ALICE Electricity Sector Country Study:

Denmark

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1. Introduction

Denmark's electricity sector has evolved under special organizational traditions like cooperatism and a high local control of electricity generation. Denmark was one of the pioneering countries (first test windmill in 1891) in exploitation of wind energy and is still the world's top manufacturer and exporter of wind turbines. By contrast nuclear energy has never played a role as an energy source and there are no significant possibilities for the utilisation of Hydro Power for electricity generation. The economic structure in Denmark is characterized by a large agricultural sector and a relatively small industry sector with more light industries. In combination with a high percentage of CHP (Combined Heat and Power generation) use this allows Denmark to have low energy intensity.
The report refers to Denmark as the main territory on the European continent without the Faroe Islands and Greenland. However Greenland is mentioned under point 5, resource endowment, because with its fossil resources it could play an important role in Denmark's future energy policy.

2. History

Electrification in Denmark started in 1891. The initiative "(…) came from the municipalities and from small farming cooperatives which built and operated their own electric power plants. These facilities were not operated for profit but to provide a needed service to individuals and cooperative or municipal enterprises." (Hadjilambrinos, 2000: 1118-1119).
Production was based on decentralized combined oil-, wind- and hydro-power stations (Heymann 1995, 71). The Danish tradition of cooperation and decentralized governance has been the driving force in the development of the nation's electricity industry. Hence almost all the distribution companies were managed as non-profit organisations.
After World War II a centralization process began in energy production that finally led to the establishment of two grid companies. In the mid 1950s the electricity pools Elsam and Elkraft where founded. The two associations remained the important forces in electricity sector until 2006 when they finally merged in DONG Energy. They had responsibility in coordination of planning for electricity generation and operation of the transmission grids.
In 1973, all of Denmark's electricity was generated in large centralized thermal power stations fired with fossil fuels (mostly coal). As Denmark has no domestic coal reserves it was highly dependent on coal imports and as a consequence was hit severely by the two oil crises in 1973-1974 and 1979-1980. In the following years the country had to face serious challenges and forced adaptation of energy industries focussing on fuels like domestic oil and gas and renewable energy.
In 1976 when the first Electricity Supply Act entered into force policy gained more influence in the electricity sector. (Hantsch, 1998) The act enables the state both to set tariffs and to decide about the entire corporate activity of the electricity supplier (Eurosolar 1997, 115).

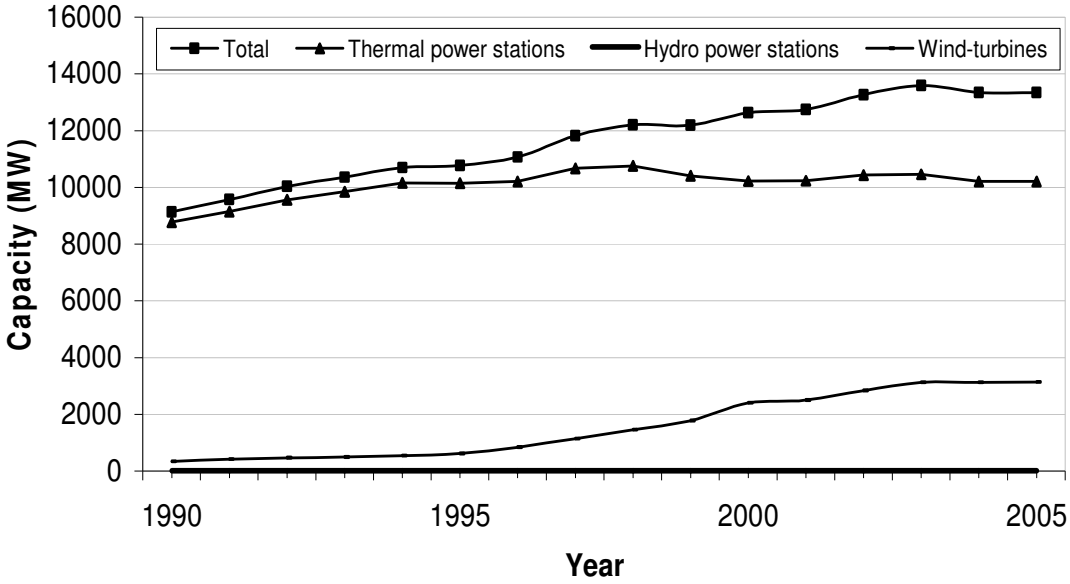
From the 1990s the government aimed at sustainable development in the energy sector. That meant primarily the reduction of CO2 emissions. The main overall target of policy was to reduce CO2 emissions in 2005 by 30% in comparison to 1988 levels and to make grow the share of renewable energy to 12-14 % of energy supply within this time period. (Hantsch, 1998)
In 1993 Denmark introduced a minor CO2 tax on trade (service sector) and industry in 1993. Later in 1995 the Danish Parliament adopted a package of new measures in order to conform to the environmental targets concerning reduction of CO2 and SO2 emissions.
The package was based on annual tax increases for trade and industry. These taxes came with an agreement scheme for those who are energy intensive, and also were recycled in the form of subsidies for energy saving, and reductions in the taxation of labour. This encouraged Industry and companies to look towards not only energy consumption and efficiency but also renewable energy as a means of meeting their needs, leading to an economic gain.
The Danish CO2 tax scheme is not coordinated with the EU or EU Member States. Therefore, the structure is designed to protect the competitiveness of the energy-intensive companies.
"After liberalizing electricity supply in 2000, changes took place in the framework of the electricity sector. Electricity transport and distribution are monopoly tasks, subject to state regulation, while electricity production and trade are subject to competition under normal market conditions."(IEA, 2004)
In 2000 the Danish electricity industry consisted of 105 local distribution companies. These were organized into eight regional generating companies and cooperatively owned the eight central generation plants which accounted for about 75% of the electricity production. (Hadjilambrinos, 2000: 1119)
In 2006 there was the merge of 6 energy-companies (DONG, Elsam, ENERGI E2, NESA[1], Copenhagen Energy's power activities and Frederiksberg Forsyning) which are now a part of the state-owned energy-generation company *DONG Energy*.

3. Current Situation: Basic data

In 2005 Denmark, with a population of around 5.4 million had an installed capacity of 13,345 MW for electricity generation. It increased from 9,133 MW installed in 1990 (see figure 1). In 2005 about 76% of the total capacity was installed in thermal power stations.

