Export of energy technology: The case of Denmark.

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Energy technology and foreign trade: The case of Denmark

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Abstract

This paper address two issues related to energy technology and trade. First it examines the importance of changes in energy technology for long-term trade developments of the Danish manufacturing industry. Secondly the trade potential of a policy to support the development of environmental friendly energy technologies is examined.

Energy technologies affect the competitive position of industries through their energy costs. This paper presents an empirical investigation of the Danish industries with respect to the energy intensity and the relative production development of the energy intensive industries relative to the average industry.

Another important effect of the change in energy technologies is the competitive option for the industries producing the capital equipment of a specific energy technology. Here the consequences for the Danish wind turbine manufacture and for the manufacture of pipes for district heating can be highlighted. Exports of the environmental friendly technologies are found to be the most important contribution to trade figures in the Danish case.

1. Introduction

Energy technology and foreign trade has been studied mainly in relation to the environmental implications of energy use. The focus has been on the environmental implications of trade. In this paper focus is switched to the trade impacts from change in energy technology and the effect on trade in energy goods and technologies induced by environmental concern.

Trade and environment have received considerable attention in both applied studies and theoretical work.[1] Two recent special issues of environmental journals[2] and books by, for example, Carraro (1994) and Rauscher (1997) have been devoted to these subjects. Much of the applied literature deals with the pollution heaven hypothesis, namely, that polluting industries will relocate to areas of the world where environmental regulation and standards are being dumped. Johnstone (1995) is also concerned with this issue and presents a number of arguments related to trade liberalisation and its environmental

[1] For a recent overview of methodologies see van Beers and van den Bergh (1996)
[2] Resource and Energy Economics19 (4), 1997 and Ecological Economics 9 (1), 1994

implications. He argues that there are many reasons that trade liberalisation could have environmental implications. However, he finds that one aspect has been neglected, and that is the impact of specialisation and homogenisation on ecosystems. Specialisation will reduce the biological diversity locally and homogenise agricultural crops. He also gives an example of trade restrictions that have impacts on the technology and energy use in the agricultural sector of Europe. The subsidies in the European agricultural market to some extent imply that the agricultural technology is more fertiliser and energy intensive than in other regions of the world. Thus, he finds that trade restrictions imply use of a technology that is energy intensive where the objective of this paper is to examine whether the energy technology used in a sector has implications for the trade performance of the sector.

A number of studies have been looking at the NAFTA complex both before the implementation of the agreement and afterwards.[3] Trade and energy related emissions has been examined in an input-output decomposition study by Gale (1995), that investigates the trade liberalisation impact on Mexican emissions of CO_2. Results from this study suggest that the trade liberalisation is likely to produce a shift away from CO_2-intensive production in Mexico. This is contrary to the often raised argument against trade liberalisation that the low-income country will attract all the polluting industries by having the least restrictive environmental standards.

Trade and environment are also tied directly to energy consumption. Batra et. al. (1998) examine trade among two countries with the conclusion that there can be two much trade because the trade itself is accompanied by a large energy consumption associated with the international transport. This could have important implications in the Danish case where there are substantial revenues from overseas transport.

Steininger (1994) discuss the impact on trade flows from environmental regulation and the need for counterbalancing the competitive disadvantage imposed on domestic producers from unilateral regulation. He refers to other studies that find very low impact on trade flows, but this is caused by the relatively small costs imposed on producers by environmental regulation. The costs imposed on the majority of the manufacturing producers amount to around 1% of total production costs only.

Duchin et. al. (1995) discuss among other issues the rise of world trade in pollution abatement and the emergence of an environment industry. They notice that trade in these products and services have been growing fast. Morthorst (forthcoming) describes the fast expansion of wind power capacity in the world and the prospects for continued growth of this market. The profitability of wind turbines in various organisational settings is examined with respect to the effect on expansion of the wind turbine market.

The experiences that have been obtained in the Danish case, with export opportunities created for new energy technologies especially wind turbines, are examined in the second part of this paper.

2. Energy technology change in Denmark and foreign trade

Changes in energy technology have impacts on foreign trade through different channels. Three different aspects of change in technology can be highlighted.

- Change in energy efficiency and technology has consequences for the competitive position of industries.

[3] Grossman and Krueger (1991), Gale (1995)

- New energy technologies create export possibilities.
- Energy technology change has impacts for trade in energy commodities.

Denmark has very few energy intensive industries today. To some extent the development of energy technologies and energy policies for the implementation of new technologies has contributed to less energy intensive industries in Denmark. It also seems that the relatively energy intensive industries have succeeded in energy efficiency improvements to some extent by changing their activities towards more R&D and consulting. Any expansion of the energy intensive part of production has then been placed abroad. There are several other explanations of why the share of energy intensive industries of Denmark has decreased. Energy intensive industries will, for example, often be characterised by increasing returns to scale. With high energy costs, the international competitive position has been dependent on the ability to decrease energy costs and compete or to lose their market.

The relative importance of technological progress in energy technologies versus labour augmenting technological progress is not very clear. For the industries with low energy intensity it is possible that cost reductions to some extent have been achieved by investments aiming at reducing labour input but not reducing energy input. For the energy intensive industries it is possible that some have achieved cost reductions by changing energy technology or introducing conservation technologies. The degree to which this has taken place, or if a failure to reduce energy intensity and costs has led to stagnation or decline in these industries, will be examined in here.

The availability of cheap power resources of a non-transferable nature and located at remote places has led to a concentration of the very energy intensive industries at such locations. Denmark has no such resources and no new energy intensive industries have been located here.

