

ENERGY STATISTICS OF SWEDEN AND FINLAND

Asko Vuorinen

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Preward

Sweden and Finland are ranked as one of the most developed countries in energy sector. They are in top five rank in renewable energy and nuclear power generation in EU. Sweden has the highest nuclear power generation per capita since 1975 in the whole world. Nuclear share is about 38 % from primary energy in Sweden and 28 % in Finland.

About 38 % of primary energy in both countries are coming from renewable sources. This means that only about 20 % is remaining to fossil sources in Sweden and 30 % in Finland. However, the nuclear energy is decreasing in Sweden and increasing in Finland. Thus, in 2022 Finland will produce 25 % of its primary energy from nuclear and Sweden only about 23 %.

Sweden has been an example of advanced energy policy for the whole world. The CO₂ emissions in Sweden per capita are less (4.2 t/capita) than the average emissions in the whole world (4.4 t/capita). The CO₂ emissions have been smaller than the LULUCF sinks since the year 2015. It will take until the year 2035 or 20 more years when Finland will reach the same position.

Following pages will try to evaluate the differences of both countries in their energy statistics and will try to forecast, what will be coming in the near future. The sources of data are the energy statistic of the both countries.

Asko Vuorinen

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Espoo

1. Primary energy sources

1.1 Sweden

Primary energy sources in Sweden have three main components: Renewables (38 %), Nuclear (38 %) and fossil (20 %) (Figure 1.1.1). The consumption of primary energy was about 580 TWh and if divided with Swedish population of 10 million 58 TWh/capita (5 toe/capita).

As can be seen from the figure that the share of renewables has been growing from about 80 TWh in 1970 to 240 TWh in 2016. The renewables have been growing 200 % in 46 years or about 2,5 % per annum.

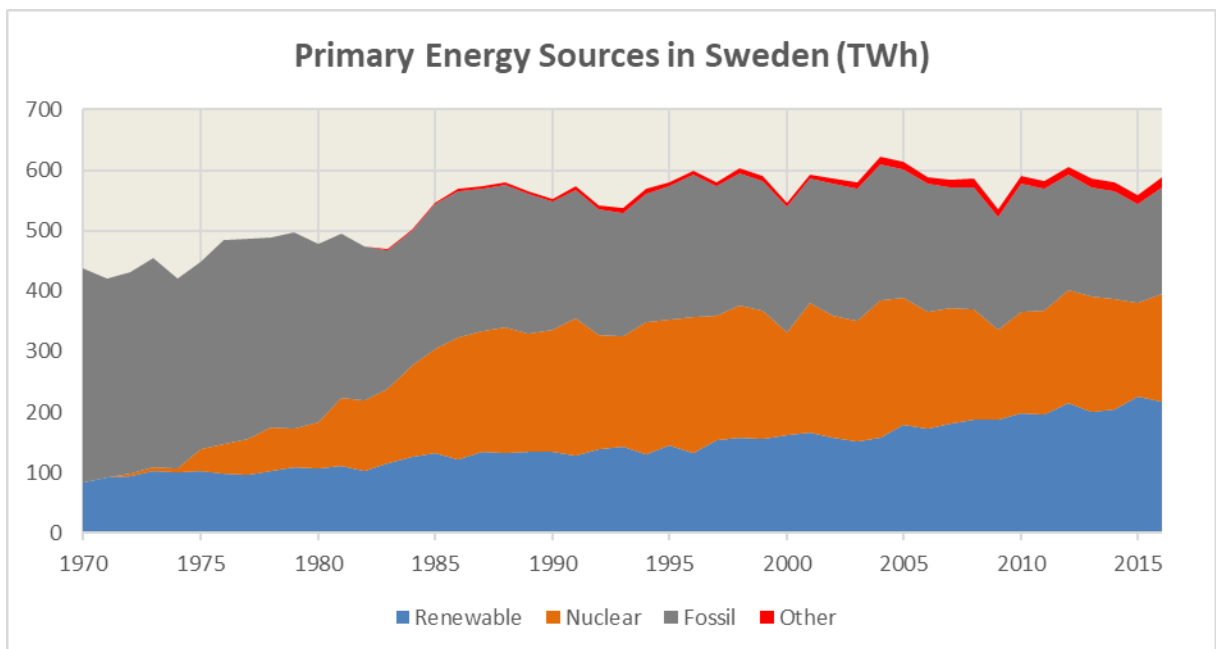


Figure 1.1.1 Primary Energy in Sweden (TWh).

During the same time the fossil sources have been declining from 350 TWh to 200 TWh or about 42 % (Figure 1.1.2). This is about 20 MWh/capita.

The drop of fossil energy was the highest during years 1975 - 1985, when the nuclear power was expanding rapidly and was replacing oil in heating and industrial sectors and coal in power generation.

While fossil energy has been dropping the CO₂ emissions have also been declining since the year 1970 about 40 %.

