme was first implemented, through 79% in 2010, to 70% in 2011. In 2016, the reduction corresponds to 53% of the general CO₂ tax rate. Other recently reduced tax reductions include CO₂ tax exemption for fossil fuels used for heating in the manufacturing process in industry outside the EU Emission Trading Scheme and the agricultural sector. Given the lack of oil and natural gas production in Sweden, the beneficiaries of all support measures recorded are intermediate and final consumers.

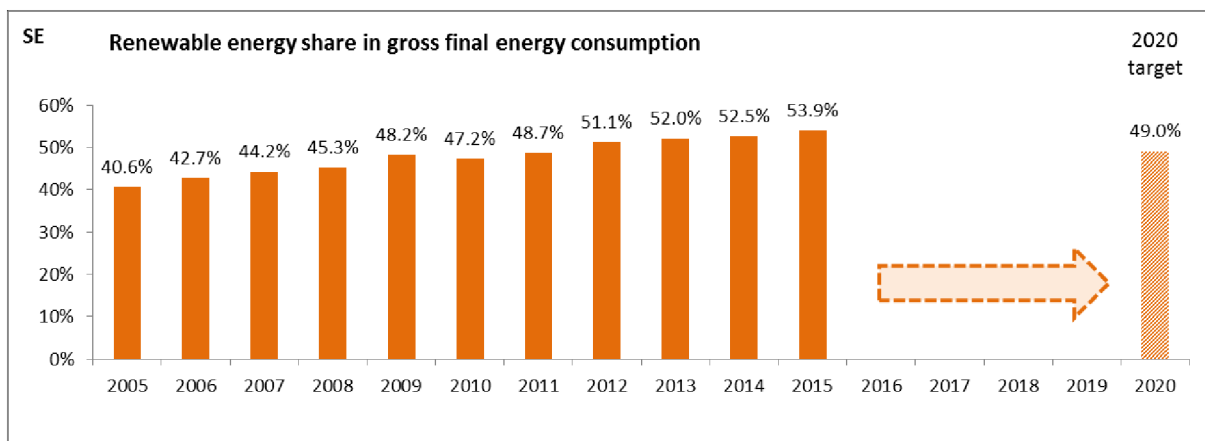


(source: OECD Inventory of Support Measures for Fossil Fuels 2015)

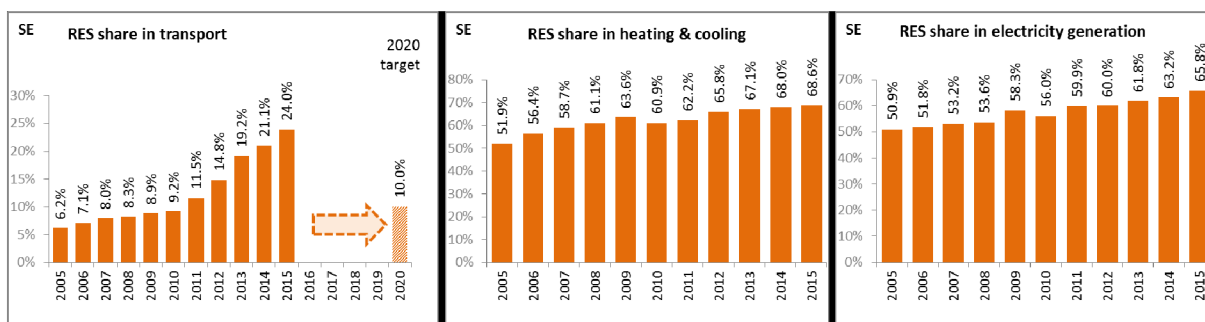
5.4. Renewable energy

Sweden has the highest share of renewable energy in the EU. At some 54% of gross final energy consumption in 2015, Sweden has already exceeded its national 2020 target of 49% according to the RES-directive. Sweden has also exceeded its national target of 50% to 2020. In addition to electricity (66%), Sweden has achieved a comparably very high share of renewables also in heating (69%) and transport (24%). The increase of renewable energy in transport has been particularly steep in recent

years, more than doubling from an already high share since 2010. The use of renewable energy in heating is facilitated by extensive district heating based on biomass.