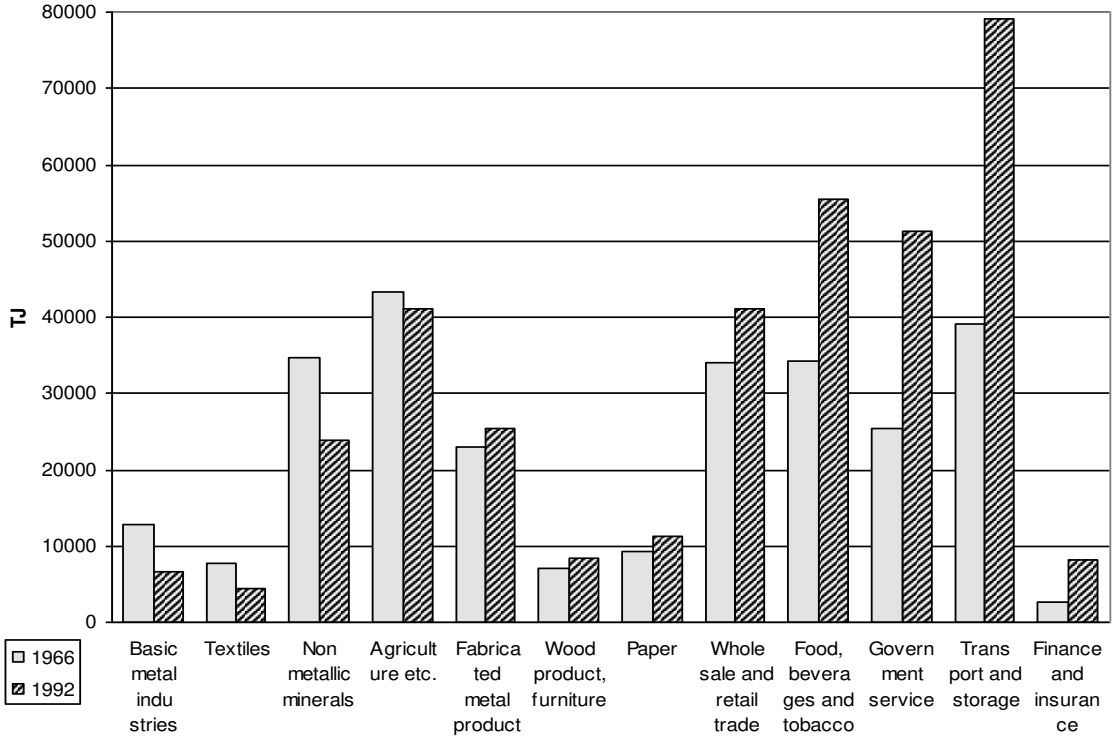


Figure 1 Energy input in Danish industries, 1966 and 1992

The industries in Figure 1 are sorted by the relative change in energy demand from 1966 to 1992. In the service sector energy demand has increased quite substantially, while in some of the manufacturing industries and agriculture energy demand has fallen. Much of the explanation for this development must be that the service sectors' share of total production has increased relative to the more primary industries but there are, at the same time, changes in the energy intensity in the sectors where especially the manufacturing sectors have reduced their energy intensities.

Danish industries	Production 1966 mill. DKK	Production 1992 mill. DKK	Energy intensity TJ per mill. DKK 1966	1992	Energy consumption 1966-1992
Basic metal industries	2601	2839	4.95	2.34	-48%
Textiles	9507	10378	0.82	0.43	-42%
Non metallic minerals	5996	6547	5.79	3.63	-32%
Agriculture etc.	30686	43006	1.41	0.95	-5%
Fabricated metal products	31465	64689	0.73	0.39	11%
Wood products, furniture	6123	11313	1.16	0.75	20%
Paper	11872	17667	0.79	0.64	20%
Wholesale and retail trade	42493	75258	0.80	0.55	21%
Food, beverages and tobacco	47610	80214	0.72	0.69	62%
Government services	52871	123902	0.48	0.41	102%
Transport and storage	30792	63491	1.27	1.25	103%
Finance and insurance	9398	14887	0.29	0.55	206%

Table 1 Production and energy intensity changes in selected Danish industries

As the data in Table 1 reveal the very different developments in Figure 1 are among other things caused by production and energy intensity changes. The industries that have experienced large reductions in energy consumption are those where energy intensity were high and where intensity have been reduced considerably. Some industries with considerable energy intensity reductions have experienced production increases that more than outweigh this. Finally the industries with relatively low energy intensities in 1966 and little reduction of this combined with large production increases are also those that exhibits the largest increases in energy consumption. To get more insight in these underlying changes, including the importance of structural change, a decomposition analysis such as in Wier (1998) could be conducted. However, this paper is more concerned with the **production and export performance** of the industries as depending on their energy technology characterised by energy intensity and fuel composition.

The change in energy technology and energy conservation technologies has created export opportunities for Danish industries. This has especially been the case for wind turbines and district heating pipelines. With regard to conservation and purification technologies both the sector producing insulation materials and also production of de-sulphuring equipment have benefited. Also the service sectors of consulting on energy technology implementation and energy planning have raised considerable export earnings. Some of these export successes will be quantified below.

A very large impact on the balance of trade can be attributed to a change in trade with energy commodities. Much of this change has nothing to do with a change in energy technology but, to the extent that a change in fuels can be characterised as a change in technology especially the introduction of coal for power production and natural gas in particular, has had large impacts on the balance of trade. Another issue is the trade in electricity, which is of growing importance with large annual fluctuations and increased transmission capacities. The dominating power production technology today of combined heat and power also has implications for the possibilities of trade in electricity.