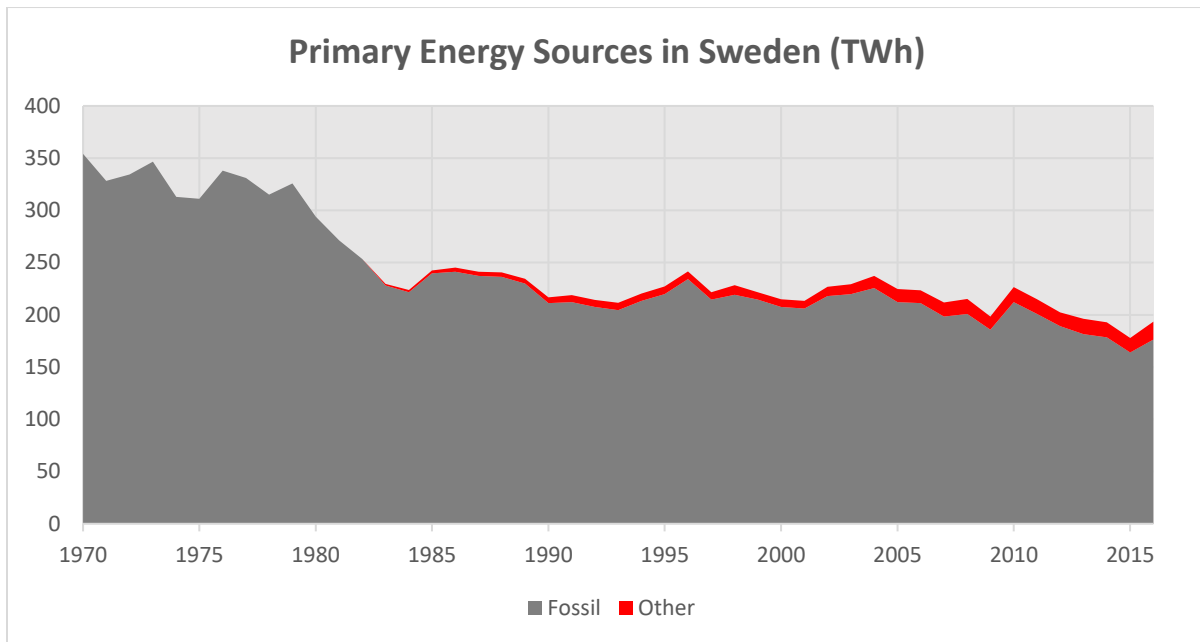


Figure 1.1.2 Fossil energy in Sweden (TWh).

1.2 Finland

The primary energy consumption in Finland has been growing much faster in Finland. About 380 TWh of primary energy was used in 2018 and if divided by 5,5 million population 69 MWh/capita. This means that a Finn is consuming about 19 % more primary energy than a Swede.

The share of renewable sources in Finland was 37 % in 2018. Nuclear share was 17 % and the fossil sources filled 41 %. About 5 % remained to others, which was mostly imports of electricity.

The fossil and peat sources of energy in Finland has been increasing from 140 TWh in 1970 to 155 TWh in 2018 (Figure 1.2.1). This is about 28 MWh/capita or 40 % higher figure than in Sweden.

While the consumption of fossil energy has increased 10 % from the year 1970, this means the emissions have been also increasing about 10 %. In Sweden the fossil energy and emissions have been decreasing with 40 % from the year 1970.

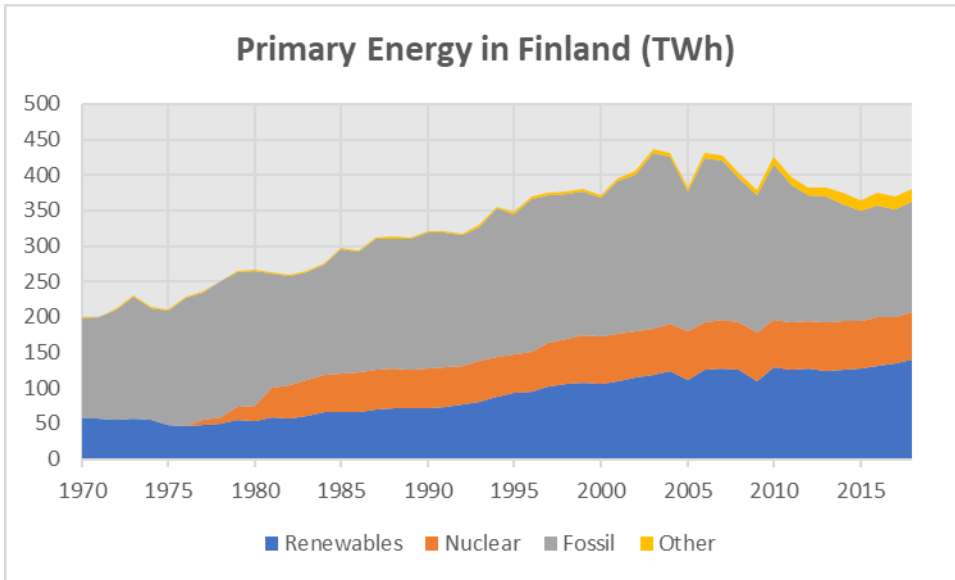


Figure 1.2.1 Primary Energy Consumption in Finland.

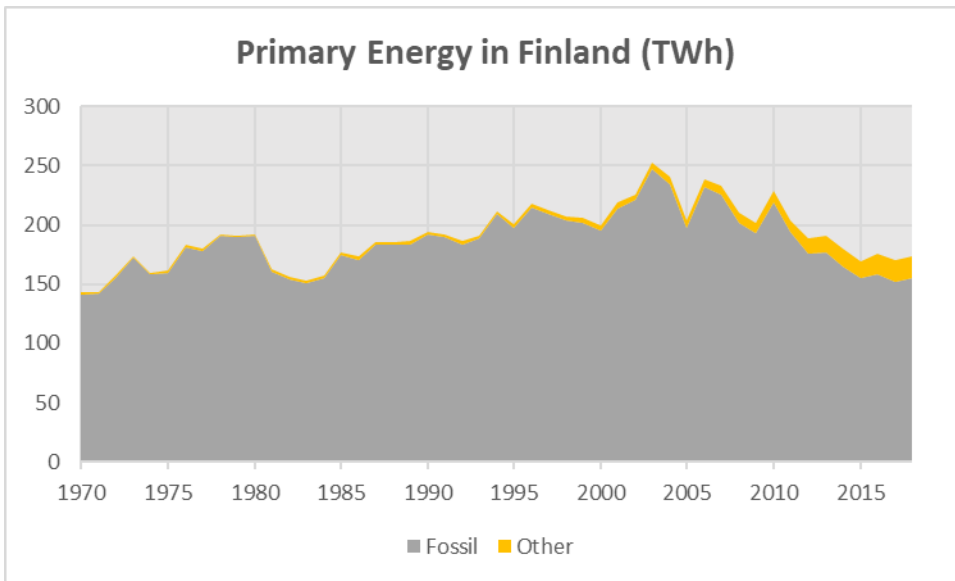


Figure 1.2.2 Fossil energy Sources in Finland (TWh).

2 Renewable sources

2.1 Sweden

Sweden has been increasing renewable energy since 1970 from about 83 TWh to 238 TWh in 2016 (Figure 2.1.1). The renewable energy sources are 24 MWh per capita in Sweden, which is the second highest figure among EU countries after Finland.