(source: Eurostat-SHARES)



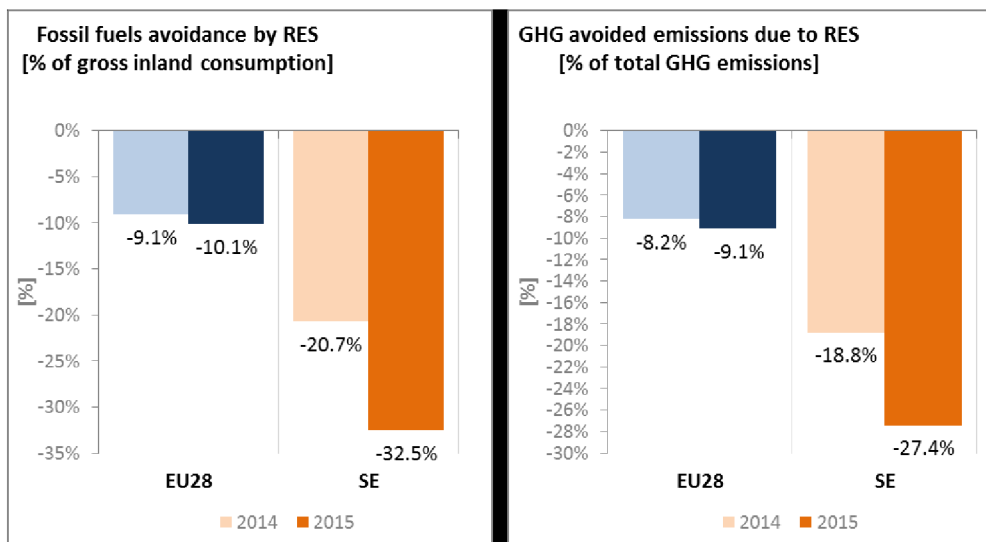
(source: Eurostat-SHARES)

The development of new capacity to generate electricity from renewable energy sources in Sweden is predominantly promoted through a green certificate system shared with Norway. The green certificate system is prolonged and the ambition is raised with 18 TWh until 2030.

In transport, the use of renewable energy is primarily incentivised through tax breaks, while the Government has announced plans to introduce a quota scheme to get the share up to no less than 50% by 2030.

Due to a consistent deployment of renewables, it is estimated that Sweden avoided about 21% of the fossil fuel in gross inland consumption and about 19% of GHG emissions in 2014.⁸

⁸ Avoided GHG emissions mentioned here have a theoretical character as these contributions do not necessarily represent 'net GHG savings per se' nor are they based on life-cycle assessment or full carbon accounting.

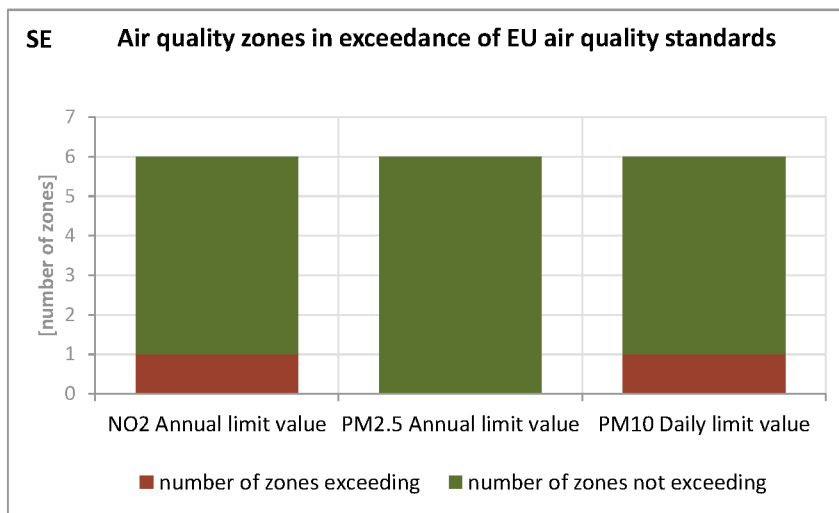


(source: EEA)

5.5. Contribution of the Energy Union to better air quality

Air quality in Sweden continues to give cause for concern. For the year 2013, the EEA estimated that about 3,020 premature deaths were attributable to fine particulate matter (PM_{2.5}) concentrations and less than five to nitrogen dioxide (NO₂) concentrations⁹.

For both pollutants Sweden reported exceedances of the binding EU air quality standards¹⁰. For the year 2015, Sweden reported exceedances of the limit value for PM₁₀ and the limit value for NO₂ in 1 out of the 6 air quality zones in Sweden¹¹.



(source: EEA)

