

A Comparison of Denmark and Sweden a propos CO₂ Emissions

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Compared to larger European countries like Germany or France, the CO₂ emissions from fuel combustion of Denmark and Sweden may be deemed marginal. However, when the per capita emissions are considered, they are in the same ballpark as Germany for Denmark and as France for Sweden¹:

	Germany	France	Denmark	Sweden
CO ₂ Emissions from fuel combustion (Mt of CO ₂)	849	387	51	52
CO ₂ per capita (t CO ₂ per capita)	10.3	6.22	9.44	5.78
Population (million)	82.5	62.2	5.4	9

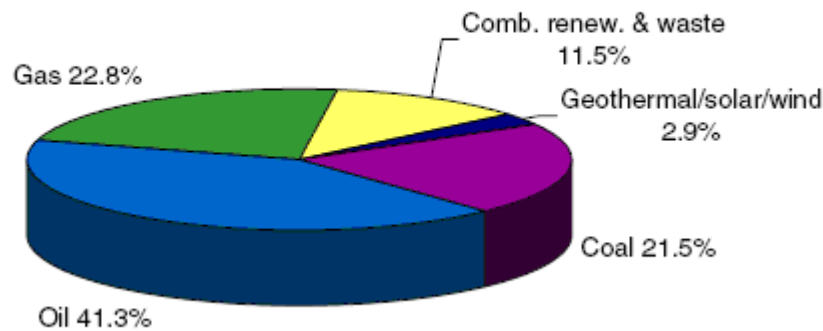
Denmark and Sweden are close neighbors, they have pretty much the same climate, so that it is interesting to try to understand what makes them so different in their per capita GHG (Green House Gas) emissions from fuel combustion. Indeed, the CO₂ emissions of Denmark and Sweden are practically equal while the population of Sweden is much larger. Thus, the per capita CO₂ emissions of Denmark are 63 % larger than those of Sweden.

WHICH PRIMARY ENERGY SOURCES?

Denmark's primary energy consumption in 2004 was 20 Mtoe, or 3.7 toe/cap/yr; that of Sweden was 54 Mtoe, or 6 toe/cap/yr (for the sake of comparison, that of France was 275 Mtoe, or 4.4 toe/cap/yr).

As shown in the figures below, the shares of the various primary energy sources in the total primary energy supply are quite different in Denmark and Sweden.

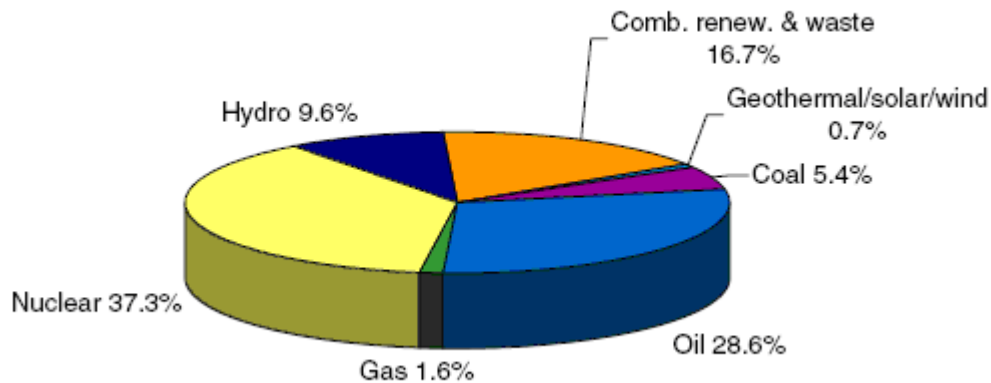
Denmark



Fossil fuels account for 85.6 % of Denmark's primary energy supply. Oil comes first with 8.3 Mtoe, a little more than half of which is consumed for transportation (5 Mtoe), representing 0.92 toe/cap/yr (in France it's 0.8). Gas (4.6 Mtoe) is shared about equally between electric power produced in combined heat and power plants (CHP) and other uses (residential, industry, ...). Coal (4.3 Mtoe) is used mainly for electric power in CHP plants. Finally, renewables (3.3 Mtoe) comprise mainly wind energy (0.58 Mtoe) biomass and waste.