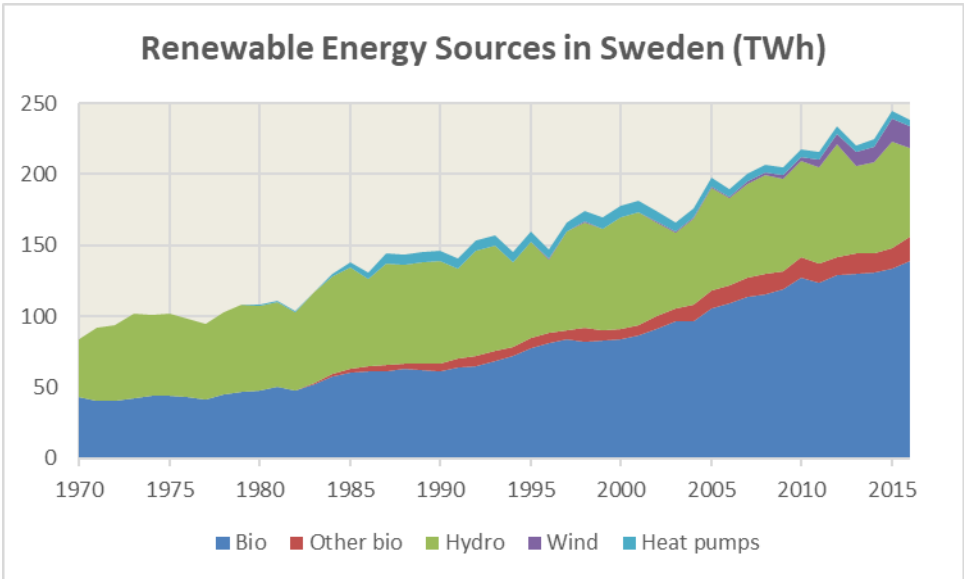


Figure 2.1.1 Renewable energy sources in Sweden (TWh).

Bioenergy has been the largest contributor of renewable sources. Bioenergy contributed 43 TWh in 1970 and 139 TWh in 2016 the growth has been 223 % or 2,6 % annually. The share of bioenergy was 59 % from renewable sources in 2016.

Hydro resources in Sweden are very large and they produce 62 TWh energy in 2016. This is 6 MWh per capita, which is the top figure in EU. Also, wind generation is very high or 15 TWh or 1.5 TWh per capita. This is among the top three countries in the world.

2.2 Finland

Renewable energy sources in Finland has been growing from 58 TWh in 1970 to 142 TWh in 2018. The renewable energy per capita 25,8 MWh is the highest figure within EU countries.

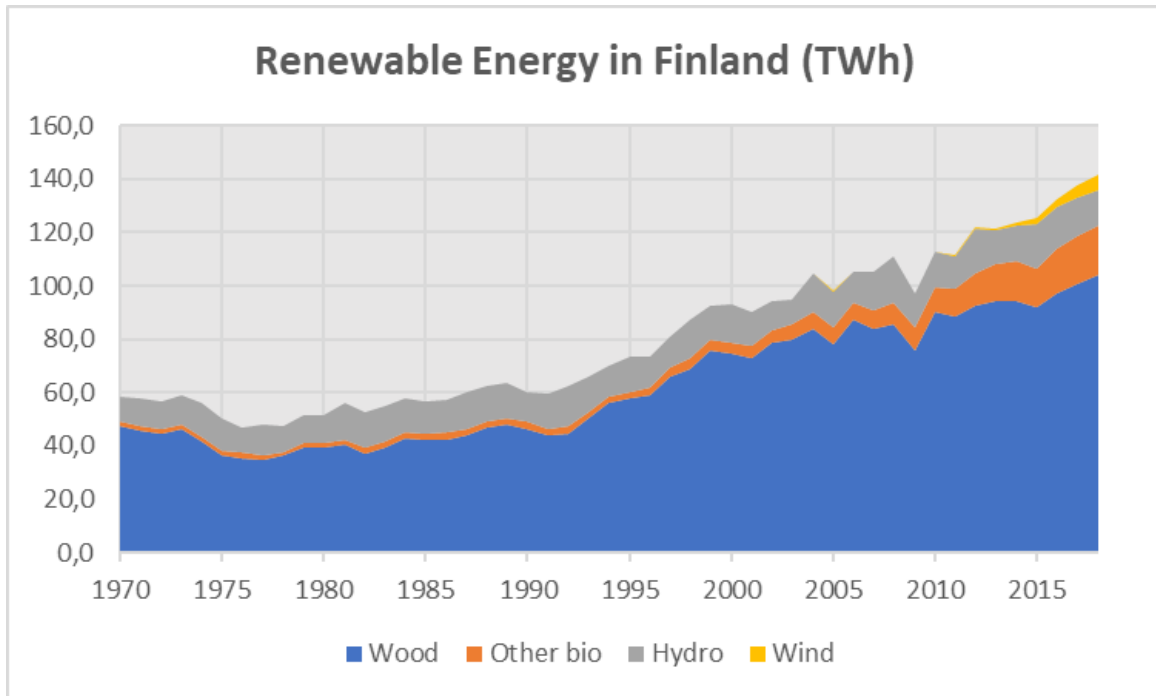


Figure 2.1.2 Renewable energy sources in Finland (TWh).

The reason for high renewable sources in bioenergy which includes wood and other bioenergy sources. They contributed 120 TWh in 2018 or 12 MWh per capita. This may be the highest figure in the whole world.

Although, hydro and wind are much smaller in Finland, the wind generation in 2018 was 5,9 TWh or 1,1 MWh per capita. This is among the top ten countries in the world. It is expected that wind power will expand rapidly in the future, because it is the most economical source of electrical power and Finland has been importing electricity about 20 TWh per year. If the electrical supply will be in balance after Olkiluoto 3 unit will be in operation and the wind power generation will reach 13 TWh.

3. Nuclear power

3.1 Sweden

Sweden has been one of the pioneering countries in nuclear power generation. It has had 13 reactors with inhabitants of 10 million or 1,3 per million people. The capacity of eight operating reactors is 8631 MW (Figure 3.1.1) or 0,86 kW/capita, which is the highest figure in the world. However, the Ringhals 1 and 2 reactors will be decommissioned in 2020, which means that the capacity will drop to 6800 MW or to 0,68 kW/capita and Finland will bypass Sweden with about 0,8 kW/capita capacity.

	Name	Type	Reference [MW]	Gross Electrical [MW]	(First Grid Connection
1	FORSMARK-1	BWR	988	1022	6.6.1980
2	FORSMARK-2	BWR	1118	1156	26.1.1981
3	FORSMARK-3	BWR	1172	1195	5.3.1985
4	OSKARSHAMN-3	BWR	1400	1450	3.3.1985
5	RINGHALS-1	BWR	882	910	14.10.1974
6	RINGHALS-2	PWR	907	963	17.8.1974
7	RINGHALS-3	PWR	1062	1117	7.9.1980
8	RINGHALS-4	PWR	1102	1171	23.6.1982
	Total		8631	8984	
	Year 2022		6842	7111	

Figure 3.1.1 Operating nuclear reactors in 2019 in Sweden (Source IAEA PRIS).