[1] ***N**ordsjaellands **E**lektricitets-og **S**porvejs **A**ktieselskap*

Figure 1: Net installed electric capacity in Denmark, Total and by generation technology, Source: nrg_113a



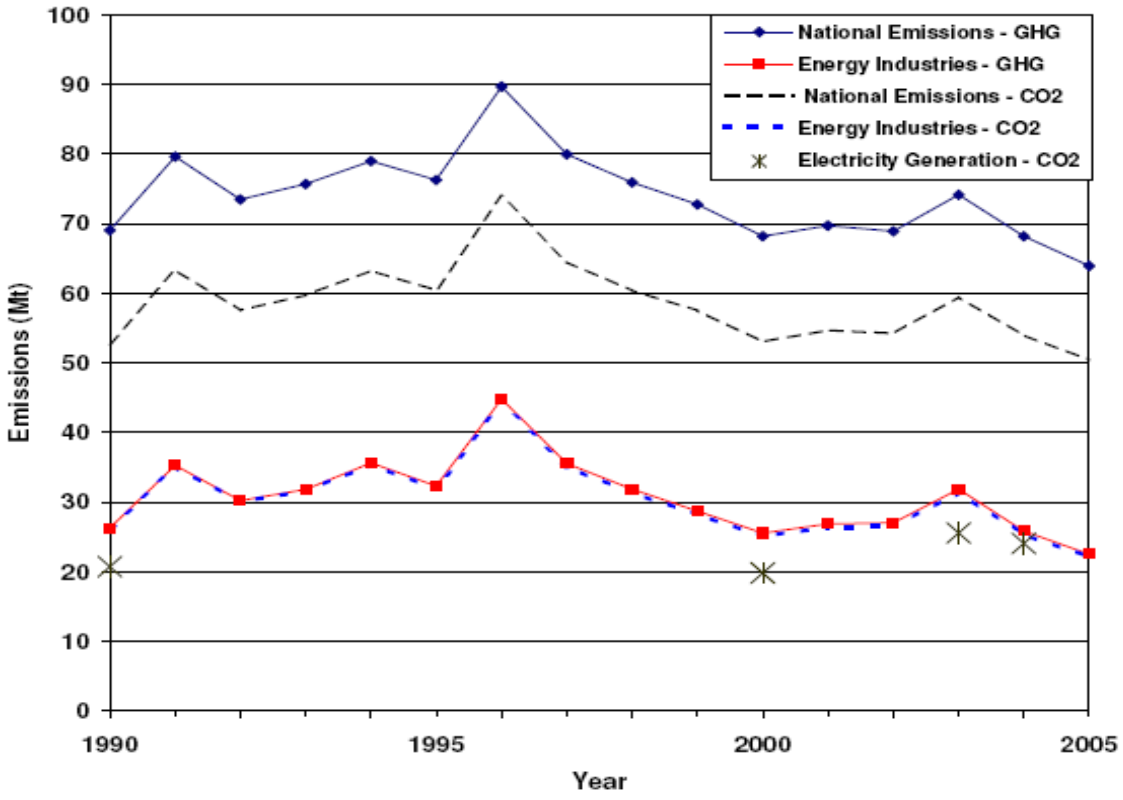
The total contribution of renewable energies in 2005 was approximately 31 % with 3,129 MW installed in wind turbines and 955 MW installed in combustion of bio fuels like municipal solid wastes, wood / wood wastes and biogas (nrg_105a). Wind-turbines, with a capacity that increased from 343 MW installed in 1990 to 3,129 MW in 2005, have become the most important renewable energy source in Denmark with a share of approximately 23% of the total capacity installed in 2005. Instead Hydro power stations with an installed capacity of 11 MW represent only a share of about 0, 08%. There are very few photovoltaic systems and solar thermal systems (not mentioned in EUROSTAT) despite in the 10 years period of 1998-2007 national large scale demonstration projects (SOL 300 and SOL 1000) have been carried out. More than 1100 PV systems have been installed in these projects, and the total installed PV capacity in Denmark is at the end of 2007 around 2,6 MW.(DEA, 2007e)
In 1985 the Danish Parliament foreclosed the option for use of nuclear power plants. (IEA Review, 1998)
There are no pumped storage plants due to Denmark's geographical relief and no geothermal plants.

3.1. Greenhouse Gas Emissions

In 1999 the Danish parliament adopted the carbon dioxide emission trading system. "The system sets local quotas for CO2 emissions from electricity production, introduces emission allowances for the individual power companies and allows for emission trading and banking." (Pedersen 2000, 1). Through national and international agreements Denmark had committed itself to stabilize

greenhouse gas emissions at 1990 levels in 2000 and therefore to reduce GHG emissions by 5%. As we can see in Fig. 2 Denmark by energy savings, increased use of combined heat and power, renewable energy as well as fuel switching and increased efficiency of power plants reached the target in the year 2000. However there has been a short increase in greenhouse gas emissions in 1996 caused by a significant increase in electricity export from Denmark to Sweden in this period which was to a large extend generated by old and environmentally outdated coal-fired power plants. The national Danish greenhouse gas emissions decreased from 70 Mt in 1990 to about 65 Mt in the year 2005.

Figure 2: Denmark's greenhouse- and CO2 emissions, National Emissions and Emissions from Energy Industries, Emissions from Electricity generation, Source: env_air_emis, Eurelectric 2002.

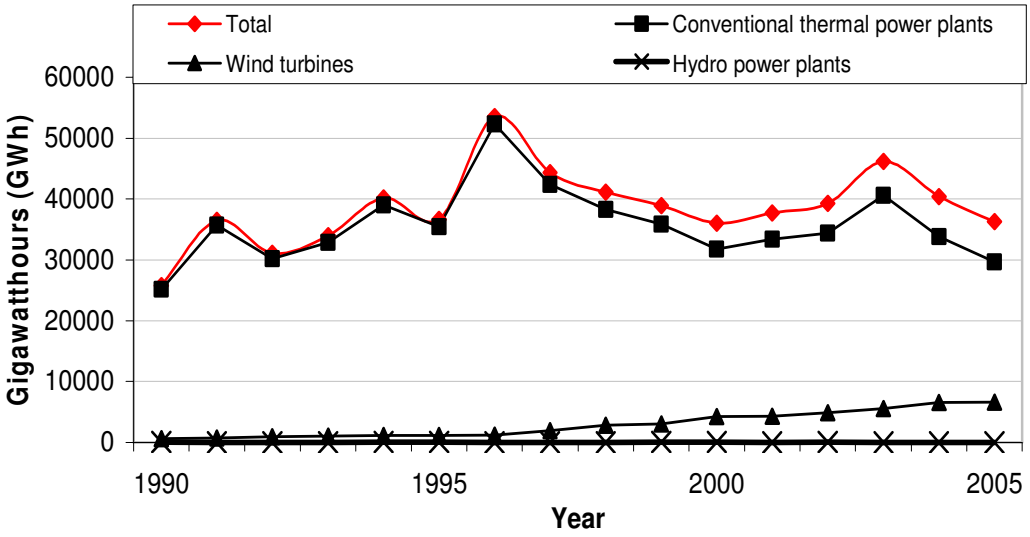


4. Electricity Production

The total gross electricity generation increased from 25,821 GWh in 1990 to 36,276 GWh in 2005. 29,639 GWh of electricity generation in 2005 came from conventional thermal power plants. That is about 82% of the total gross electricity generation. (See figure 3)