3. Production and export performance related to energy intensity and energy technology

In the period from the mid sixties to the early nineties the energy technology used in production sectors as well as in energy conversion has changed drastically. The economy has become less energy intensive due to a change in the composition of final demand and a change in production structure along with a reduction in energy intensity for nearly all sectors. In a study by Pløger (1984) the Danish domestic energy use as well global energy content were examined. The decomposition of global energy consumption for production of Danish final demand shows that the structural components of input-output structure and composition of final demand are even less important for changes in global energy content than in a decomposition of domestic energy use for production. Another result is that the effect of changes in imports tended to decrease the part of global energy content in final demand actually being used in Denmark. One reason for this last result could be that Danish industries with high energy intensity have behaved relatively worse than the average industry with respect to import competition. The study of Pløger analysed data for the period 1966-1979, whereas this study uses data for the period 1966-1992.

Manufacturing industries in Denmark are relatively less energy intensive compared to international levels. This is mainly a result of the very few energy intensive industries in Danish manufacturing. An interesting question is the performance of manufacturing industries with respect to production dependent on the energy intensity of their production. It is obvious that manufacturing as a whole has experienced slower demand growth than the overall economy due to a shift in consumption towards services. But it is not necessarily the case that the energy intensive industries should experience slower growth than the less energy intensive industries.

Therefore the Danish manufacturing industries have been examined with respect to their production and export performance combined with energy intensity and fuel composition. The appendix includes data on all the manufacturing industries sorted by their energy intensity in 1992.

Energy intensity classification 1992 TJ/mill. DKK	Share of manufacturing production 1992	Average energy intensity TJ/mill. DKK	Change in production 1966-1992	Change in exports 1966-1992	Share of direct exports in production 1992
< 1	86.2%	0.41	+83%	+193%	50%
1 – 3	12.3%	1.67	+62%	+293%	40%
> 3	1.5%	6.71	-1%	+135%	49%
Total manufacturing	100.0%	0.66	+78%	+199%	49%

Table 1 Change in production and exports dependent on energy intensity

In Table 1 the 82 branches of manufacturing have been grouped according to their energy intensity in 1992. The three categories in the table show that only 1.5% of Danish manufacturing production can be attributed to very energy intensive production. An additional 12.3% of manufacturing production can be referred to industries with energy intensity significantly higher than the average but with an intensity average of only 1.67 TJ per mill. DKK (1980 prices) these industries will probably not have the major share of production costs from energy use. The four very energy intensive branches: cement, structural clay products, paper and pulp and iron and steel works, have experienced a much less favourable development than the majority of manufacturing industries. Only structural clay products have experienced a drastic reduction of production, whereas the three others have experienced more stable production. For the three most energy intensive industries it is striking that they have not been able to achieve the same reduction in intensity as most other manufacturing industries and also iron and steel works have (see appendix). All four energy intensive industries have increased their export with the largest increase for manufacture of pulp, paper and paperboard (329%) but on average the increase of exports for these four industries is below the average for manufacturing industries. However, the reason for this whether caused by deteriorated competitive position as a consequence of high energy costs or by a global reduction of demand for their output cannot be answered by these data.

Also the group that consists of 18 manufacturing industries with energy intensity between 1 and 3 TJ/mill. DKK have experienced slower growth than the average for manufacturing industries. However, their export performance is better than the average. The good export performance is dominated by one industry namely manufacture of basic industrial chemicals. The export growth for this sector is mainly based on industrial enzymes that are not depending on the energy technology used for its production.

Energy intensity classification 1992 TJ/mill DKK	Share of liquid fuels 1966	Share of liquid fuels 1992	Share of electricity 1966	Share of electricity 1992	Share of natural gas 1992
< 1	52%	18%	33%	64%	6%
1 – 3	68%	27%	18%	42%	14%
> 3	66%	10%	15%	48%	11%
Total manufacturing	55%	19%	30%	61%	7%

Table 2 Fuel technology change

The very energy intensive industries have more substitution possibilities between fuels than the two other groups. This can be seen from Table 2 where the energy intensive industries reduced the share of liquid fuels much more drastically than the two other groups. It is also for the two most energy intensive group of industries that natural gas has been most widely introduced. For the manufacturing industries with low energy intensity the share of electricity is very high. This is a result of a limited number of processes where there are any alternative to electricity. It is only due to the inclusion of iron and steel works that the energy intensive industries have an electricity share of 48%. In iron and steel works the electricity share is as high as 83%. For iron and steel works the substitution to electricity has reduced the energy intensity considerably, where the

fuel substitution for the three other energy intensive industries has been accompanied by minor changes in energy intensity only. Natural gas has been introduced more in the energy intensive industries than in the group of the least energy intensive industries. A few industries in this group are using 30% or more natural gas and at the same time these industries have experienced high export growth. There are examples where the level of aggregation in the data does not give a correct picture of energy intensity changes and fuel composition. For manufacture of glass and glass products the decline in energy intensity from 12.28 TJ per mill. DKK in 1966 to 1.63 TJ per mill. DKK in 1992 is caused not by an efficiency increase or fuel substitution but is a result of a change in the composition of production within that industry. Production of raw glass is not taking place any more and instead more processed glass products dominate the sector.

Fuel technology change is closely related to emissions from Danish production activities. Wier (1998) in a decomposition analysis shows that one of the major explanations for changes in emissions from Danish production over the period 1966-1988 is the change in fuel mix.