The primary energy generation from nuclear power has been varying between 150 and 220 TWh and has been declining lately because five of the 13 reactors has been decommissioned and another two (Ringhals 1 and 2) will be commissioned very soon (Figure 3.1.2).

Sweden will have in operation only six reactors after the year 2022 and the primary energy from nuclear power will drop from about 170 TWh in 2018 to about 130 TWh (13 MWh/capita). They will contribute only about 22 % from the total 600 TWh of primary energy.

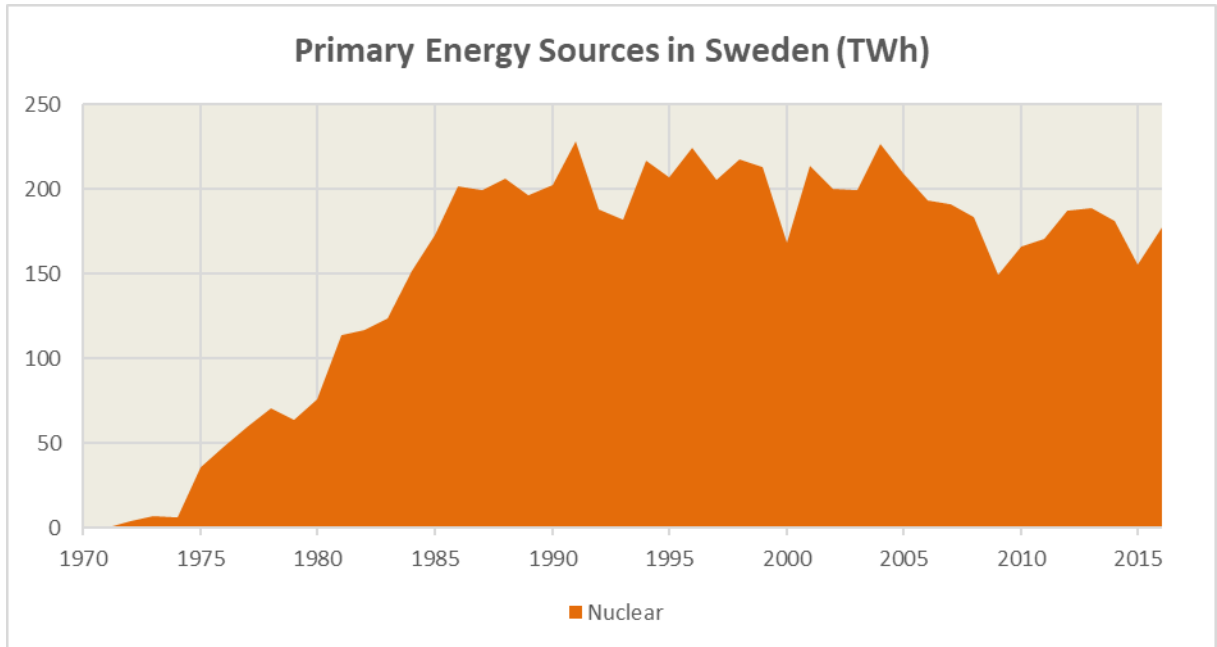


Figure 3.1.2 Nuclear energy as a source of primary energy (TWh).

3.2 Finland

Finland has four operating reactors. The fifth reactor will be commissioned in 2020 and will rise the nuclear capacity to 4380 MW (Figure 3.2.1). This is then 0,80 kW/capita.

Name	Type	Reference Uni [MW]	Gross Electric [MW]	First Grid Connection
LOVIISA-1	PWR	507	531	8.2.1977
LOVIISA-2	PWR	507	531	4.11.1980
OLKILUOTO-1	BWR	880	910	2.9.1978
OLKILUOTO-2	BWR	890	920	18.2.1980
OLKILUOTO-3	PWR	1600	1720	
Total		4384	4612	

Figure 3.2.1 Nuclear reactors in Finland.

Finland has been increasing its nuclear generation from 66 TWh in primary energy 100 TWh by 2021. Nuclear power will then contribute about 25 % of the 400 TWh of primary energy sources and 18 MWh/capita. Thus, the nuclear share of primary energy will bypass Sweden, which will have only about 22 % from nuclear or 13 MWh/capita.

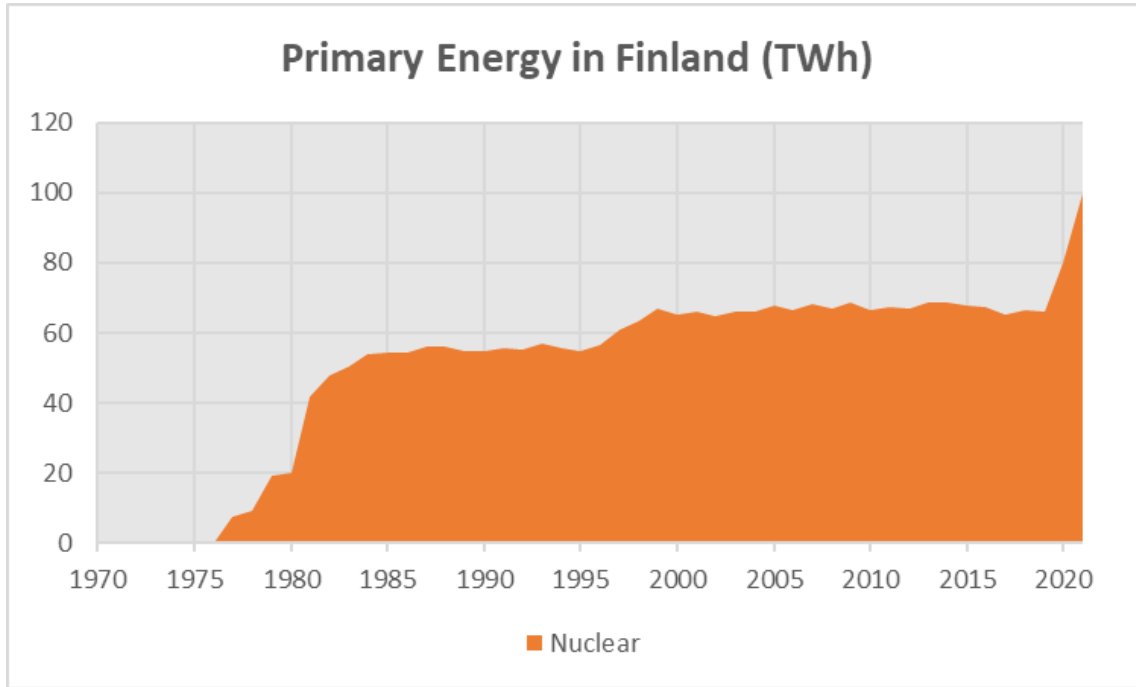


Figure 3.2.1 Nuclear power as primary energy in Finland (TWh).