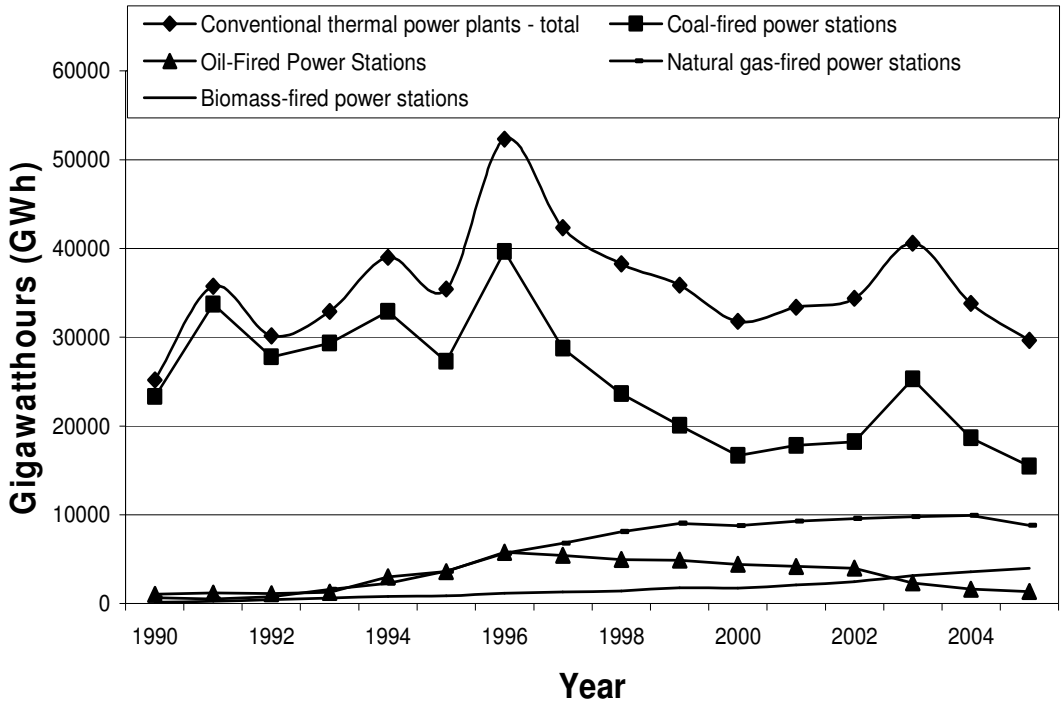
In the same year (2005) the share of electricity generated in wind turbines was 6,614 GWh (about 18% of total gross electricity generation) and 23 GWh, which is less than 1 % of the total gross electricity generation, were generated in hydro power plants.

Figure 3: Gross electricity generation total and by technology
Source: nrg_105a



Conventional thermal power plants can be split into coal-fired power stations (15,466 GWh in 2005), oil-fired power stations (1,371 GWh in 2005), natural gas-fired power stations (8,818 GWh in 2005), biomass-fired power stations (3,982 GWh in 2005) and other power stations (2 GWh in 2005). The biomass-fired power stations use different types of biomass for electricity generation such as municipal solid wastes (1,810 GWh in 2005), wood / wood wastes (1,898 GWh in 2005) and biogas (274 GWh in 2005).

Figure 4: Gross electricity generation of conventional thermal power plants by fuel, Source: nrg_105a



1996 was a record year for electricity production in Denmark. As shown in figure 3 there was an increase of 47% on 1995 up to 52,313 GWh only for conventional power plants. This did not result from an increase in domestic demand but from exports of 17,491 GWh (Nordel, 1996) mainly to Norway and Sweden according to the bad hydropower situation in the Nordic region. In 2003 the situation was similar. Denmark produced 46,180 GWh (nrg_105a) and exported 15,707 GWh (Nordel, 2003) mainly to Sweden and Norway.
The output from public thermal power stations was 26,778 GWh in 2005 while autoproducers' thermal power stations output was 2,861 GWh. (nrg_105a)

5. Average base and peak loads

As shown in table 1 peak loads in Denmark have been around 47% of the capacity installed in the last 5 years. "Currently the Danish electricity sector is in a state of oversupply." (IEA, 2006) Maximum demand in Denmark was 6,317 MW in 2005 whereas EUROSTAT estimates that capacity was 13,345 MW.
However, this very high reserve margin is somewhat misleading because a lot of the capacity (more than 3 GW) is installed in wind power. Wind power is considerably less reliable given the vagaries of the weather and will have a much lower capacity factor throughout the year. Anyway supply far exceeds demand

which results to a great extent from Denmark's renewable energy policy. (IEA, 2006)

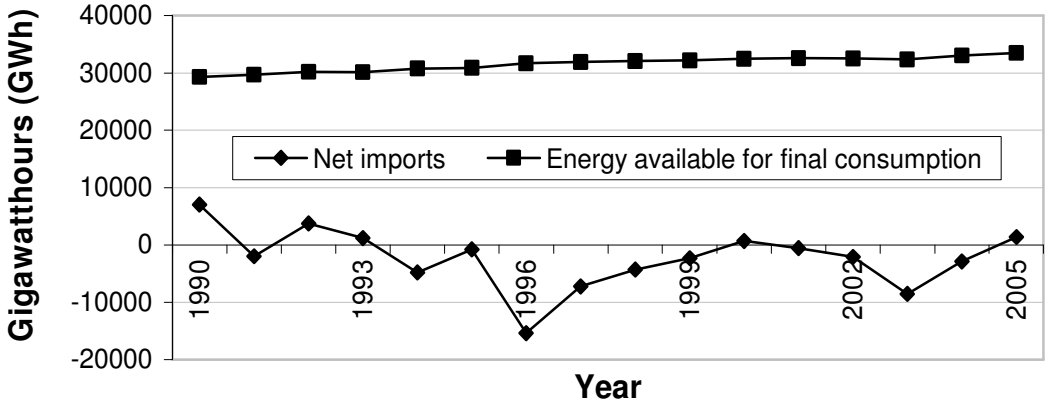
Year	Peak load demand DK total [MW]	Peak load demand DK West [MW]	Peak load demand DK East [MW]	Total capacity [MW] (nrg_113a)	Load factor [%]
2002	6,082	2,683	3,656	13,269	46%
2003	6,435	3,780	2,655	13,590	47%
2004	6,200	3,780	2,655	13,340	46%
2005	6,317	3,698	2,619	13,345	47%

Table 1: Peak load demand from 2002 to 2005
Source: Nordel 2002-2005

6. Consumption of electricity by sector

Net imports (that is total imports minus total exports of electrical energy) in 2005 were 1,369 GWh. Figure 5 shows that the value is fluctuating around zero except the two years of record electricity production in Denmark, 1996 and 2003. In 1996 exports were 15,401 MW and in 2003 8,545 MW due to the under figure 4 mentioned demand of the other Nordic countries mainly Norway and Sweden.