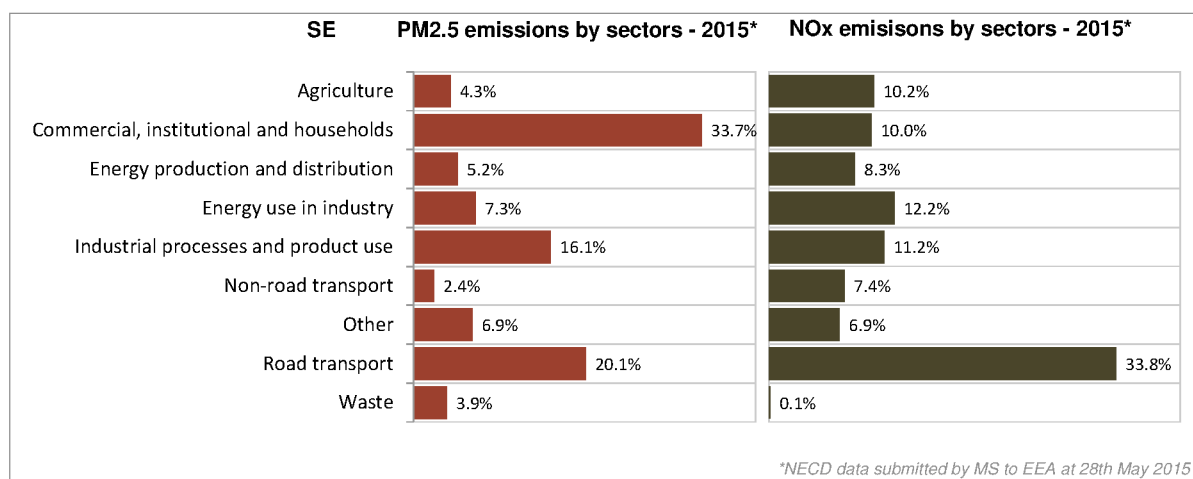
⁹ European Environment Agency, 2016, *Air Quality in Europe – 2016 Report*, table 10.2. The report also includes details as regards the underpinning methodology for calculating premature deaths.

¹⁰ 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, OJ L 152, 11.6.2008, p.1-44

¹¹ Compliance data as reported by the Member States as part of their official annual air quality report for the calendar year 2015 (available on the European Environment Agency's (EEA) Eionet/Central Data Repository), <http://cdr.eionet.europa.eu/se/eu/aqd>

The health-related external costs from air pollution in Sweden have been estimated to be more than EUR 3 billion/year (income adjusted, 2010), which includes the intrinsic value of living a healthy life without premature death as well as the direct costs to the economy such as healthcare costs and lost working days due to sickness caused by air pollution¹².

The Energy Union can substantially contribute to addressing these air quality problems through measures reducing emissions of both GHG and air pollutants such as PM and nitrogen oxides (NO_x) from major contributing sectors such as (road) transport, energy production, industry and residential heating (e.g. stoves and boilers)¹³.



(Source: EEA. This table reflects only sources of primary PM_{2,5} emissions.)

6. Research, innovation and competitiveness

6.1. Research and innovation policy

The current Swedish Energy research and innovation (R&I) programme is part of Swedish research policy, but also an integral part of Swedish energy policy. The programme is based on having a balanced portfolio of thematic sub-programmes, activities and funding instruments to support the development and deployment of clean energy solutions and technologies. To maximise its flexibility, the Swedish Energy R&I programme includes not only sub-programmes initiated as an answer to detailed and technically specific calls of proposals, but also sub-programmes that are open for new and unexpected ideas. The responsibility for strategic planning and implementation of the programme rests with the Swedish Energy Agency.

In addition to funding research, development, demonstration and innovation, there are also a number of Swedish programmes or policies to promote the uptake of new, clean and efficient energy technology. Among these measures are the Climate Step, an investment programme for industry, local governments, regions and organisations to reduce climate change impacts. The budget is SEK 3.5 billion for the period 2015–2020. A special fund for public venture capital for energy and climate

¹² See also the EU Environmental Implementation Review Country Report for Sweden, SWD(2017)56 final of 3.2.2017

¹³ National emission data as reported by the Member States to the EEA (available on the EEA's Eionet/Central Data Repository), http://cdr.eionet.europa.eu/se/eu/nec_revised

technologies is also being established. The total budget for this fund is expected to be SEK 650 million.

The government's guidelines and goals for the Energy R&I programme for the period up to and including 2020 were decided upon in 2016, when it was also decided to increase funding for energy research and innovation with SEK 620 million during 2017-2020¹⁴.

Sweden is also an active contributor to the ongoing work of the SET Plan. It participates in nine (out of fifteen) temporary working groups for the implementation of the integrated SET Plan.

Regarding the Horizon 2020 programme, Sweden has received so far 3.9% of the EU contribution devoted to the 'secure, clean and efficient energy' part of the programme. As of September 2017, 140 participations from Swedish organisations have been awarded about EUR 71 million in Horizon 2020 energy projects. This includes a grant of over EUR 7.5 million to Swerea Mefos for its participation in project STEPWISE (CO₂ capture). Sweden is also very active in the field of Smart Cities. Two of the 27 current European H2020 Lighthouse cities are Stockholm (GROWSMARTER 2014) and Umeå (RUGGEDISED 2016).