4 Fossil energy

4.1 Sweden

Fossil energy sources have been declining from 350 TWh in 1970 to 160 TWh in 2016 (Figure 4.1.1). The fossil fuels contributed about 28 % of total primary energy in Sweden.

The main source of fossil energy has been oil, which contributed 127 TWh (80 %) of fossil sources in 2016. Per capita consumption of oil was 12,7 MWh/capita, which is about the same figure as nuclear energy per capita in 2022. Oil is still needed in transportation sector, where the share of oil is about 90 %.

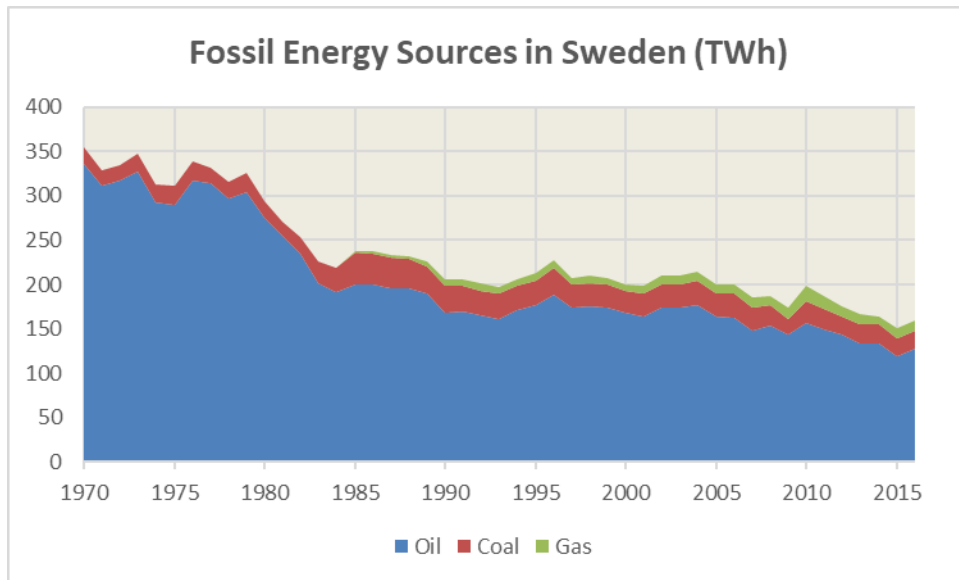


Figure 4.1.1 Fossil energy sources in Sweden (TWh).

4.2 Finland

Fossil sources of energy in Finland cover 150 TWh or 43 % from total primary energy of 363 TWh (Figure 4.2.1). Oil contributed 85 TWh or 57 % of fossil sources. Share of oil was 15,5 MWh per capita, which is 22 % higher than in Sweden.

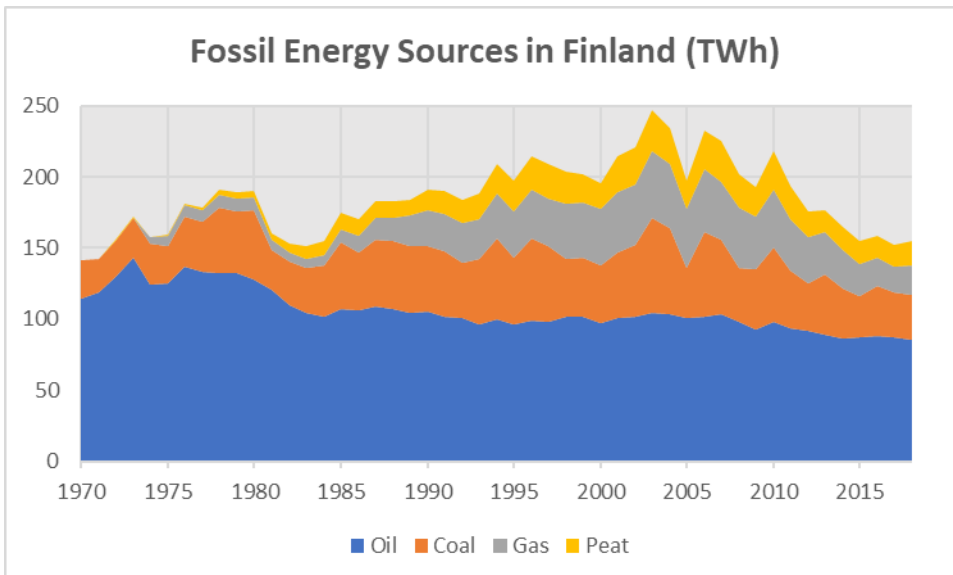


Figure 4.2.1 Fossil energy sources in Finland (TWh).

Difference in Finland to Sweden comes from the much higher share of coal (32 TWh) in Finland versus Sweden (21 TWh) and higher share of gas in Finland (20 TWh) versus Sweden (11 TWh). There is also difference in peat, which Finland is using 17 TWh annually.

5 CO2 Emissions

5.1 Sweden

CO2 emissions in Sweden have been declining from 100 MtCO2 in 1970 to about 44 MtCO2 in 2016 (Figure 5.1.1). The emissions have decreased 56 % or in average 1.8 % per year. CO2 emissions per capita are 4,4 tCO2/capita, which is the same as the average emissions in the world.