Energy technology change can to some extent be represented by the change in fuel use. The general pattern for manufacturing is a reduction of liquid fuels and an increase in the share of electricity. The decline in the use of liquid fuels is general if all 82 branches of manufacturing are examined (Appendix A) with one exception (book printing). This indicates that the reduction in energy intensity has been partly accomplished by reducing the processes using liquid fuels, that means a move towards more sophisticated processing for all manufacturing industries. To some extent the processes using liquid fuels have changed towards use of natural gas, in some instances coal (sugar factories and refineries), electricity in the case of steel works and, in some cases, district heating.

Fuel technology change has been necessary to compete internationally. If the large share of liquid fuels had persisted the production costs would have included a much larger energy dependency. In some cases industries that had less substitution options have been hit by international competition. This has been the case for: structural clay products, paper and pulp, manufacture of raw glass and basic plastic materials. For the latter two industries the energy intensity has been reduced drastically which is a result of closing down some very energy intensive plants, and the structure within the industry changing totally towards production of different and new products. For both these industries the product change has been accompanied by success in export markets.

4. Trade patterns, cheap energy and taxation

Denmark has a much less energy intensive production structure today. The availability of cheap energy resources at other places has led to stagnation or decline for the very energy intensive industries that existed in Denmark in 1966.

On the other hand the price on energy paid by the industries has been relatively competitive as regards the energy prices paid in other countries. Taxation on energy use has not been widespread and the competition-threatened industries have always been widely exempted from energy taxation. Electricity has been low priced relative to many other European countries. Compared to this the domestic consumer has been very heavily taxed with respect to energy consumption.

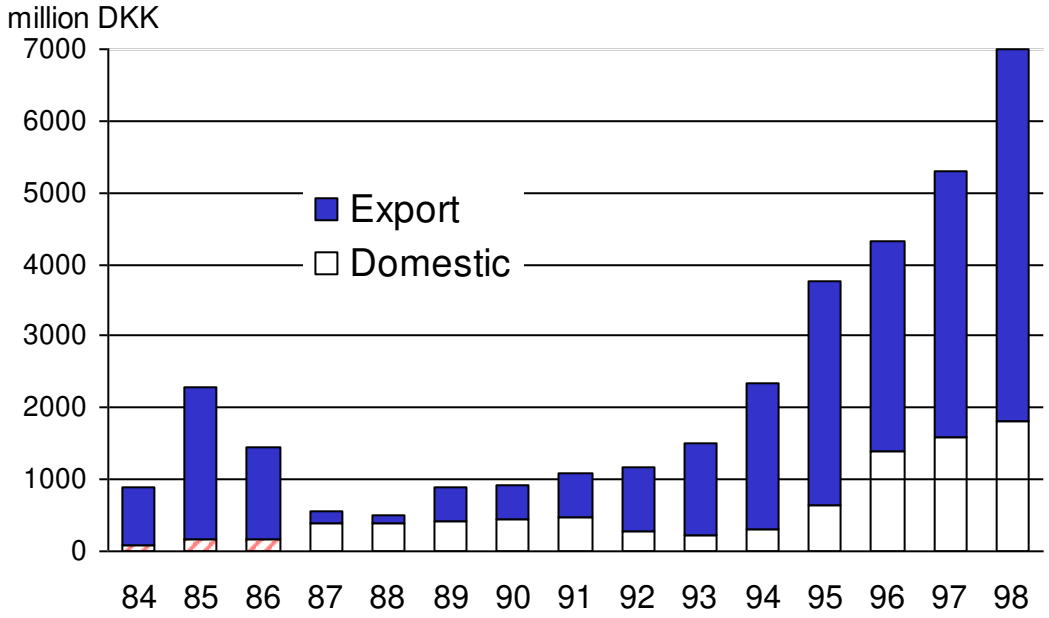
The change towards reliance on electricity instead of liquid fuels has not itself contributed to changing trade patterns, but it is an indication that Danish manufacturing

has increased labour productivity by increasing electricity based capital equipment. This has contributed to maintaining international competitiveness of Danish manufacturing.

Cheap energy is important when energy is a major input factor and thus an important determinant for competitiveness. For the very few energy intensive industries in Denmark there has not been cheap energy available. Cheap energy can be a result of either a subsidisation of energy or the existence of specific local resources e.g. hydropower or natural gas. In the Danish case the subsidisation of the energy intensive industries has not been through subsidising energy use, but has in a very limited number of cases been directed through other channels in the form of direct capital investment support. In general industrial policy directed at conserving heavy industries in Denmark has not been especially emphasised.

5. Export opportunities from new and renewable energy technologies

New energy technologies introduced in Denmark have led to considerable contributions to export performance. Total Danish exports of energy capital equipment and consulting services are covered by a recent report from Danish Energy Agency (1999b). The total export revenue in 1998 for the companies included in this analysis[4] is 16 bill. DKK for equipment, and 370 mill. DKK for consulting. A very rapid growth of export revenue has been seen with a doubling from 1994 to 1998. Exports of energy related equipment and services now constitute around 5% of total Danish exports. One of the major contributors to this development is export of wind turbines, where Denmark has been a major actor in international markets. The world market share is close to 50%.



Source: Danish Wind Turbine Manufacturers Association

Figure 2 Turnover for Danish wind turbine manufacturers

[4] The analysis covers the majority of producers in the field 78 companies in equipment and consulting are included but the major share (80%) of exports can be referred to only 13 equipment companies and 22 consulting companies.