¹ We will be using figures for 2004 from IEA statistics: <http://www.iea.org/Textbase/stats/index.asp> throughout this text

Sweden



Fossil fuels account for only 35.6 % of the Swedish primary energy supply (52 % in France).

Here, too, oil comes first with 15.4 Mtoe, of which about half is for transportation: 8.1 Mtoe, or 0.9 toe/cap/yr a value close to that of Denmark; this is not where the two countries differ. Coal accounts for less than 3 Mtoe and gas for 0.9 Mtoe.

Among the non GES emitting energies, nuclear energy is the biggest: it accounts for 20 Mtoe, producing electricity in the amount of 77 486 GWh. Next is hydro power with 5.2 Mtoe, producing 60 178 GWh. Other renewables account for 9 Mtoe, the biggest contributor being wood with 8.2 Mtoe (the Swedish forest produces just a little less than the French one).

ELECTRICITY AND INDUSTRIAL HEAT

Electricity production and consumption

Denmark's electric power consumption is 32 793 GWh, while Sweden's is 130 361 GWh, almost four times as much (France's consumption is 415 880 GWh). Both Sweden and Denmark export a small amount of the electricity they produce. The contribution of the different energy sources used to produce their electricity are shown in the tables below.

	Production	Net export	Coal	Oil	Gas	Biomass	Waste	Wind	
GWh	40 477	2 872	18675	1633	10 001	2 099	1 446	6 583	
Percentage			7.1	46.1	4	24.7	5.2	3.6	16

Table 1: Denmark's Production of Electricity

	Production	Net export	Coal	Oil	Gas	Biomass	Nuclear	Hydro	Waste Other	
GWh	151 727	2 104	2 510	1 954	749	6709	77 486	60 178	2 141	
Percentage			1.4	1.7	1.3	0.5	4.4	51	39.6	1.4

Table 2: Sweden's Production of Electricity

In 2004 Sweden produced only 3.5 % of its electricity from fossil fuels. On the contrary, Denmark produced 74.7 % of its electricity from fossil fuels, mostly coal. Coal alone represents 7 Mtoe burned, or the emission of approximately 18 Mt of CO₂. Wind power accounted for 16 % of the electric power produced in Denmark in 2004.

The time evolution from 1971 to 2004 ([see figure](#)) of the primary energy sources contributing to electricity production for both countries shows that, while Denmark has been progressively reducing its reliance on coal in its production of electric power to the benefit of gas and wind, coal still contributes too much. Moreover, gas, too, is a fossil fuel, after all.

Heat production for district heating

District heating is quite developed in Sweden and even more so in Denmark where more than 6 out of 10 homes are connected to a district heating network. Both countries feed their district heating networks with the heat from CHP plants as well as with that from dedicated heat plants. The contributions of the different primary energy sources that produce this industrial heat, as measured in ktoe equivalent caloric value, are shown in the tables below. The primary energy heat equivalent amounts are given separately for CHP plants and for heat plants.

	Coal	Oil	Gas	Biomass Waste	Other	Total Sources	<i>Heat Produced</i>	<i>Electricity Produced</i>
CHP plants	4 121	364	2 225	1 207		7 917 ²	2 522	2 908 (33 820 GWh)
Heat plants	1	40	73	424	5	543	567	-2 (-23 GWh)

Table 3: Denmark's Industrial Production of Heat (ktoe)

	Coal	Oil	Gas	Biomass Waste	Total Sources	<i>Heat Produced</i>	<i>Electricity Produced</i>
CHP plants	907	450	246	2 862	4 465	2 564	1 113 (12 944 GWh)
Heat plants	105	147	32	961	1 245	1 374	-202 ³ (-2 349 GWh)

Table 4: Sweden's Industrial Production of Heat (ktoe)