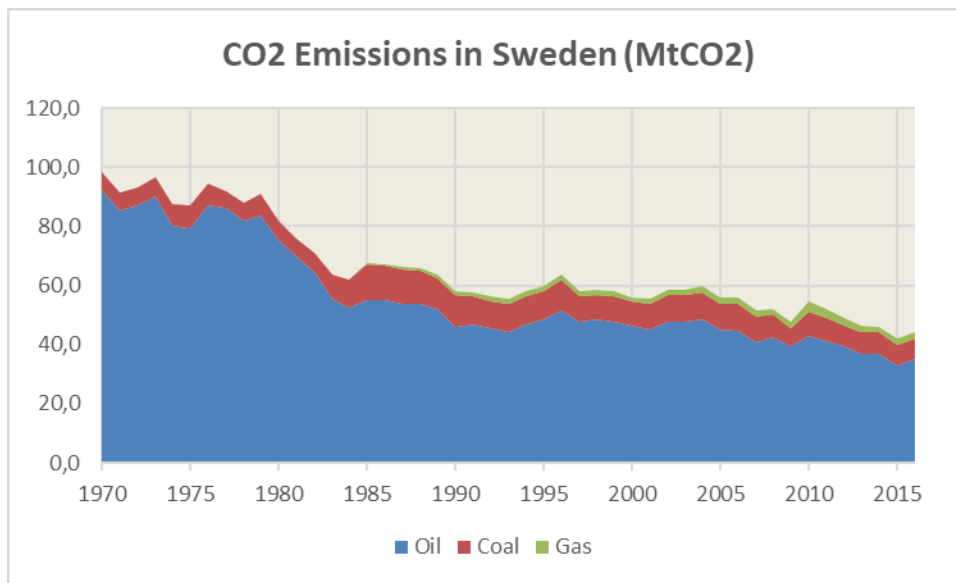


Figure 5.1.1 CO2 emissions in Sweden from fossil sources.

The CO2 emissions have been decreasing from 58,1 MtCO2 in 1990 to 44,4 MtCO2 in 2016 or with 24 %. This is more than the 20 % EU goal until 2020.

5.2 Finland

The CO₂ emissions in Finland have increased from 40 MtCO₂ in 1970 to 45 MtCO₂ in 2018 (Figure 5.2.2). This number (45 Mt) was higher than in Sweden and specific emissions in Finland were 8,2 t/capita, which was 86 % higher than in Sweden.

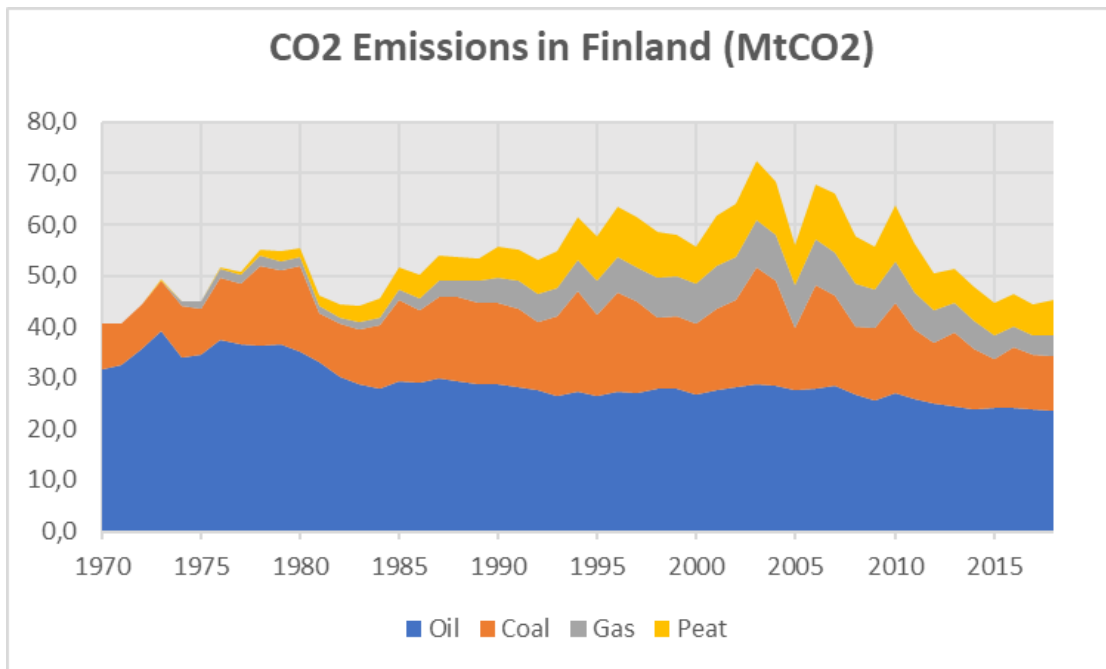


Figure 5.2.1 CO₂ emissions in Finland (MtCO₂).

From 1990 the emissions have been decreasing from 55,6 MtCO₂ to 45,3 MtCO₂ in 2018. This is 19 % smaller than in 1990 and Finland will reach its goal to decrease 20 % emissions until 2020.

6. Land use, land use change and forests (LULUCF).

6.1 Sweden

Land use, land use change and forest (LULUCF) form carbon sink in Sweden, which has been acting as a carbon net sink of about 34 MtCO₂ in 1990 and about 44 MtCO₂ in 2017 (Figure 6.1.1).