District heating systems, especially pipelines, have a long tradition in Denmark and this technology has been improved partly based on the public support for expanding district heating in Denmark. Denmark has one of the two largest manufacturers of pre-insulated pipes in the world. The exports from the four largest producers in Denmark amount to 1.4 billion DKK in 1997. Exports of pumps, heating controls etc. from other producers related to district heating should be added to this figure.

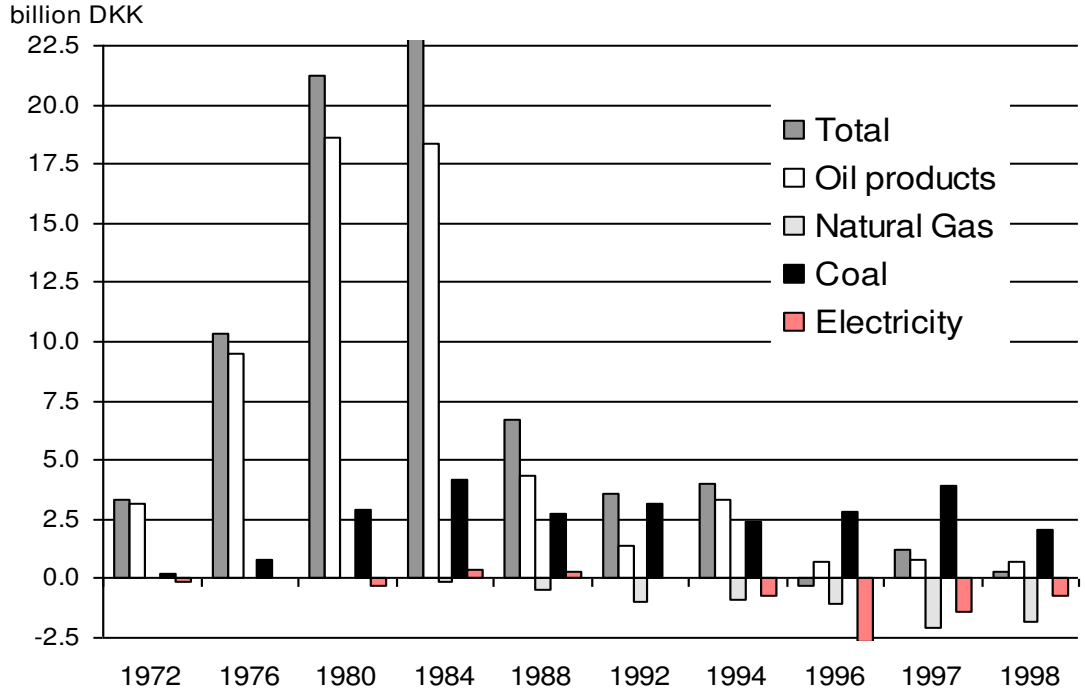
Some export success has been recorded for environmental technologies related to specific power producing technologies. Recently (1999) contracts has been signed for the construction and operation of biomass (straw) power plants in England and Spain amounting to more than 1 bill. DKK. This is a new and very promising field for renewable energy technology export for Danish companies.

Consulting in the field of renewable energy is a positive contributor to service balances. This has been supported by the international reputation of the Danish case as a very "green" and environmental friendly policy. Also a very long tradition for detailed energy planning and especially the implementation of renewable energy has contributed to export opportunities for consulting firms and institutions. Some of the consulting activities have been tied to bilateral aid activities to developing countries or countries in transition. But in the field of fully commercial projects the consultants have also been successful.

6. Trade in energy commodities

Denmark has experienced major shifts in the trade with energy commodities. Originally nearly 100% reliant on foreign resources, the Danish economy is today (1998) more than self-sufficient (129%) in oil products and even self-sufficient (102%) in total energy consumption. For total energy this is a drastic increase from around 5% in 1980 and 52% in 1990[5]. The Danish Energy Agency (1999a) reports in detail on the oil and natural gas production activities in Denmark. The aggregate reserves of oil and gas constitute around 14 years of extraction for oil and 16 years for natural gas at current extraction levels (1998).

[5] The Danish Energy Agency calculates these self-sufficiency rates based on climate adjusted primary energy consumption and primary energy production.



Source: Danish Energy Agency, www.ens.dk/uk/statis.htm

Figure 3 Net import value of energy commodities

Oil products were the main source of the very large trade deficits in energy commodities until the mid-eighties. The shift from oil towards coal in the power sector and the reduction of liquid fuels in manufacturing industries contributed to a reduction of the import volumes of oil products. The fall of oil prices in the mid-eighties also contributed to a reduction of oil import costs. Danish extraction activities increased very much from then and today the country is more than self reliant in oil products. Natural gas has also contributed to reduce imports of oil products and has to some and increasing extent been exported.

Electricity trade has traditionally been with Scandinavian countries and Germany. The size of such trade has been determined by seasonal and climatic conditions. Recently the yearly change in trade flows has been very large and has caused production changes from +50% to –50%. This is partly technologically dependent, as investment in transmission capacities determines the possible sizes of daily transmission exchanges. Also expansion of hydropower has created more scope for trade fluctuations. The expansion of wind power in Denmark could benefit from the connection to hydropower resources[6].

[6] If the share of wind power exceeds some level there will occasionally be overflow of electricity production in the Danish system, which could be exported to countries with hydropower reservoirs that could reduce production. Wind capacity could thus be expanded above the level that is critical for the isolated system. Secondly the hydropower can be back-up capacity for wind-power in Denmark, so that total capacity requirements in Denmark can be reduced. The unstable availability of wind power does thus not result in a lower capacity value for wind power capacity.