Sweden is a founding member of Mission Innovation¹⁵. As a result, it has committed to doubling its public funding of major clean energy R&I programmes from SEK 134 million¹⁶ on average in the period 2013-15 to SEK 270 million in 2020. Sweden has chosen to double the parts of its energy R&I programmes that focus on funding for researchers and industry to work bottom-up with solutions to energy challenges and which at the same time support long-term and transformative research and development.

6.2. Investments and patents in the Energy Union R&I priorities

In 2016, public (national) investments in the Energy Union R&I priorities reached EUR 139 million, having increased by 12% compared to 2015. The largest share of investments (42%) was attracted by the Sustainable Transport priority of the Energy Union, followed by the Smart System and the Efficient Systems priorities (33% and 13%, respectively). In the period 2007–2016, the maximum annual public investment was EUR 163 million, reported in 2014. For the same year, the most recent for which data from most Member States are available, public investment per GDP in Sweden was higher than the EU average.

Private investment in the Energy Union R&I priorities in 2013 was estimated at EUR 774 million (5% of the private R&I investment in Energy Union R&I priorities in the EU). The focus was on Sustainable Transport, which received 46% of these investments, followed by the Smart System and Efficient Systems priorities, which received 29% and 13% respectively.

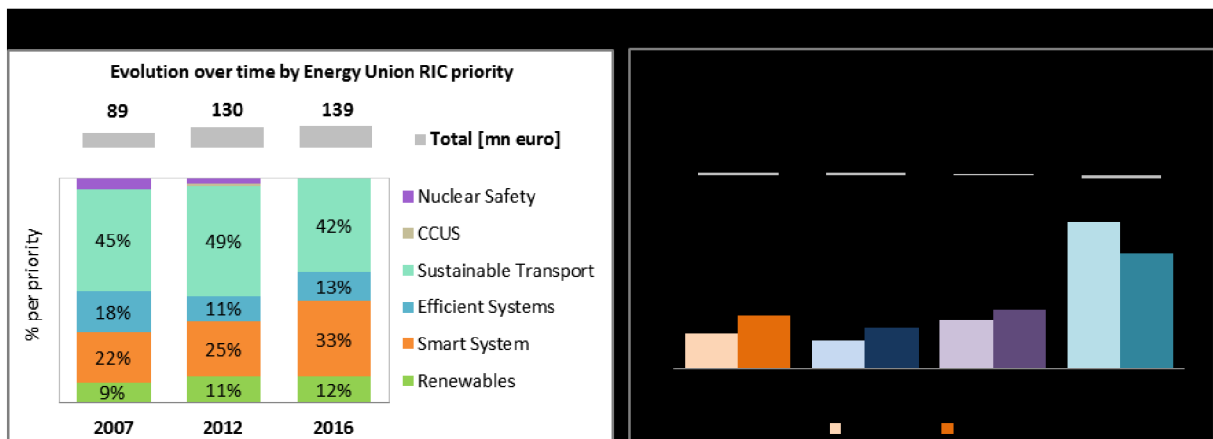
¹⁴ Govt. Bills 2016/17:66 and 2016/17:1.

¹⁵ <http://mission-innovation.net/>

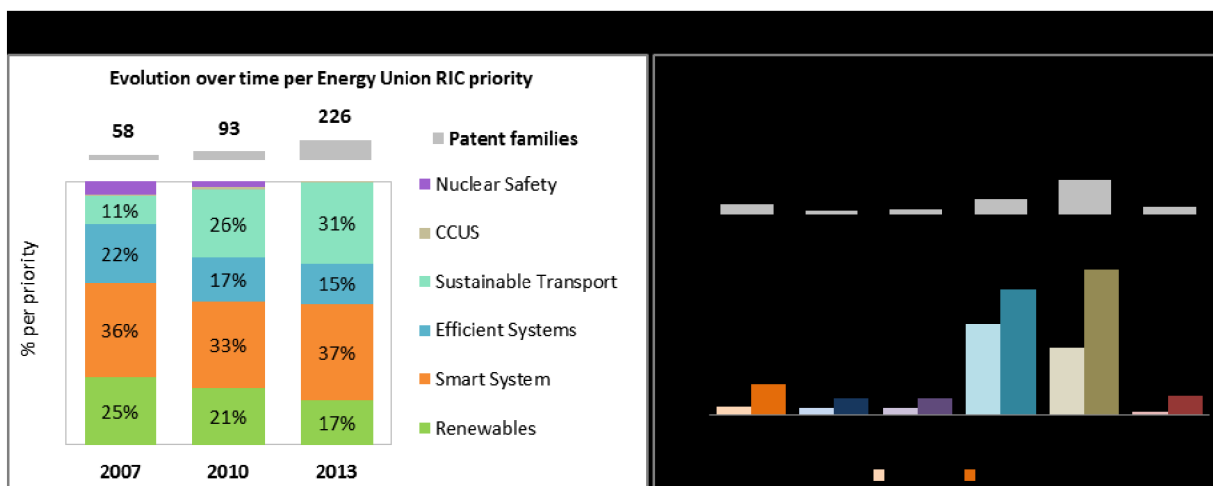
¹⁶ The baseline number of 134 million SEK relates to the activities of Basic Energy Research, Innovative and energy relevant research and development, and energy relevant Strategic Innovation Areas. These three programmes are characterized by not having a specific technology focus beyond being original and excellent and addressing the energy challenge within the overall focus of renewables, efficiency, electricity and energy transmission and distribution, and energy systems.