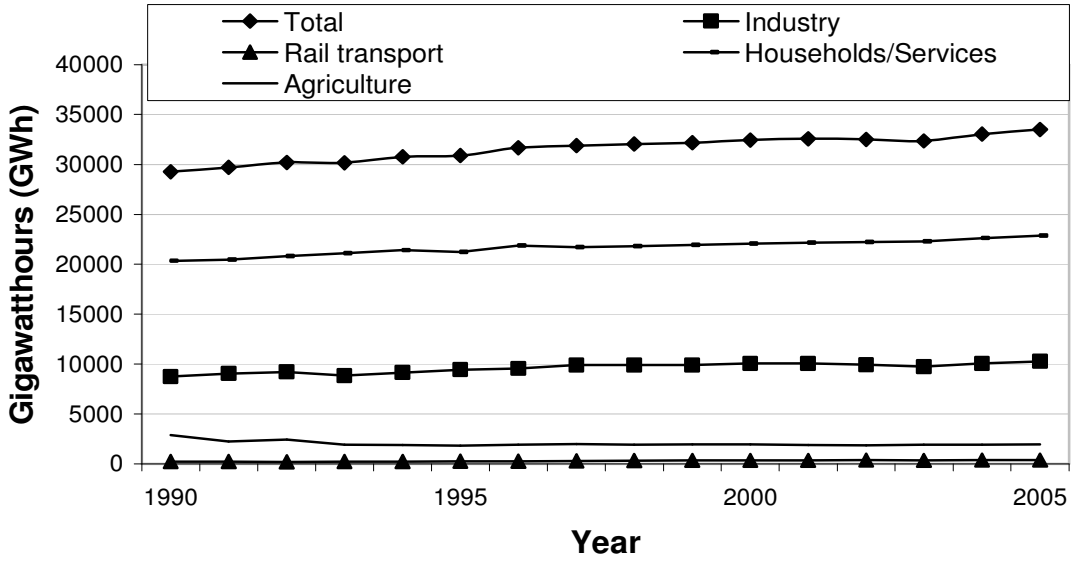
Figure 5: Energy consumption
Source: nrg_105a



About 92% of the in figure 2 mentioned 36,276 GWh total gross electricity generation (that is 33,500 GWh) were available for final consumption in 2005. In this year transformation output was 29,639 GWh, exchanges, transfers and

returns accounted for 6,637 GWh, consumption of the energy sector was 2,588 GWh and distribution losses where 1,557 GWh.

Figure 6: Final energy consumption by sector, Source: nrg_105a



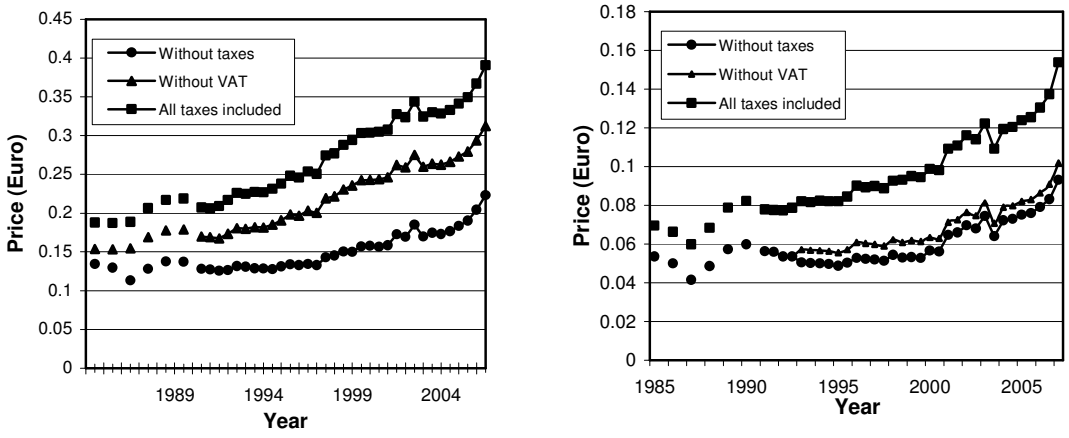
Final energy consumption is the sum of final energy consumption of industry (10,261 GWh in 2005), rail transport (375 GWh in 2005) and households, services and agriculture which together made 22,878 GWh in 2005. Final energy consumption from 1990 to 2005 was often slightly higher than energy available for final consumption which is strange but can be due to calculation differences in EUROSTAT.

7. Electricity prices for households and industries

The total price paid by consumers consists of market electricity, grid tariffs, subscription to grid owner and electricity dealer, state levies and VAT and Public Service Obligation. The total price depends on the consumer category, grid owner, location, market prices etc.
Public Service Obligations (PSOs) are compulsory services the state applies to companies to satisfy public interests (ENS, 2007). At the end of 2004, there were about 40 such companies (IEA, 2006).Transmission system operator and grid owners pass PSOs on to the consumers. The state is using around 3/4 of all PSO receipts as subsidy for environmentally-friendly electricity production. Moreover research and development of environmentally-friendly production technology and security of supply is financed by PSOs.
As shown in Figure 7 (left) in the period from 1985 to 2007 final energy prices increased from 0.1877 € to 0.3905 € per kWh. VAT was 18% in 1985 and increased to 20 % in 1992 where it is still today. Electricity prices for Danish households were about 45% below the EU-15 average in 1995. As a result of

the constant increase in 2006 they were only about 7% below the European averages (European Commission (2007)). Pre-tax price for electricity in Denmark is generally lower than European averages but the final electricity price is among the highest. That is because Denmark is among the EU countries with the greatest taxation of the electricity price for private households. For a typical user (3,500 kWh per year) the share of tax of the electricity price was 57.8% in 2006 (EUROSTAT, 2006).
Prices for industrial users have been increasing since 1995 and are currently marginally below the European averages (about 4%). Prices for industrial users are lower in absolute terms than for households (European Commission, 2007). Until 1992 there was no taxation on prices for industrial users other than VAT which in 1985 made about 23% and increased up to 30% of the final electricity price in 1992. Owing to the introduction of the CO2 tax prices where rising in 1992. In 1993 the CO2 tax was 8% of the final electricity price and remained rather low in the following years. In 2007 it was about 6% of the final electricity price.

Figure 7: left: prices for households (Annual consumption: 600 kWh), right: prices for industries (annual consumption of 30 MWh, maximum demand of 30 kW, annual load of 1,000 hours), sources: nrg_pc_204, nrg_pc_205



The Danish Energy Regulatory Authority (DERA) is responsible for regulating consumer prices. DERA regulates the price of supply-obligation electricity and grid payment. Suppliers of electricity with a supply obligation deliver electricity to customers who do not use the open market: households and smaller enterprises. These suppliers are subject to maximum prices, which are calculated on the basis of the market prices. The objective of DERA's regulation is to ensure that supply-obligation companies do not earn more from supply-obligation services than similar products on the free market. (DERA, 2005, 2006)

8. Resource Endowment

8.1. Available fossil resources /reserves

Table 2 shows the historical (cumulative) oil and gas production up to January 2006. Total reserves of oil were estimated 268 million m^3 and 255 million m^3 of oil had been produced until January 2006. At 1 January 2007 gas reserves were estimated at 120 billion Nm^3 (DEA, 2007a). Even if production from Denmark's oil and gas fields has provided a boon to the economy at current production levels, ongoing and approved reserves will be depleted in eight years for gas and just over nine years for oil. (IEA, 2006) Expected new discoveries and enhanced recovery techniques will likely boost those figures to 13 years for gas and 12 years for oil. Anyway depletion of domestic oil and gas reserves will have a substantial impact on the Danish energy sector, including security of supply, within the next 15 to 20 years (IEA, 2006).

	Oil, million m^3	*Gas, bcm*
Production (to 1/1/06)	255	109
Total reserves	268	142
Ongoing and approved reserves	211	88
Planned recovery	8	7
Possible recovery	49	37
2004 production	22.6	10.9
Reserve lifetime at current production level	11.9 years	13 years

Source: "Oil and Gas Production 2004"; Danish Energy Agency (DEA).