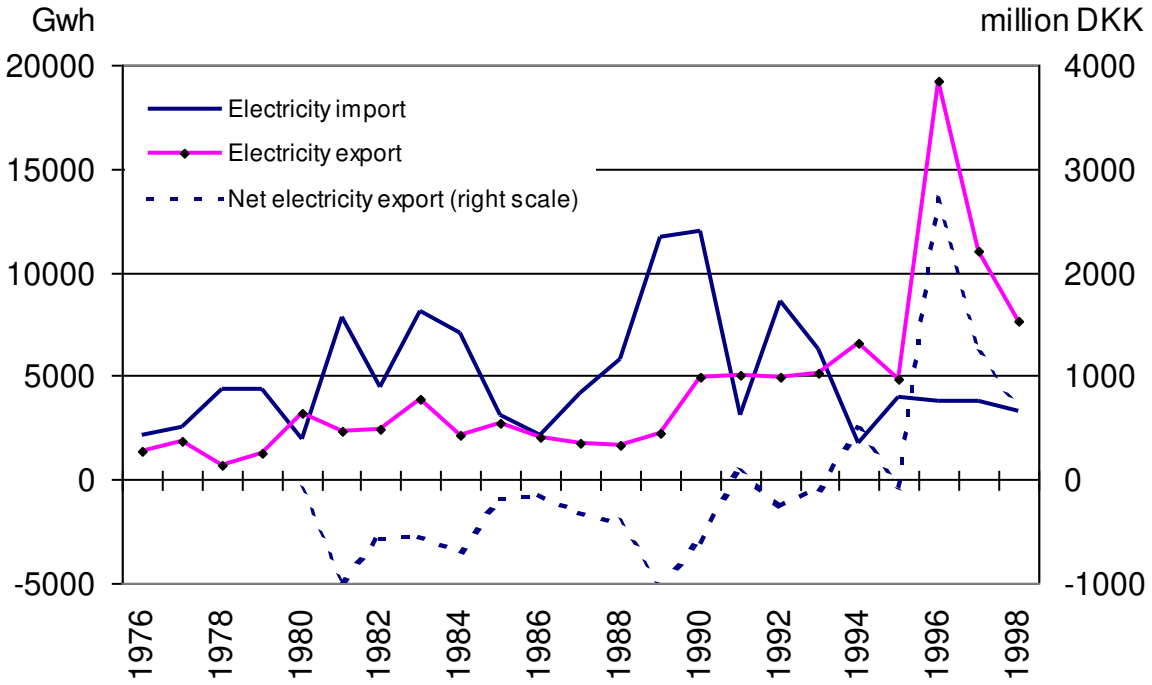


Figure 4 Trade in electricity

Trade in electricity has for many years resulted in a deficit both in physical terms and in fiscal terms. The size of the deficit has not been very big and has mainly been a result of the availability of periodically cheap hydropower from Norway and nuclear power from Sweden combined with a lack of competitors on the demand side. This trade pattern might change as the transmission capacities between Scandinavia and northern Europe are being expanded rapidly; and as the liberalisation of electricity markets increases the number of buyers. The surpluses in electricity trade recorded in recent years (1991, 1994 and 1996-1998) have been caused by lack of rain in Scandinavia and to some extent temporary unavailability of nuclear power plants. The year 1999 is set to reverse this situation and cause problems for Danish utilities.

The value of electricity trade has historically been based upon very cheap imports and relatively high prices for exports. This picture will probably change towards a more equal price mainly due to an expected higher import price. The extreme case of 1996, with net exports of 2.7 billion DKK, will not be typical in the future, but Danish producers will continue to benefit at times of low water resources in Scandinavia. This export revenue is of course partly off-set by increased imports of coal and oil products used for this additional power production in the extreme year of 1996.

7. Concluding remarks

Energy technologies in a broader meaning have had an impact on trade patterns. This impact has been direct in the case of exporting energy technology equipment such as wind turbines and district heating pipelines. The indirect effect, through energy technology change and impacts on competitiveness, can be seen in the relative decline of the energy intensive industries of Denmark.

The relative energy intensive manufacturing industries of Denmark have experienced a stagnation of production and much slower export growth than the average of manufacturing. The number of industries with high energy intensity have also declined and now the production share of these four energy intensive industries is just 1.5% of total manufacturing production.

Exports of products that are related to new energy technologies have been rising fast. The examples of wind turbines and district heating pipes show that Danish producers have captured very large shares of the world market. Exports of just these two goods constitute more than 2% of total manufacturing exports.

In the field of trade with energy commodities the period from 1966 to 1992 reflected major shifts in the fuel technology of the Danish economy. A shift from liquid fuels towards coal around 1980 resulted in a coal-based combined heat and power sector which is relatively robust to international competition in a rising market of electricity trade. The future trade in electricity could be of a substantial value as the recent figures suggest; and the technological developments in this sector will have a large impact on trade in this commodity.

In conclusion, the issues of energy technology and trade developments seem to be related. The effect of the general competitive position from changing energy technologies will be rather limited as the Danish manufacturing industries have a very small share of energy in total production costs. Just as important are the export opportunities for the industries producing energy technology equipment for the world market.