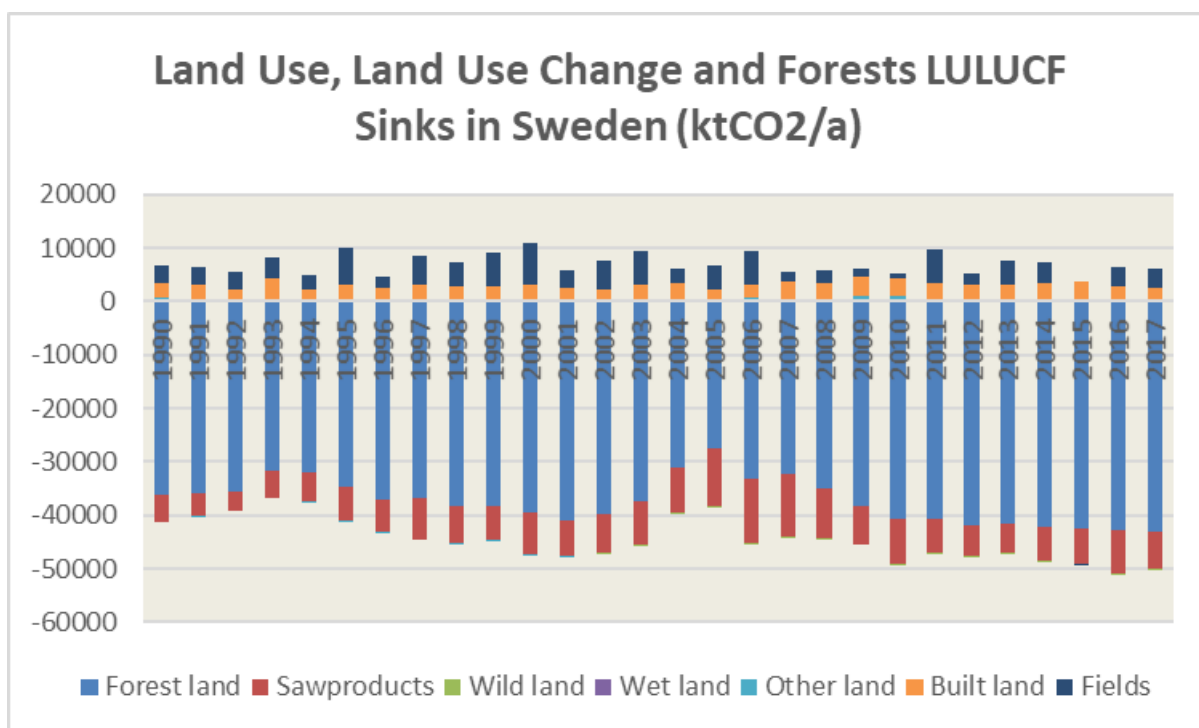


Figure 6.1.1 Land use, land use change and forests (MtCO₂).

The net influence of LULUCF sector has been that it has been acting as a carbon sink, which has been absorbing about 45 Mt CO₂ annually during years 2016 and 2017 (Figure 6.1.2). The main carbon sink has been forests and forest products which have been increasing their carbon sink from 41,2 MtCO₂ in 1990 to 49,9 MtCO₂ in 2017.

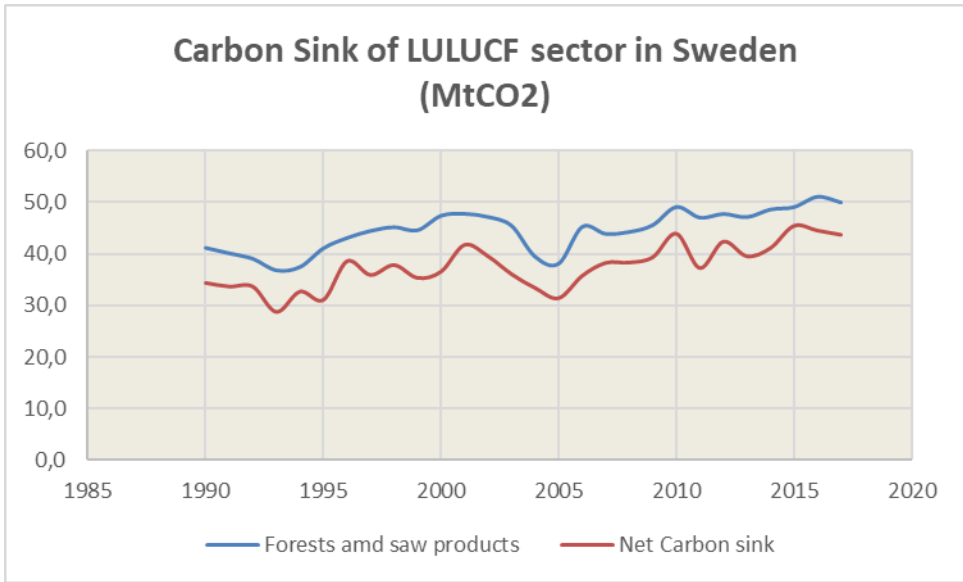


Figure 6.1.2 Carbon sink of LULUCF sector in Sweden (MtCO₂).

6.2 Finland

Land use, land change and forest (LULUCF) sector has carbon sinks in forest and saw products and emissions in fields, grassland wet land and built land (Figure 6.2.1).

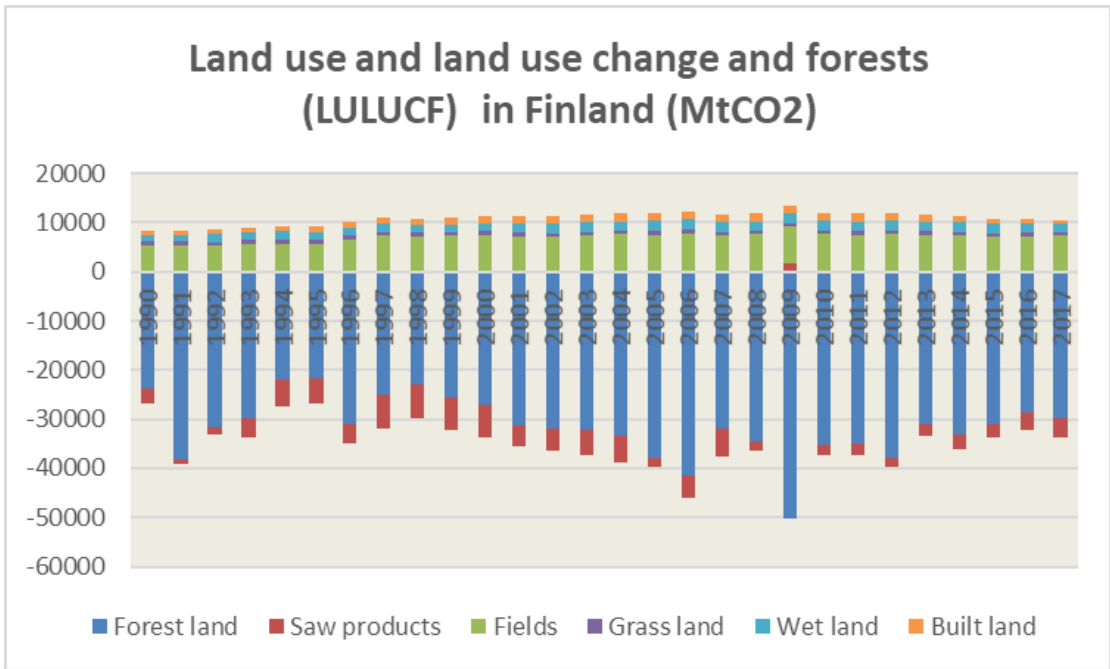


Figure 6.2.1 Land use, land use change and forests (ktCO₂).