Table 2: Cumulative oil and gas production and likely reserves
Source: IEA, 2006

Figure 8 shows the extraction and development of the reserves of conventional Petroleum and natural gas per annum from 1995 to 2001. From 1999 to 2000 the amount of extracted petroleum was rising by almost 3 megaton. "The government forecasts that oil supply in Denmark will grow in absolute terms from 8.37 Mtoe in 2003 to 8.70 Mtoe in 2010 and 9.38 Mtoe in 2030." (IEA, 2006)

Figure 8: Annual extraction and development of the reserves of conventional Petroleum (left) and of conventional natural gas (right)
Source: BGR 2002

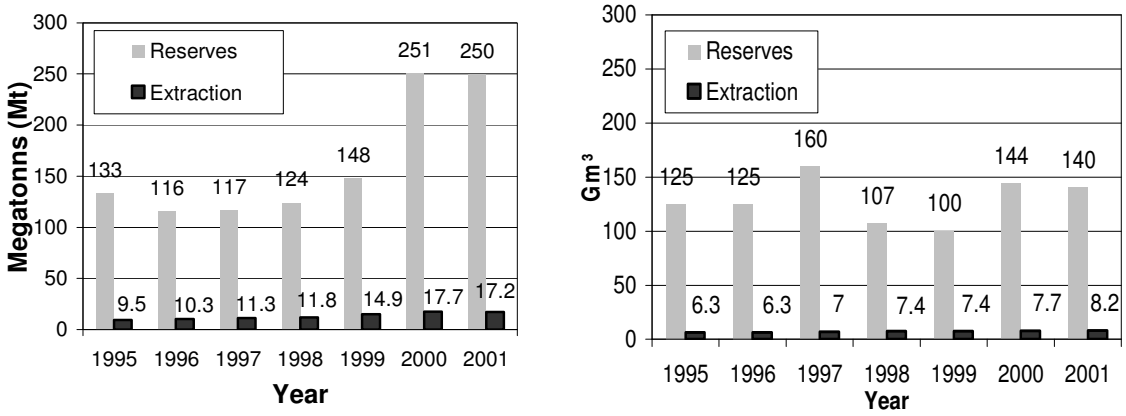


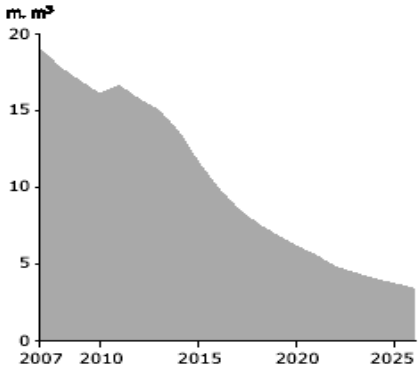
Table 3 shows the estimated ultimate recovery of conventional Petroleum and conventional natural gas in the end of 2001. Resources of conventional Petroleum in Denmark remained the same from 1997 to 2001 while resources of conventional natural gas increased from 50 Gm^3 [2] in 1993 to 76 Gm^3 in 1997 and finally to 200 Gm^3 in 2001. Potentially the great Petroleum resources in Greenland may play a role in Denmark's energy future.

		Resources			extraction	Reserves
		1993	1997	2001	2001	2001
Conventional Petroleum (Mt)	DK	-	50	50	17.2	250
	Greenland	-	-	500	-	-
Conventional natural gas (Gm^3)	DK	50	76	100	8.2	140
	Greenland	2,800	2,800	2,300	-	-

Table 3: extraction and development of the reserves of conventional Petroleum and natural gas, Source: BGR

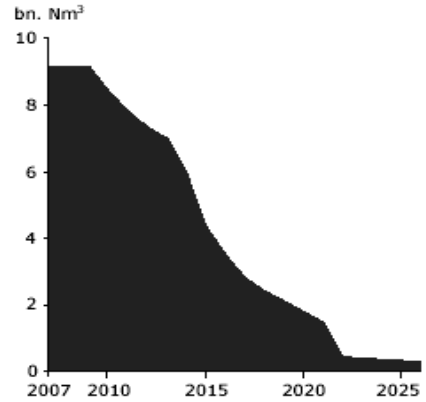
[2] $1Gm^3 = 10^9\ m^3$; $1Mm^3 = 10^6\ m^3$

Figure 9: Contribution from reserves, oil, Source: DEA 2007a



For oil, the contribution from reserves shows a generally declining trend. However, production is expected to increase in 2011 due to the development and further development of various fields. The 20 years forecast does not provide for major field developments after 2011.

Figure 10: Contribution from reserves, natural gas, Source: DEA 2007a



Natural gas production is estimated at 9.1 billion Nm^3 for 2007.
Figure 9 shows the contribution from reserves for natural gas. The volume of production is expected to decline until 2022.

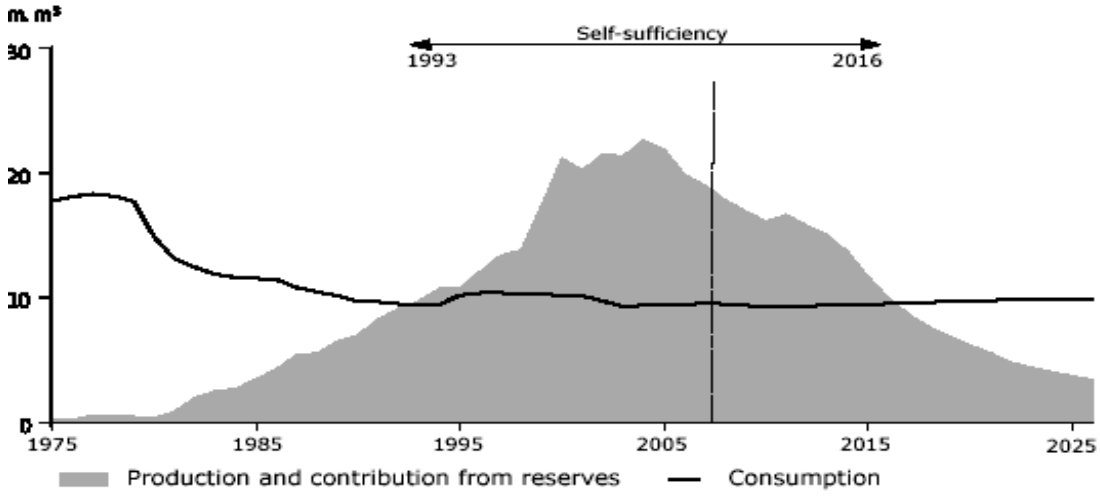


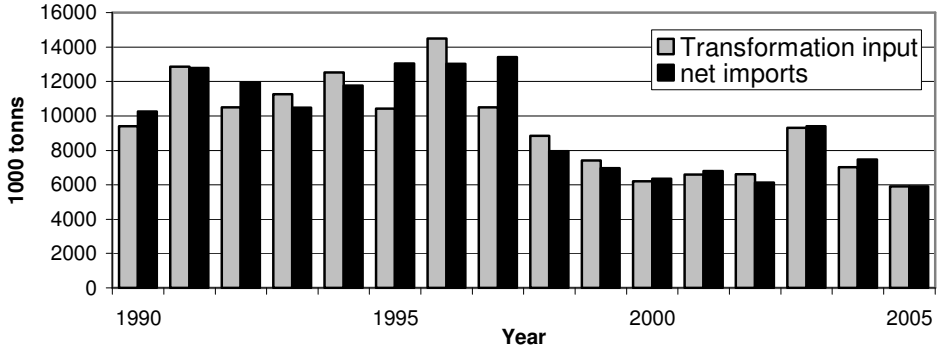
Figure 11: Oil production and contribution from reserves
Source: DEA 2007a

Denmark is expected to be self-sufficient in oil up to and including 2016. The natural gas forecasts show a scenario similar to the oil forecasts. On the basis of the contribution from reserves, Denmark is forecast to be self-sufficient in natural gas up to and including 2015, as shown in Figure 11.