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Appendix A: Data

Manufacturing industries

	TJ/mill. DKK 1966	TJ/mill. DKK 1992	Production 1966 mill. DKK	Production 1992 mill. DKK	Electri-city 1966	Electri-city 1992	Liquid fuels 1966	Liquid fuels 1992	Natural gas[7] 1992	Export 1966	Export 1992	Export share 1966	Export share 1992
Magazine publishing	0.14	0.13	835	751	10%	70%	52%	11%	6%	0	0	0%	0%
Other publishing	0.15	0.13	541	1289	10%	59%	53%	9%	5%	0	0	0%	0%
Knitting mills	0.53	0.16	1259	1998	33%	68%	51%	8%	2%	352	1192	28%	60%
Manufacture of jewellery, etc.	0.16	0.16	1249	376	24%	55%	40%	12%	1%	251	131	20%	35%
Manufacture of wearing apparel	0.34	0.17	3678	3262	24%	52%	54%	18%	8%	409	1935	11%	59%
Manufacture of footwear	0.40	0.19	865	829	25%	61%	55%	16%	14%	87	258	10%	31%
Petroleum refineries	0.24	0.19	7800	13620	99%	99%	0%	0%	0%	1875	5986	24%	44%
Slaughtering etc. of pigs and cattle	0.24	0.20	18638	29959	29%	67%	60%	23%	5%	10725	19541	58%	65%
Manuf. of telecommunication equipment	0.81	0.22	896	5537	19%	70%	66%	9%	11%	311	3465	35%	63%
Newspaper printing and publishing	0.23	0.23	3164	2933	38%	77%	20%	2%	1%	48	42	2%	1%
Reproducing and composing services	0.42	0.23	285	1080	33%	78%	21%	3%	0%	10	87	3%	8%
Professional and measuring equipment	0.21	0.23	734	4084	37%	70%	36%	9%	7%	436	3178	59%	78%
Book and art publishing	0.31	0.24	808	573	11%	58%	61%	9%	5%	0	0	0%	0%
Manuf. of made-up textile goods	0.30	0.28	316	1153	27%	57%	49%	19%	8%	41	428	13%	37%
Other printing	1.03	0.29	321	1087	34%	69%	45%	3%	3%	7	185	2%	17%
Manuf. of other electrics supplies	0.74	0.32	3536	5008	39%	64%	42%	19%	2%	770	1796	22%	36%
Processing of fish	0.29	0.33	1267	5816	40%	71%	41%	18%	4%	921	4606	73%	79%
Poultry killing, dressing, packing	0.94	0.33	575	2025	38%	76%	51%	16%	2%	375	1108	65%	55%
Manuf. of toys, sporting goods, etc.	0.84	0.33	947	3147	18%	72%	66%	9%	2%	357	2154	38%	68%
Manufacture of soap and cosmetics	0.73	0.33	759	1227	16%	53%	77%	30%	6%	112	612	15%	50%
Manufacture of household machinery	0.44	0.35	561	2072	48%	63%	36%	28%	2%	163	1470	29%	71%
Manuf. of chemical products n.e.c.	1.67	0.35	484	1032	13%	52%	81%	37%	0%	137	426	28%	41%
Ship building and repairing	0.51	0.36	5466	6634	35%	73%	44%	18%	1%	2219	3865	41%	58%
Manuf. of refrigerators, accessories	0.78	0.38	4400	12743	22%	64%	73%	19%	6%	1607	7296	37%	57%
Tobacco manufactures	0.59	0.38	1049	977	30%	69%	53%	15%	13%	81	317	8%	32%
Manuf. of metal cans and containers	0.94	0.40	955	1797	28%	64%	57%	9%	23%	61	512	6%	29%
Manufacture of industrial machinery	0.52	0.40	2855	4855	32%	59%	54%	26%	4%	1775	3123	62%	64%
Railroad and automobile equipment	0.57	0.41	2068	2546	22%	63%	55%	18%	7%	310	1255	15%	49%
Dairies	0.64	0.42	10152	11868	22%	55%	72%	30%	7%	3787	4928	37%	42%
Manuf. of structural metal products	1.23	0.43	1812	6719	21%	66%	59%	17%	6%	303	2404	17%	36%
Bookbinding	0.20	0.44	318	433	34%	77%	25%	3%	2%	8	51	3%	12%
Manuf. of electrical home appliances	0.78	0.45	308	411	29%	56%	61%	32%	7%	112	203	36%	49%
Offset printing	0.43	0.47	833	2084	19%	42%	52%	4%	38%	51	274	6%	13%
Manuf. of agricultural machinery	0.68	0.47	1373	1755	16%	50%	73%	27%	6%	615	1100	45%	63%
Repair of machinery	0.87	0.50	2045	2430	12%	46%	66%	7%	4%	0	0	0%	0%
Manuf. or paints and varnishes	0.54	0.50	905	1058	20%	59%	71%	18%	8%	185	439	20%	41%
Chocolate and sugar confectonery	0.48	0.50	989	2129	48%	59%	40%	26%	5%	154	824	16%	39%
Manuf. of paper containers, wallpaper	1.01	0.53	1892	4338	22%	63%	69%	14%	19%	194	1214	10%	28%
Processing of fruits and vegetables	0.40	0.53	909	2064	21%	51%	63%	38%	9%	132	641	15%	31%
Cake factories	1.10	0.53	506	1540	14%	58%	62%	31%	7%	127	890	25%	58%
Book printing	0.36	0.54	2037	2158	27%	32%	42%	54%	2%	118	379	6%	18%
Margarine manufacturing	0.73	0.55	589	683	25%	48%	66%	31%	15%	22	217	4%	32%
Manuf. of wooden furniture, etc.	0.52	0.56	3231	6206	24%	52%	52%	8%	5%	736	4141	23%	67%
Cordage, rope and twine industries	0.96	0.58	567	521	45%	73%	49%	6%	12%	156	267	28%	51%
Manuf. of other fabricated metal products	0.95	0.60	3458	5862	27%	69%	62%	15%	7%	881	2079	25%	35%
Ice cream manufacturing	1.33	0.60	204	976	47%	72%	31%	6%	0%	9	404	4%	41%
Manufacture of metal furniture	1.05	0.62	344	1503	14%	55%	59%	23%	13%	69	627	20%	42%
Manufacture of cycles, mopeds, etc.	1.40	0.63	341	591	16%	33%	72%	13%	49%	67	287	20%	49%
Manufacture of drugs and medicines	0.79	0.66	789	5599	55%	54%	38%	38%	4%	483	4535	61%	81%
Grain mill products	0.77	0.67	1069	1049	54%	85%	41%	4%	9%	73	278	7%	26%