The net carbon sink (sinks minus emissions) in Finland has been about 24,5 MtCO₂ annually since the year 1990 (Figure 6.2.2). However, the Finnish figures have not been updated.

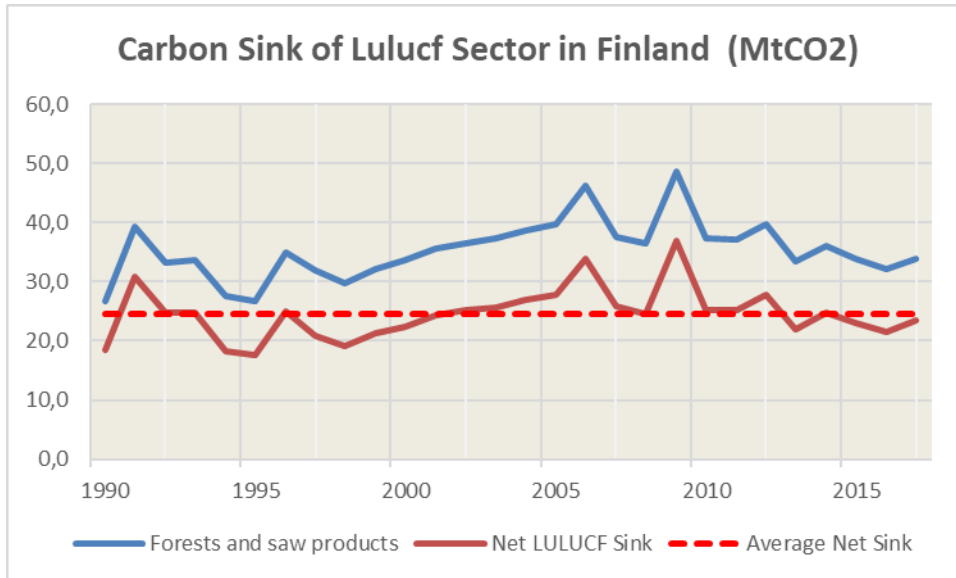
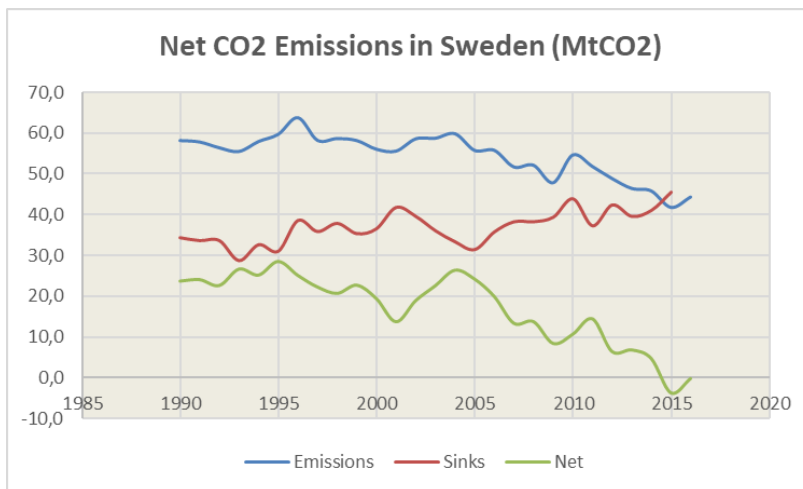


Figure 6.2.2 Carbon sink of LULUCF sector in Finland (MtCO₂).

7 Net Emissions

7.1 Sweden

The net CO₂ emissions in Sweden have reached zero in the year 2015 (Figure 7.1.1). Sweden is the first country to reach zero CO₂-emissions in EU.



7.1.1 Net carbon emissions in Sweden (MtCO₂).

7.2 Finland

The net carbon emissions in Finland have been declining from 40 MtCO₂ in 1990 to about 21 MtCO₂ in 2017 (Figure 7.2.1). The reasons for reductions are mainly the CO₂ emissions, which have been declining from about 58 MtCO₂ in 1990 to about 45 MtCO₂ by 2017. This reduction has been 13 MtCO₂ or with 20 %. The net carbon sink has remained at the same level of about 25 MtCO₂ since 1990.

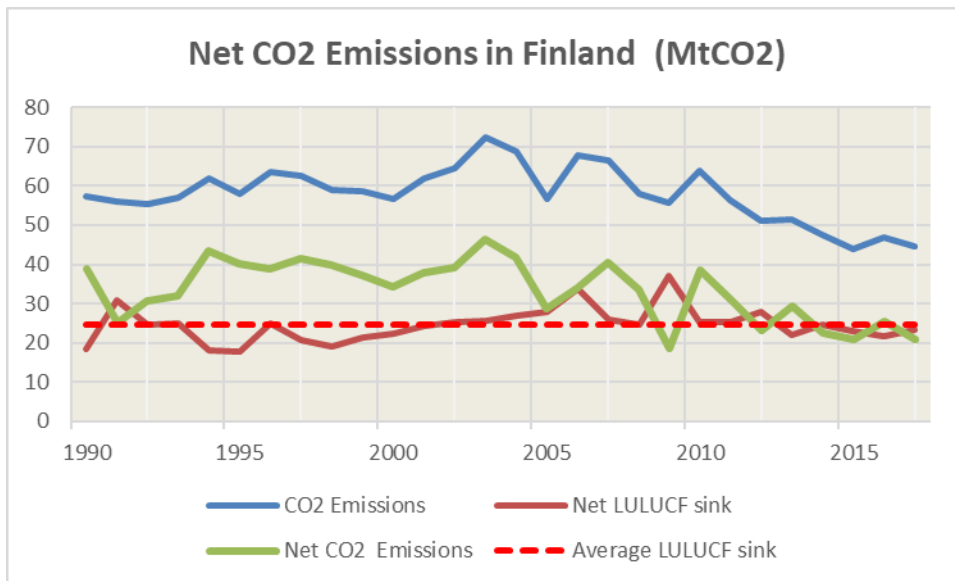


Figure 7.2.1 Net CO₂ emissions in Finland (MtCO₂).

The emissions have been declining about 25 MtCO₂ (from 70 to 45 Mt) during the last 14 years or 1,8 tCO₂/a. If the same trend (1,8 tCO₂/a) will continue the emissions will reach the sinks of 24.5 Mt after 11 years or by the year 2030. However, the LULUCF sinks have been declining during the last years because the use of wood has been increasing.