8.2. Usage of fossil fuel for electricity generation

The major part of Denmark's electricity production is ensured by fossil fuels, representing 73, 3 % of the total (EDF, Observ'ER, 2007). Solid fuels are mainly used to run conventional thermal power stations. As Denmark hardly has any solid fuels, it is constrained to import almost all of it. In figure 12 can be seen that net imports and transformation input to thermal power plants are almost the same.

Figure 12: Net imports and transformation inputs of solid fuels from 1990 to 2005 in thousand tons. Source: NRG_01a



Regarding the usage of oil figure 13 shows that Denmark imported the oil used for electricity generation until 1996. In the following 2 years Denmark started with a modest oil export of 530t in 1997 and 174t in 1998 that increased constant and finally reached 10,370t in 2004.

Figure 13: Net Imports and transformation input of Crude oil and Petroleum Products from 1990 to 2005 in thousand tons.
Source: nrg_102a

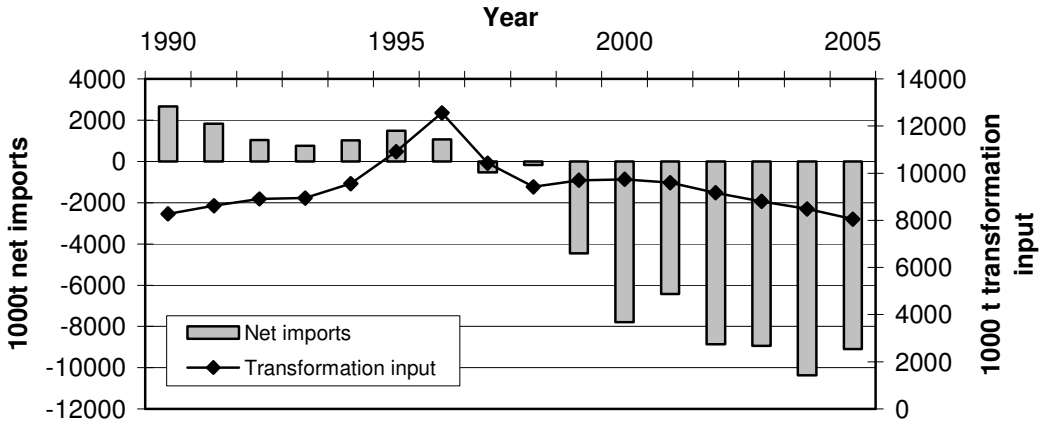
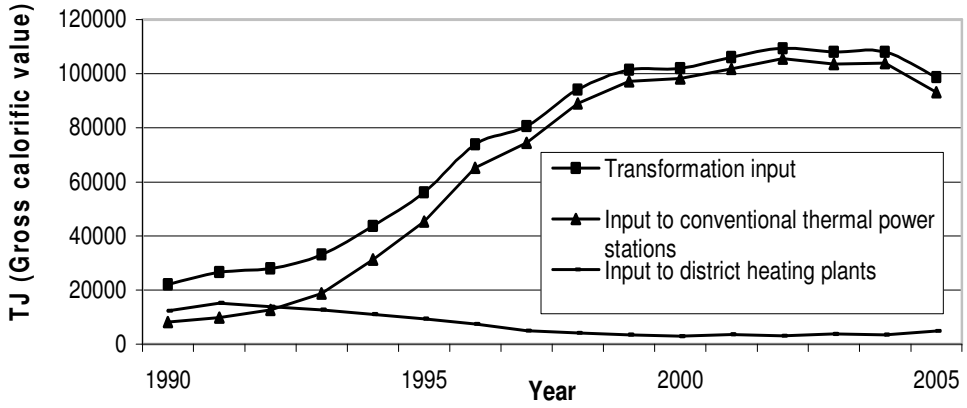


Figure 14: Transformation input of natural gas total and by technology
Source: nrg_103a



There were no imports of natural gas according to EUROSTAT.

8.3. Available potential for RES

Wind potential:

Denmark with 5.28 TWh of electricity production in 2002, together with Germany and Spain are the leading countries in terms of wind energy production in Europe (EWEA, 2004). According to the 1993 assessment of the technical onshore wind resource for OECD countries (Van Wijk, Coelingh, 1993) the "technical" wind potential estimated for Denmark is 29 TWh per annum which represents 91% of the total energy consumption in 2002. (nrg_105a). Consequently with it's estimated technical wind potential of 29 TWh per annum Denmark could cover a

big part of it's energy production by wind energy when fully exploiting the potential. However wind energy production was 5.28 TWh in 2002 what meant that only 18% of the technical potential where already exploited. The technical wind energy potential in this case is derived from the land area on which wind speeds of 5.1 m/s and more are experienced. In addition the land must be considered suitable for terrain or climatic reasons and only 4% of the land can be used for wind energy installations as a result of practical and social constraints. The energy estimate is derived by assuming 8 MW per km^2 land.
There are two estimates of offshore wind potential. One refers to a study of the European commission from 1995 (Garrad Hassan, 1995) and the other to the CA-OWEE project (Concerted Action on Offshore Wind Energy in Europe, 2001). According to the 1995 study Denmark has an offshore wind potential of 550 TWh per annum that is the second largest among EU countries after the UK. The 2001 survey estimates the potential to be only 26TWh per annum which is much lower but together with onshore wind potential still 55 TWh wind energy potential could be reached.
An overview of the Potential of other renewables is given in Table 4. Note that the figures given are based on data collected before 1995 and that greater estimates coming along with the technological progress can be estimated.

Energy source	Technical potential (GWh/a)	Market penetration (GWh/a)	Used potential (%)
PV el.	4,392.3	0	0
Aktiv solar	2,661.6	31.4	1.8
Wood wastes	3,432.3	3,120.3	90.9
Agricultural wastes	12,786.6	374.3	2.9
Enrgy plants	10,138.4	177.7	1.75
industrial wastes	20,827	1,990.4	9.55
municipal wastes	4,885.5	4,284.3	87.7
geothermy el.	0	0	0
Geothermy heat	28,000	18.2	0.065

Table 4: Potential and usage of renewable energy (1995) Source: Espey, 2001

Denmark's topography, which limits possibilities for hydroelectric installations, does not make it possible to develop the hydropower sector which even decreased strongly for 2005 (-14. 8%). It now only represents 0. 2% of the renewable total and shows an average evolution of -2.6% per annum.

9. Investments in and Decommissions of Plants and Installations

9.1. Investments in plants and R&D, projections and announcements for future years

There are three research and development programmes administrated of Energinet.dk. The programs aim to support a future energy system that is both environmentally-friendly and provides security of supply.