In 2013, the most recent year for which complete patent¹⁷ statistics are available, 85 companies and research organisations based in Sweden filed 226 patents in low-carbon energy technologies (3% of the EU total). The focus was on the Smart System priority (37%), followed by Sustainable Transport (31%) and Renewables (17%).

In 2013, private R&I investments and patents in Energy Union R&I priorities were higher than the EU average when normalised by GDP and by population respectively. In the period 2007–2013 both private R&I investments and the number of patents in Energy Union R&I priorities increased on average by 21% and 25% per year, which is higher than the respective rates of increase for the same indicators at EU level (6% and 15% respectively).



Note: The international comparison (right) is shown for 2014 (Sweden had reported EUR 164 million). Reporting at EU level for 2015 is not as complete, and very few countries have reported for 2016.



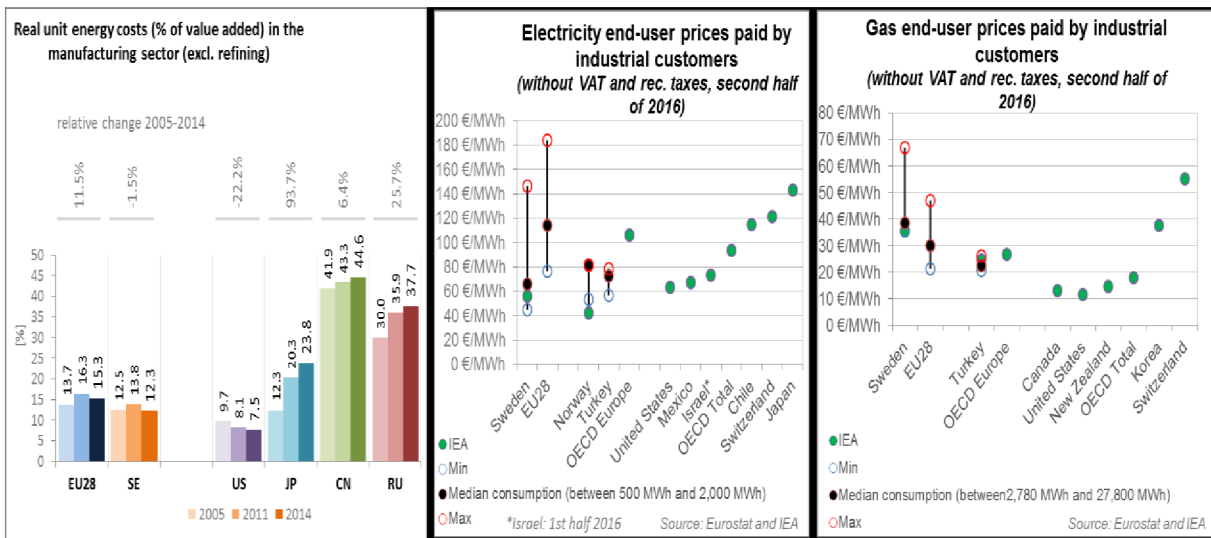
(Data sources: Public investment as available in the International Energy Agency RD&D Statistics database¹⁸ for codes relevant to Energy Union RIC priorities. Patent data based on the European Patent Office PATSTAT database¹⁹. Private investment as estimated by JRC SETIS. Detailed methodology available from the JRC²⁰.)

¹⁷ In the context of this document, the term 'patent' refers to patent families, rather than applications, as a measure of innovative activity. Patent families include all documents relevant to a distinct invention (e.g. applications to multiple authorities), thus preventing multiple counting. A fraction of the family is allocated to each applicant and relevant technology.

¹⁸ <http://www.iea.org/statistics/RDDonlinedataservice/>

6.3. Competitiveness

In 2014, the real unit energy costs (RUEC)²¹ in Sweden (12.3) were below those of the EU average (15.3), well above those in the US but significantly below those in e.g. Japan and China. The electricity prices paid by industrial consumers in Sweden are below the EU and OECD averages and by some measures the lowest in the EU. Conversely, gas prices for industrial consumers are well above the EU average, the impact of which is mitigated by the relatively low share of natural gas in final energy consumption of industry.