Manuf. of basic plastic materials	3.35	0.68	636	3991	25%	87%	7%	7%	4%	213	2166	33%	54%

Appendix A: Data (continued)

Manufacturing industries	TJ/mill. DKK 1966	TJ/mill. DKK 1992	Production 1966 mill. DKK	Production 1992 mill. DKK	Electri-city 1966	Electri-city 1992	Liquid fuels 1966	Liquid fuels 1992	Natural gas[7] 1992	Export 1966 mill. DKK	Export 1992 mill. DKK	Export share 1966	Export share 1992
Non-ferrous metal works	1.18	0.72	826	424	39%	65%	45%	27%	3%	148	222	18%	52%
Manuf. of accumulators and batteries	0.65	0.76	312	141	38%	88%	49%	8%	0%	111	92	36%	65%
Oil mills	1.75	0.78	1232	1849	8%	47%	90%	46%	7%	419	776	34%	42%
Bread factories	0.78	0.78	740	907	16%	46%	68%	30%	6%	18	95	2%	10%
Processed cheese, condensed milk	1.11	0.81	1429	2896	16%	37%	76%	40%	15%	1185	2013	83%	70%
Manuf. of plastic products n.e.c.	0.83	0.85	1166	5042	61%	74%	34%	8%	15%	306	2203	26%	44%
Manufacture of leather products	0.95	0.85	545	261	19%	47%	67%	37%	12%	74	107	14%	41%
Manufacture of wood products, ex. furnit.	1.87	0.98	2892	5107	42%	29%	44%	10%	0%	587	2031	20%	40%
Manufacture of food products	1.80	0.99	538	2518	48%	21%	45%	8%	37%	146	1338	27%	53%
Manuf. of earthenware and pottery	2.42	1.10	517	235	15%	33%	46%	21%	4%	138	159	27%	67%
Spinning, weaving etc. textiles	1.92	1.12	2278	2354	23%	56%	74%	25%	17%	410	1168	18%	50%
Tyre and tube industries	2.24	1.13	140	234	7%	46%	79%	40%	0%	0	47	0%	20%
Bakeries	0.88	1.20	2978	1561	12%	67%	66%	10%	6%	0	0	0%	0%
Non-ferrous metal casting	1.37	1.23	210	376	15%	72%	78%	23%	3%	22	126	11%	34%
Concrete products and stone cutting	0.68	1.29	2317	2706	29%	25%	46%	26%	32%	111	654	5%	24%
Manuf. of rubber products n.e.c.	2.14	1.31	507	602	33%	55%	64%	23%	20%	146	410	29%	68%
Fish meal manufacturing	2.41	1.32	480	2347	10%	36%	89%	21%	28%	275	1161	57%	49%
Distilling and blending spirits	8.64	1.35	248	318	4%	25%	62%	32%	11%	52	114	21%	36%
Breweries	1.52	1.39	2381	4598	9%	31%	81%	50%	9%	559	1110	23%	24%
Manuf. of glass and glass products	12.28	1.63	500	839	9%	50%	88%	8%	39%	58	264	12%	31%
Manuf. of basic industrial chemicals	2.45	1.71	768	4469	19%	62%	80%	26%	8%	480	3460	62%	77%
Manuf. of fertilizers and pesticides	4.02	1.75	759	894	42%	65%	53%	18%	16%	70	328	9%	37%
Sugar factories and refineries n.e.c.	2.10	2.20	922	2013	6%	7%	81%	27%	0%	126	844	14%	42%
Manuf.of asphalt and roofing cater.	2.26	2.33	830	1261	17%	22%	76%	55%	21%	48	284	6%	22%
Iron and steel casting	2.69	2.42	567	656	30%	85%	42%	6%	1%	72	246	13%	38%
Non-metallic mineral products n.e.c.	5.67	2.55	883	1500	14%	38%	66%	7%	9%	207	706	23%	47%
Manuf. of prepared animal feeds	2.92	2.61	714	2120	25%	35%	70%	21%	14%	204	615	29%	29%
Iron and steel works	10.10	3.10	998	1383	8%	83%	84%	2%	14%	367	890	37%	64%
Manuf. of pulp, paper, paperboard	5.60	5.30	838	941	22%	42%	71%	18%	9%	97	416	12%	44%
Manuf. of structural clay products	6.78	6.50	907	410	16%	19%	67%	11%	18%	168	194	19%	47%
Manuf. of cement, lime and plaster	16.74	14.20	871	856	13%	12%	41%	13%	1%	124	274	14%	32%

[7] Natural gas was first introduced for domestic use in 1985 and has from then increased its importance considerably.