- ForskEL programme is to support the development and use of environmentally-friendly electricity generation technologies, and for the period up to and including 2008 an annual amount of DKK 130 million[3] is available for the programme.
- ForskIN comprises research and development in the maintenance of supply security and development of the electricity system. At present, the programme has an annual budget of approx. DKK 10 million.
- ForskNG programme is to ensure development of the natural gas system, eg to be able to transport biogas and hydrogen in the long term. At present, the programme has an annual budget of approx. DKK 5 million.

Moreover Energinet.dk, as the owner of the overall infrastructure, is in the process of planning the power connections for two new offshore wind farms with a capacity of 200 MW each at Horns Rev in Western Jutland and Rødsand south of Lolland, respectively. The offshore wind farms and the power connections are expected to be operational in 2009. (Energinet.dk, 2007)

10. Regulatory Environment

10.1. Most important subsidies and policies for technologies and fuels

Subsidies for electricity generated by central power stations
The biomass agreement of 1993 forced central power stations to use biomass. This element of their production is eligible for a subsidy which when combined with market price ensures a tariff of 40 øre per kWh for a 10-year period.

Subsidies for electricity generated by decentral CHP plants
Subsidy rules usually depend on fuel type and the size and age of the plant. In addition to the subsidy, existing decentral CHP plants based on natural gas or waste are eligible for a state aid up to 10 øre/kWh.

[3] 1 DKK= 0.13420 Euro

Plants	Output	Subsidy	Period
Existing	>5 MW	non-production related, corresponding to the respective subsidy received in the period 2001-2003	Paid for 20 years, from the date of grid connection and for at least 15 years as from 1 January 2004.
Existing	=/ < 5MW	22 øre/kWh at low demand, 46 øre/kWh at high demand, 59 øre/kWh at peak demand	Started in 2005

Table 5: Subsidies for plants based on natural gas or waste,
Source: DEA, 2007b

Plants	Period	Tariff
Existing	For 20 years of grid connection and for at least 15 years as from 1 January 2004.	together with market price 60 øre/kWh
New	for 10 years	60 øre/kWh
	for the following 10 years	40 øre/kWh

Table 6: Subsidies for plants based on RE apart from wind power,
Source: DEA, 2007d

Special rules for new biogas plants mean that this subsidy is only applicable to plants connected to the grid before the end of 2008 and with a ceiling of 8 PJ for total biogas use in Denmark.
There are approximately 40,000 solar heating systems (hot water) in Denmark. For such systems there were subsidies for a number of years, but the subsidy was withdrawn on 1.1.2002. (DEA, 2007)

Subsidies for wind turbines
Subsidies depend on when the turbine is connected to the grid and its age, whilst ownership has no influence. The transmission system operator (TSO) will sell electricity production on the spot market from turbines for which the owner is not responsible for sales on market terms. This will primarily concern production from older turbines.

Connected to grid	Sale	Subsidy	Period
from 1 January 2005	Plant owners are responsible for the sale of production on the electricity market and for related costs	fixed premium of 10 øre/kWh allowance of 2.3 øre/kWh for offset costs	For 20 years
2003-2004	Plant owners are responsible for the sale of production on the electricity market and for related costs	premium up to 10 øre/kWh allowance of 2.3 øre/kWh for offset costs etc. (must not exceed 36 øre/kWh)	For 20 years
2000-2002	The system operator will sell the production on the spot market. Once full load hours are used up, turbine owners are responsible for the sale of production on the electricity market and for related costs	subsidy together with the market price will ensure a tariff of 43 øre/kWh for 22,000 full load hours	10 years

Table 7: Subsidies for wind turbines,
Source: DEA, 2007c

11. Manufacturing and Generation RES electricity

11.1. Top manufacturers and annual sales for RES devices

- **Vestas Wind Systems A/S**

Having installed more than 32,500 wind turbines worldwide (31 December 2006) Vestas is the world's largest manufacturer of high-technology wind power systems. Sales in Europe are 2,109 MW, twice as much as in America (1,070 MW) and Asia/Pacific (1,060 MW) (Vestas, 2006). Only in 2006 approx 15,020 MW were installed worldwide, a 32 per cent increase relative to 2005. In 2006 Vestas shipped wind power systems with an aggregate capacity of 4,313 MW and 4,239 MW had been handed over to the customers. Vestas' market share of 28 per cent was calculated on the basis of the 4,239 MW delivered to the customers. In 2005, the market share was also 28 per cent. The market share target of at least 35 per cent reflects Vestas' ambition of remaining the dominant player in the market, the growth of which is expected to attract new players in the

years ahead. According to Vestas' estimations market share in Denmark was 80% in 2006.

- **NEG Micon A/S (Vestas)**

Vestas arranged a stock exchange in 2004 and NEG Micon became a subsidiary of Vestas. After the takeover Vestas held a market share of 35%. According to Vestas annual report NEG Micon had a share of capital of 267,110,000 DKK in Vestas in 2006.

- **Siemens Power Generation (PG)** (former Bonus Energy A/S)

Siemens Power Generation (PG) is one of the world's leading suppliers of components and systems to companies in the energy and electricity industry. With the acquisition of Bonus Energy A/S December 1, 2004, Siemens Power Generation (PG) entered the wind energy market. Today Denmark is the head office of Siemens' activities in the wind business and more than 2700 employees are working for Siemens in the Danish locations Brande, Aalborg and Engesvang.

12. Market Structure

Liberalisation of the Danish electricity market started in the late 1990s. Since than it has been fully opened to competition, but remained highly concentrated. The electricity transmission system operator is owned by the Danish state, while supply and distribution companies have been legally unbundled. Supplier switching is fairly common among large customers, but is much more limited for small companies and households, which have the option of remaining on a regulated tariff with a default supplier (Supply Obligation).
The Danish electricity market is divided into two parts, East and West, without a direct physical link between them. West Denmark (Jutland and Funen) is synchronous with the European continent, while East Denmark (Zealand and Lolland-Falster) is synchronous with the rest of Scandinavia. However, a physical link between the two parts is planned to be in operation by 2010.
The generation sector remains very concentrated and is dominated by two main generating companies (DONG Energy and Vattenfall). (EC, 2007)