(source: ECFIN)

(source: Eurostat and IEA)

Regarding the competitiveness in wind and solar energy, Sweden performs moderately well in the wind energy sector, while it does not perform well in the solar PV industries, as indicated by the revealed comparative advantage indicator²² below. The Swedish economy is not specialised in either of these industries. The relative trade balance²³ confirms that Sweden is overall a net importer of both wind and solar components, which contrasts to EU as whole which has a positive trade balance in the wind industry. Sweden recorded nonetheless a trade surplus in wind turbine power electronics in 2015.

¹⁹ <https://www.epo.org/searching-for-patents/business/patstat.html#tab1>

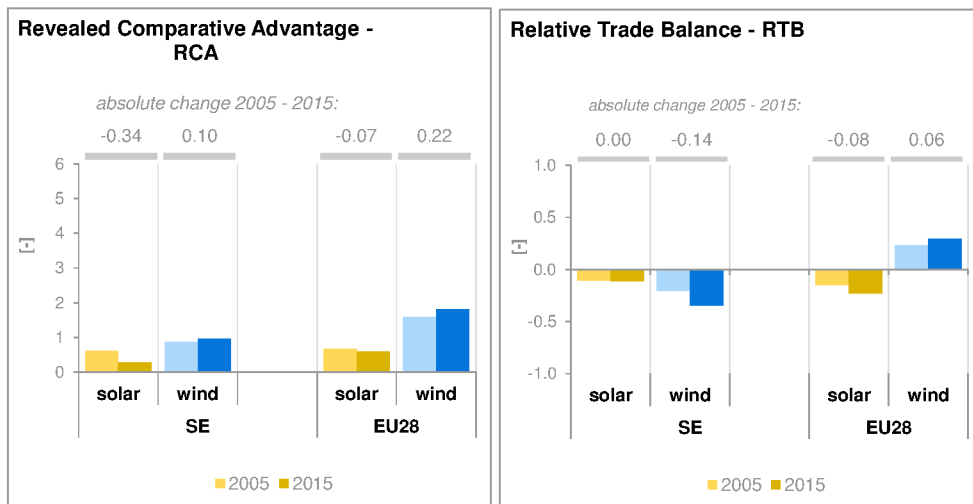
²⁰ <https://setis.ec.europa.eu/related-jrc-activities/jrc-setis-reports/monitoring-ri-low-carbon-energy-technologies>

²¹ This indicator measures the amount of money spent on energy sources needed to obtain one unit of value added.

²² The RCA index for product "i" is defined as follows: $RCA_i = \frac{\frac{X_{j,i}}{\sum_i X_{j,i}}}{\frac{X_{w,i}}{\sum_i X_{w,i}}}$ where X is the value of exports, and j is

the country and w is the reference group, the World economy. 2005 refers in the text to the indicator average over the 2000-2009 period, while 2015 represents the average over the 2010-2016 period. The same applies for the RTB indicator - see below.

²³ The RTB indicator for product "i" is defined as follows: $RTB_i = \frac{X_i - M_i}{X_i + M_i}$ where X_i is the value of product's "i" exports and M_i imports.



(source: UN comtrade)

7. Regional and local cooperation

Sweden is part of the Baltic Energy Market Interconnection Plan (BEMIP), the first High-Level Group launched in 2009 by the Commission and Denmark, Sweden, Poland, Finland, Estonia, Latvia, Lithuania, Germany and Norway (observer status). BEMIP's main objectives are to develop an internal and regional energy market between the EU Member States in the Baltic Sea region and integrating it fully into the EU's energy markets, thus increasing security of supplies. BEMIP projects have been part of the European Economic Recovery Plan (EERP) and the Trans-European Energy Networks Programme. BEMIP projects have also been funded through the EU's structural funds, including the European Regional Development Fund (ERDF) and the Cohesion Fund (CF). Many infrastructure projects are supported through co-funding from the Connecting Europe Facility amounting to 534.3 million euro in the region. In the framework of the societal challenge for secure, clean and efficient energy of the Horizon 2020 programme, 16.9 million euro is allocated to participants from the Baltics to stimulate research and innovation in this field. The most important project including Sweden in this regard is the undersea DC electricity interconnector – NordBalt – between southern Sweden and Lithuania. The project was supported by the EERP and the interconnector is in operation since beginning of 2016.

Sweden is also part of Nordic Cooperation under the auspices of the Nordic Council and the Nordic Council of Ministers together with Finland, Denmark, Iceland, Norway, the Faroe Islands, Greenland, and Åland. As part of the modernisation and reform process towards a 'New Nordic Region', it was decided to commission strategic reviews of all sectors. On 27 October 2015, the energy ministers agreed to commission a strategic review of co-operation in their sector. The objective is to ensure effective co-operation now and for the coming 5 to 10 years. The report on this review was issued in June 2017.