It is interesting to compare Denmark and Sweden in this area as well. Sweden feeds its CHP plants mostly with biomass (wood). These produce 13 TWh while its dedicated electricity power plants produce ten times as much, 139 TWh. Denmark feeds its CHP plants mostly with coal and gas. These produce almost all of Denmark's electricity: 34 TWh, the remainder being only 6.7 Twh, mostly due to wind turbines. These data confirm what we had already noted for electric power but soften the results somewhat in that the heat produced in furnace power plants is used to supply district heating networks. However, only seldom do the demand for heat and for electricity coincide so that the true energy efficiency of cogeneration is debatable, especially when it is the principal electric power producer as in Denmark. What with the heat when the weather is warm?

To conclude, Denmark resorts heavily to fossil fuels for its production of both its electric power and its industrial heat whereas Sweden resorts to other primary energy sources which are either renewable or do not emit CO₂. True, Sweden is in a privileged situation for its access to hydro power and to biomass but Denmark could considerably reduce its CO₂ emissions if it were to call on nuclear power as Sweden has been doing.

² The total for CHP plant final heat (7 917) is counted as direct heat for 2 522 and heat for electric power production for 2 908. The remaining 2 487 ktoe of primary energy is lost to the atmosphere (cold source, Carnot cycle ...).

³ This corresponds to electric boilers.

SOME GLOBAL INDICATORS

A comparison of some global energy and CO₂ emission indicators of Denmark and Sweden is instructive as well. In the table below, we compare their

- **Energy intensity:** the ratio of the Total Primary Energy Supply (TPES) to the Gross Domestic Product (GDP). It is given in toe/thousand \$. The dollars are year 2000 US \$. The GDP is corrected for the purchasing power parity (PPP). TPES/GDP (PPP) in toe/1000\$
- **CO₂ Intensity:** the ratio of CO₂ emissions from fuel combustion to the GDP corrected for the PPP. CO₂/GDP (PPP) in kg CO₂/\$
- **CO₂ emissions per unit primary energy supply:** the ratio of CO₂ emissions from fuel combustion to the TPES in t CO₂/toe.

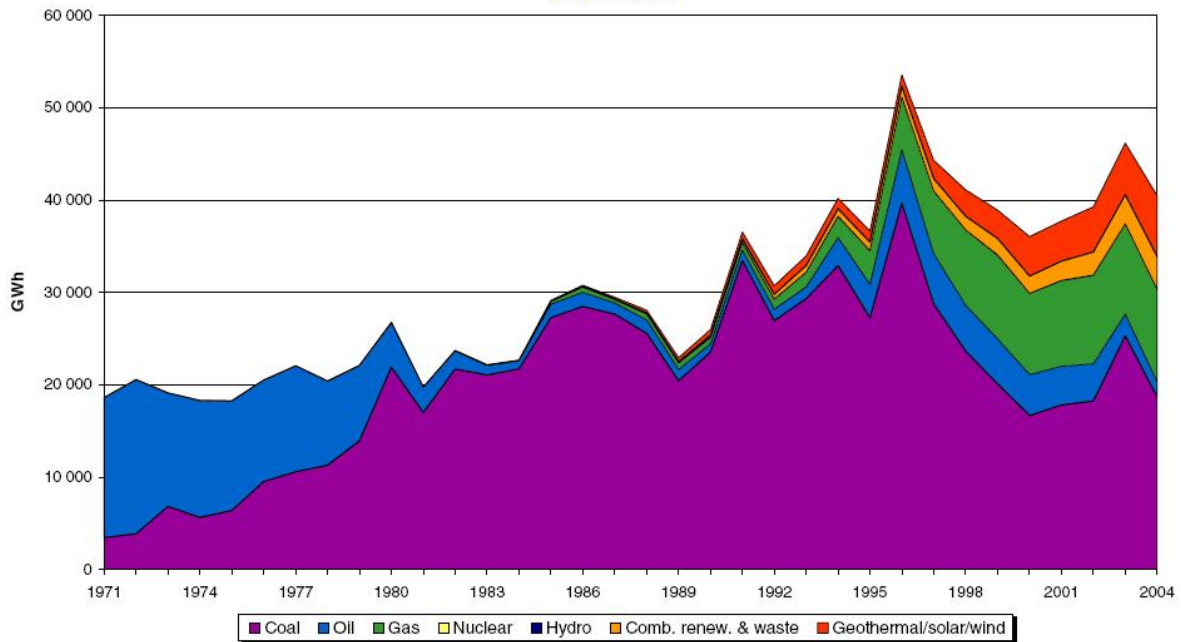
	Energy intensity	CO ₂ intensity	CO ₂ /TPES
Denmark	0.13	0.32	2.54
Sweden	0.21	0.20	0.97