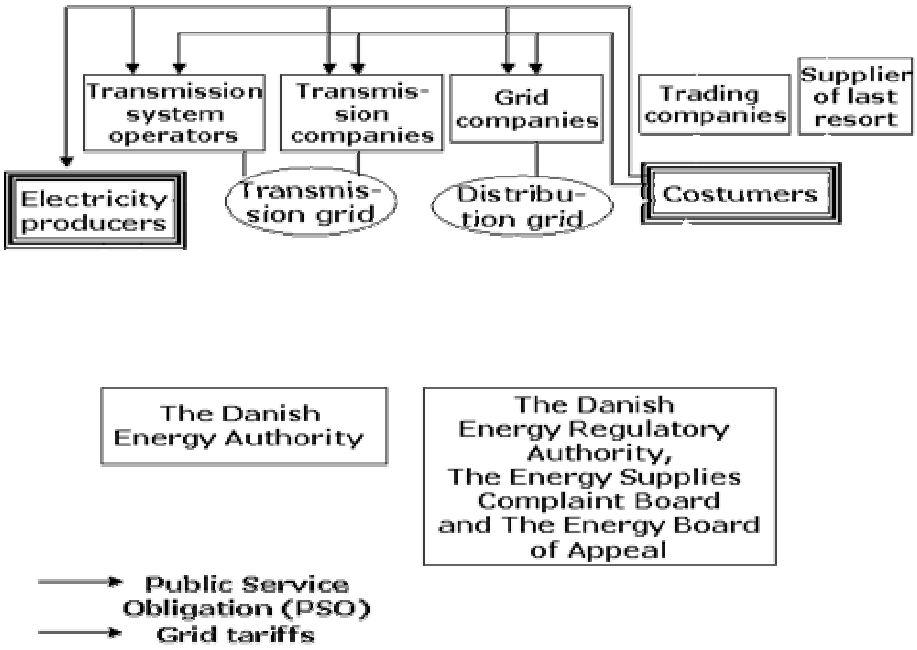


Table 8: The structure of the energy market
Source: Energinet.dk, 2007b

The entire Danish electric power was opened to competition at the end of 2002. Under the new Danish Electricity Supply Act, electric power production and trade will be commercial, run on a commercial basis and the ownership of production and trading companies will be organized accordingly. Grid owners and transmission system operators will continue to be owned by consumers, and will be run as non-profit companies subject to close price control by the public energy inspectorate. The Act introduced market competition in 1998 for large-volume power producers and consumers (100 GWh or more annually). The threshold was reduced gradually until the end of 2002 and from 1 january 2003 all customers could trade freely. Danish legislation requires that high priority is assigned to renewable energy in the nation's power system. The government's action plan "Energy 21" envisioned that offshore wind farms will be generating 4,000 MW before 2030. (ENS, 2007b)
In 2004 only central power stations were operated on commercial terms. Wind-generators, local CHP installations, and industrial co-generating plants were feeding electricity into the grid at politically determined prices not linked to market prices. Distribution network and transmission companies were primarily ensuring local security of supply. They are subject to public control.

DONG Energy

DONG Energy was founded in 2006 as the result of a merger involving six Danish energy companies – DONG, Elsam, ENERGI E2, Nesa, Copenhagen Energy's power activities and Frederiksberg Forsyning.
DONG has established renewable energy facilities and, after the deregulation of the electricity market, has actively participated in energy trading.
DONG Energy, as a company owned by the Danish state supplies energy to customers in the Danish, Swedish, German and Dutch markets and trades in energy on European energy exchanges.

Energinet.dk

As the owner of the overall infrastructure, Energinet.dk maintains the security of supply and ensures the smooth operation of the market for electricity and gas. The state owned company generates an annual gross turnover of approx. 8 billion Danish crowns. Energinet.dk is the result of a merger between Eltra, Elkraft System, Elkraft Transmission and Gastra. The merger took place on 24 August 2005 with retrospective effect from 1 January 2005. Energinet.dk is an independent public undertaking owned by the Danish state as represented by the Danish Ministry of Transport and Energy. Energinet.dk owns the 400 kV electricity transmission grid and is co-owner of the international connections between Denmark and the Nordic countries and Germany. Furthermore, the company has at its disposal the 132 kV and 150 kV electricity grids.

12.1. Average price levels

Electricity from Danish electricity producers is sold on market conditions either via bilateral agreements, via Nord Pool (the Nordic power exchange) or other power exchanges. The larger power stations will usually be expected to sell electricity on market conditions whilst the transmission system operator (TSO) will to a large degree sell production from small plants and RE-based production on the Nord Pool spot market.
The spot market price is adjusted hour-by-hour in advance of every 24 hours depending on supply and demand. System prices and a series of area prices are used, including Denmark West and Denmark East. Apart from the spot market price, Nord Pool also operates with futures and forward prices and a range of other prices. The market price for electricity is defined as the spot market price at Nord Pool in the area where the generator is connected to the grid.

12.2. Availability of a central exchange for trading electricity

Electricity from Danish electricity producers is sold on market conditions either via bilateral agreements, via Nord Pool (Nordic power exchange) or other power exchanges. Nord Pool Spot is a part of the Nord Pool Group and is owned 20%

by Nord Pool ASA and the Nordic Transmission System Operators: Statnett SF, Svenska Kraftnät, Fingrid Oyj and Energinet.dk own 20 % each.
There are two markets in Nord Pool Spot, Elbas and Elspot. Elbas is the physical intra day power market currently available in Sweden, Finland Denmark and Germany. Trading at Elbas can be conducted up to one hour before delivery. Elspot is the physical day-ahead-market for the Nordic countries and North-Eastern Germany. Traded volumes through Nord Pool Spot in 2006 amounted to 249.8 TWh in Elspot and 1.1 TWh in Elbas. This equals more than 60% of the total consumption of electricity in the Nordic countries.
Nord Pool Spot's system price is the reference price for futures, forwards and options contracts traded on the exchange with Nord Pool ASA. Nord Pool Spot has NVE (Norwegian Water Resources and Energy Directorate) as regulatory authority.

Year	DK west	DK east
1996	-	-
1997	-	-
1998	-	-
1999	-	-
2000	16.41	-
2001	23.74	23.54
2002	25.47	28.59
2003	33.68	36.8
2004	28.8	28.35
2005	37.23	33.8
2006	44.18	48.53
2007	26.42	27.22
Data updated: 28. Sep. 2007, 12:47 Time is CET (GMT +1)		

Table 9: Prices at Nord Pool Spot (EUR/MWh), source: Nord Pool

DONG Energy trades in electricity, natural gas, oil, coal and CO2 quotas on the most important energy markets in Northern Europe, including in Scandinavia (Nord Pool), Germany (EEX), the Netherlands (TTF, APX), Belgium (ZBP), and the UK (NBP and ICE). DONG Energy trades in both physical and financial energy products. In recent financial years, DONG Energy's positions on energy markets equalled more than 100 TWh of electricity.

12.3. Number of top generators

More than 75 % of the Danish electricity generation is taking place in power plants owned and operated by the electricity supply industry. The top generators are DONG Energy A/S, E.ON Denmark A/S and Vattenfall Denmark A/S.
DONG Energy is Denmark's largest power generator producing 50% of Denmark's power and approximately 40% of the district heating based on fossil fuels. Furthermore, DONG is the leading thermal generator by volume on Nord

Pool power exchange. (DONG, 2008) DONG owns power production facilities and projects in Germany, Norway, Sweden and the United Kingdom.
Vattenfall controls approximately 24 per cent of the Danish power generation capacity, installed in thermal and wind power.

13. Networks

13.1. Membership in interconnected power systems

The eastern regions of Denmark (DK east: Seeland, Lolland, Funen) are in the Nordel power system. As shown in section 4 Denmark could export great amounts of energy to Norway and Sweden in 1996 and 2003 when dry summers caused a lack of electricity from Hydropower stations in this countries. “The Danish electricity generating system based on fossil fuel fired power stations and wind power is able to co-operate with the systems in Norway and Sweden, which are based on hydropower and nuclear power.” (Dansk Energi, 2004)
The western areas of Denmark (DK west: Jütland and Funen) are in UCTE.

Year	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
to:						
Germany	n.d.	n.d.	394	4,740	7,853	4,658
Norway	n.d.	n.d	393	3,905	550	2,564
Sweden	n.d	n.d	123	704	470	1,846

Table 10: Electricity exchanges of Denmark west (in GWh) in UCTE, source: UCTE database

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