The electricity markets of Norway, Sweden, Finland and Denmark together form the Nordic electricity market. The common electricity market combines the wholesale markets in the Nordic countries, creating the price signals to produce electricity where the price is lowest. The Nordic Council tasked the Nordic National Regulatory Authorities (NordREG) to develop a more harmonised Nordic electricity retail market. The focus is to reduce obstacles for electricity suppliers to be active

in all Nordic countries. Recent measures include the development and progressing implementation of the supplier centric market processes and of data-hubs.²⁴

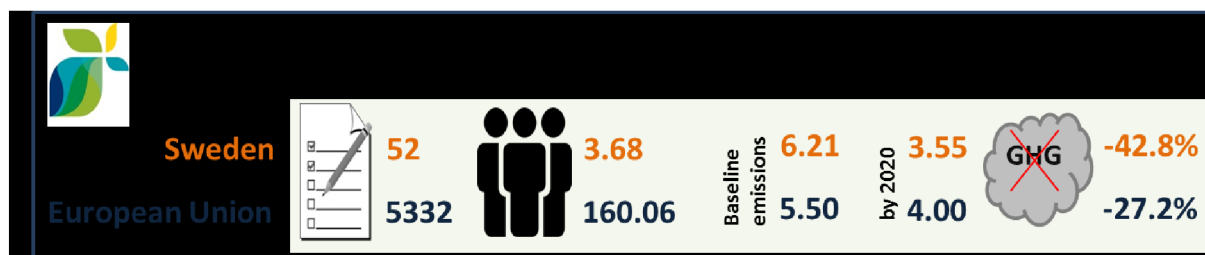
Sweden is a member of the High-Level Group on North Seas Energy Cooperation. In June 2016 Sweden signed the Political Declaration on energy cooperation between the North seas countries. This Declaration has established a High-Level Group to give the necessary political impetus to a project which is fundamental to facilitate the cost-effective deployment of offshore renewable energy and to promote further interconnection and further integration of wholesale electricity markets around the North Seas. Through a coordinated approach will be achieved market integration and the integration of substantial amounts of indigenous low carbon generation, at lower cost and with an optimal use of maritime space (avoidance of conflicts with other North Seas users). It will boost economic growth and create a significant amount of highly skilled jobs in the region. Sweden is also a member of the North Seas Off-shore Grid Regional Group.

The Nordic Energy Technology Perspectives 2016 presents technology pathways towards a near-zero emission Nordic energy system by 2050. The analysis is presented around the Nordic Carbon-Neutral Scenario which results in 85% reduction of emissions by 2050 (compared to 1990 levels). The analysis was performed by Nordic researchers and Nordic Energy Research in cooperation with the International Energy Agency.

The EU macro-regional strategy for the Baltic Sea Region in which Sweden takes part can be used as a basis for regional cooperation on energy. European Territorial Cooperation – 'Interreg' – under EU cohesion policy also provides further opportunities for cross-border, transnational and interregional cooperation, including in the Energy Union areas.

Cities and urban areas have a key role in the energy and climate challenge. The Urban Agenda for the EU, established by the Pact of Amsterdam in May 2016, better involves cities in the design and implementation of policies, including those related to the Energy Union. It is implemented through Partnerships, in which the Commission, Member States, cities and stakeholders work together on a number of important areas, including on Energy Transition, Urban Mobility, Air Quality, Climate Adaptation and Housing. Sweden is participating in the partnerships on Energy Transition, with the city of Gothenburg as member, and Urban Mobility, with the region of Skåne and the city of Malmö as members.

With regard to the Covenant of Mayors, the sustainable energy action plans delivered by 52 Swedish municipalities cover about 3.7 million inhabitants representing more than a third of the total population of Sweden. All together, these municipalities' commitments imply a GHG reduction of some 43% by 2020 compared to 1990 baseline).



(source: JRC 2016. Notes: SEAP=sustainable energy action plan, GHG=greenhouse gas emissions)

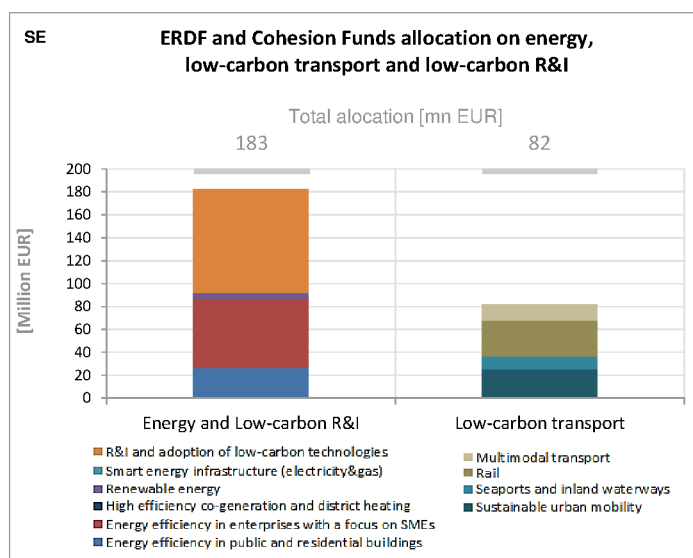
²⁴ NordREG Report – 2016, Published: 2016-07-29