Table 5: A Few Global Variables for Denmark and Sweden

Sweden's energy intensity is about 60 % larger than Denmark's yet its CO₂ intensity is 40 % smaller. This confirms that the smaller CO₂ emissions of Sweden are not related to more thrifty energy consumption, on the contrary. The key lies in the choice of primary energy sources that we have illustrated in the tables above. This is confirmed, if need be, by the ratio of CO₂ emissions to the Total Primary Energy Supply of the two countries. Denmark's is more than twice that of Sweden.

Evolution of Electricity Generation by Fuel from 1971 to 2004

Denmark

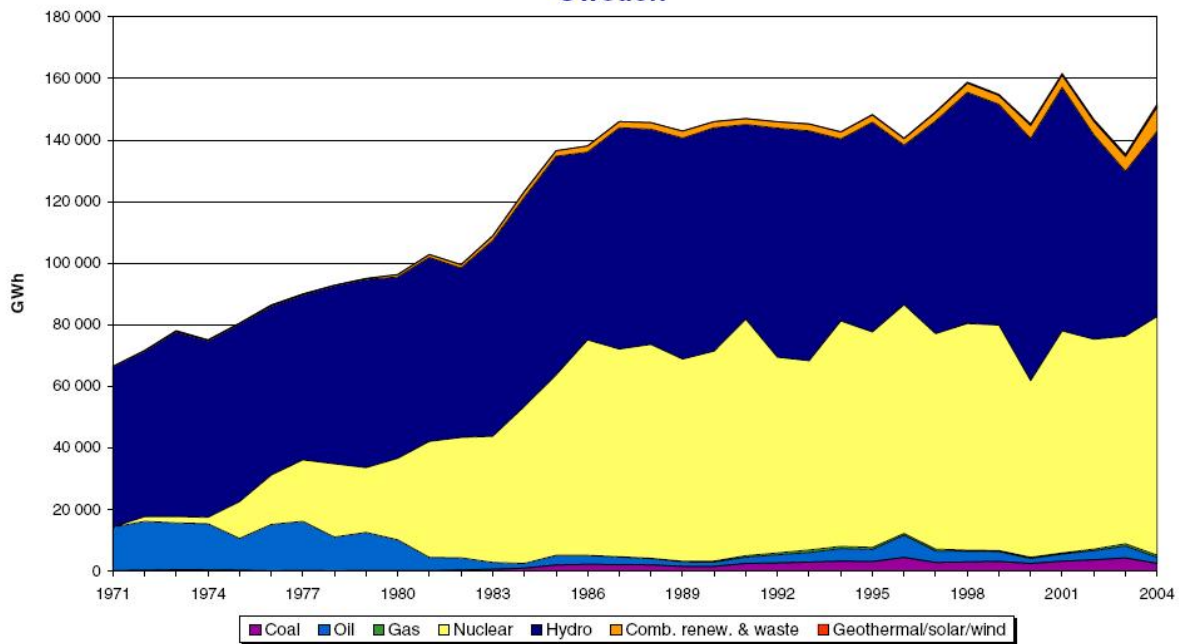


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For more detailed data, please consult our on-line data service at <http://data.iea.org>.

Evolution of Electricity Generation by Fuel from 1971 to 2004

Sweden



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