In Sweden, by September 2016, four cities (covering 0.94 million inhabitants) have committed to conduct vulnerability and risk assessment and develop and implement adaptation plans in the framework of the Covenant of Mayors for Climate and Energy.

8. Cohesion policy and EU-supported clean energy investments

EU cohesion policy makes a key contribution to delivering the Energy Union objectives on the ground, including investment possibilities to implement energy policy objectives in Sweden which are complemented by national public and private co-financing, aiming at optimal leverage. It also ensures integrated territorial solutions to energy and climate challenges, supports capacity building and provides technical assistance.

Over 2014-2020, cohesion policy is investing some EUR 92 million in energy efficiency improvements in public and residential buildings and in SMEs, as well as in renewable energy in Sweden. Cohesion policy is also investing significantly in R&I and in SME competitiveness in Sweden, based on the national strategy as well as regional strategies for smart specialisation. For Sweden, the strategies include a focus on support for networks, clusters and incubators for SMEs working with energy efficiency and a key issue is the increased potential for commercialisation of innovation in the energy sector. In addition, development of strategies and plans for sustainable and energy efficient urban planning, favouring energy conservation and non-fossil energy, is supported. At this stage, at least EUR 91 million is foreseen for investments in R&I and adoption of low-carbon technologies in Sweden, but this might increase further in line with the evolving content of the smart specialisation strategy. A further estimated EUR 82 million is invested in supporting the move towards an energy-efficient, decarbonised transport sector.



(source: DG REGIO)

These investments are expected to contribute to around 10,000 households with improved energy consumption classification, a decrease of around 40,000,000 kWh per year of primary energy consumption of public buildings, as well as to around 100 km of reconstructed or upgraded railway lines. Overall, the EU cohesion policy investments in Sweden over 2014-2020 are expected to contribute to an estimated annual decrease of GHG emissions of around 6,000 tonnes of CO₂eq.

For example, the "VIRUS" (Hosting, Innovation, Regional development and Synergies around Electric roads for fossil-heavy logistics) project received a contribution from the European Regional Development Fund (ERDF) of EUR 530,000 (total investment EUR 1.2 million). It is located in North-Mid Sweden and is running from January 2016 until June 2018. It is the world's first electric road construction project for truck traffic. The project's goal is to create knowledge, experience and conditions for decision support and can serve as a platform for an electrification of Sweden's major transport routes.

As another example, "ClimateSync" is a project targeting all Swedish projects co-financed by the European Regional Development Fund (ERDF) in the area of supporting the shift towards a low-carbon economy. The purpose of ClimateSync is to achieve synergies, to avoid overlaps, enhance learning, cooperation and coordination between regions and between the regional and national level on energy and climate related work. The project is running until the end of 2020 and is co-financed from the national ERDF program with EUR 1.39 million. The Swedish Energy Agency and the Swedish Agency for Regional and Economic Growth contribute each 25% (EUR 0.69 million).

Through its support to sustainable transport systems, The Connecting Europe Facility (CEF) also contributes to the goals of the Energy Union. Following Swedish participation in the CEF – Transport 2014-2015 Calls, the Swedish action portfolio comprised 39 signed grant agreements, allocating EUR 144.5 million of actual CEF Transport Funding to Swedish beneficiaries²⁵ (state: February 2017). The transport mode which receives the highest share of funding is air (37.1% of actual funding). Concerning air traffic management (ATM), Sweden is involved in both mono and multi-beneficiary actions, both studies and works, including the Single European Sky ATM Research (SESAR) Deployment Manager. These actions contribute to the deployment of SESAR as well as to the modernisation of the ATM system.

Sweden has also demonstrated a strong commitment to the greening of the maritime sector, developing new technologies and upgrading a number of maritime links through better performance of ships and increased handling efficiency of ports. Moreover, Sweden has made consistent efforts to promote the integration of maritime transportation in the supply chain. As regards the Swedish rail actions, the main investments are allocated to works on the freight line through Bergslagen. Also, studies are being performed on the Bothnian Corridor (North Bothnia Line) to design plans for a new railway line and on the Iron Ore Line to increase capacity in the TEN-T core network.²⁶

²⁵ Note that European Economic Interest Groups and International Organisations are excluded from the analysis.

²⁶ Source: INEA