Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA)

In-depth Review of Energy Efficiency Policies and Programmes of Denmark

Energy Charter Secretariat

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INTRODUCTION

The Energy Charter Treaty was signed in December 1994 and entered into legal force in April 1998. To date the Treaty has been signed or acceded to by fifty-one states [1]. The Treaty was developed on the basis of the European Energy Charter of 1991. Whereas the latter document was drawn up as a declaration of political intent to promote East-West energy co-operation, the Energy Charter Treaty is a legally-binding multilateral instrument covering investment protection, liberalisation of trade, freedom of transit, dispute settlement and environmental aspects in the energy sector.

The Energy Charter Conference, the governing and decision-making body for the Energy Charter Treaty, meets on a regular basis - normally twice a year - to discuss policy issues affecting East-West energy co-operation, review implementation of the provisions of the Treaty, and consider possible new instruments and projects on energy issues. All states who have signed or acceded to the Treaty are members of the Conference. Regular meetings of the Conference's subsidiary groups on transit, trade, investment and energy efficiency and environment are held in between Conference meetings.

The Energy Charter Protocol On Energy Efficiency And Related Environmental Aspects

The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA) is a legally-binding instrument that was signed together with the Energy Charter Treaty in December 1994 by the same 51 states that signed the Treaty itself. It requires its Signatories to formulate energy efficiency strategies and policy aims, to establish appropriate regulatory frameworks, and to develop specific programmes for the promotion of efficient energy usage and the reduction of harmful environmental practices in the energy sector.

Implementation of PEEREA is kept under review and discussion by the Energy Charter Working Group on Energy Efficiency and Related Environmental Aspects. A

[1] Albania, Armenia, Austria, Australia, Azerbaijan, Belarus, Belgium, Bosnia and Hercegovina, Bulgaria, Croatia, Czech Republic, Cyprus, Denmark, Estonia, European Communities, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Moldova, Mongolia, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, The Former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Ukraine, Uzbekistan, United Kingdom.

key feature of the Working Group's activities is the development of a series of in-depth reviews of individual states' energy efficiency policies and programmes. Recommendations to the authorities of the states concerned resulting from these in-depth reviews are presented to the Energy Charter Conference for discussion and endorsement.

For further information on PEEREA and the in-depth energy efficiency review series, contact Mr Tudorel Constantinescu at the Energy Charter Secretariat in Brussels (Tel: +322 775 9854)

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EXECUTIVE SUMMARY

Background

Denmark is a small Scandinavian kingdom with a population of 5.3 million, excluding Greenland and the Faeroe Islands, and a landmass of 43,000 square kilometres. It is a member of the European Union and has a robust, export-oriented economy.

In November 2001 a new liberal-conservative coalition, led by the liberals, was elected, replacing a centre-left coalition, which, in various combinations, had been in power since 1993. The new liberal-conservative coalition has profoundly affected all aspects of economic policy. There is an overall emphasis on competitiveness and effectiveness, also in relation to energy efficiency programmes.

Denmark is a producer of oil, natural gas and renewable energies. Domestic oil and gas started making significant contributions in the early 1980s and Denmark is now self-sufficient in energy. Because it is dependent on imports of coal for a large share of its electricity production, energy security is an important issue in energy policy, even with its sizeable domestic energy production. Denmark is part of the Nordic electricity market organised in the Nord Pool. There are relatively large swings in the trade balance for electricity, depending on price levels in the Nord Pool determined by the hydro-dominated power production in the Norwegian and Swedish systems. Denmark has traditionally used a planned approach to the provision of energy services such as heat, electricity and gas. The country has one of the highest shares of district heating (DH) and combined heat and power (CHP) in Europe.

The residential and services sectors represent over 46% of total final consumption. Transport is next at 32.4% and Industry at 21.5%. The largest end-use sector is the household sector. In the 1970s, industry was second but it has been replaced in the 1990s by the transport sector. The biggest decrease in energy consumption has been in the household sector since the 1970s, while the transport sector has shown steady growth until recently. The shares of all the energy sources in Total Primary Energy Supply (TPES) in 2000 were: coal 20.7%; oil 44.9%; gas 22.9%; and renewables 11.3%.

Overall energy intensity (TPES/GDP) has continued to decrease since the mid-1990s and it is one of the lowest of the IEA countries.

Denmark has been amongst the global leaders in promoting energy efficiency, both in terms of its success in improving energy efficiency nationally and in developing energy-efficient technologies and systems, many of which are exported. Denmark enjoys a strong reputation for energy efficiency, its commitment to both meeting climate change goals, and for striving towards sustainable development as well as its goal of having environmentally friendly energy systems.

Energy policy setting

Since the late 1970s, energy policy has been re-formulated several times to reflect changing priorities and approaches. Energy policy is the responsibility of the Ministry of Economic and Business Affairs and the Danish Energy Authority (DEA), which is part of the Ministry. The Ministry was created at the end of 2001, when economic and business affairs were merged. At the same time environmental policy was de-merged from energy, which was integrated into the broader economics ministry. Several other ministries and agencies have important and complementary roles to play in energy efficiency policy and programmes. Utilities, municipalities, industry associations and Non Governmental Organisation (NGOs) are also active in promoting energy efficiency.

Energy policy is, in large part, being driven by EU energy policies. EU policies include electricity and gas liberalisation, a renewable energy directive and several directives on energy efficiency. The EU is also playing a central role in the climate change response strategy and in the burden sharing arrangement to meeting commitments under the Kyoto Protocol. The Government has provided a more market-based orientation to energy policy and is committed to EU-wide energy policies and other international co-operation relevant for the energy sector.

Today, the main energy policy objectives in Denmark are: the energy sector shall contribute to economic growth and welfare through low energy prices and energy costs and liberalisation of energy markets; a stable and secure energy situation which include security of supply and reduced dependency on oil; and protection of the environment, in large part by fulfilling international obligations in the most cost-effective way.

DH and CHP have been important features of Danish energy policy for more than two decades. There has been considerable success, with about half the country's heat demand provided by DH and CHP providing about 55% total electricity production. The Government is looking at ways of improving competitiveness and cost-effectiveness.

Renewable energy has been a key element of Danish energy policy for more than two decades. Renewables and decentralised CHP were encouraged, in large part through feed-in tariffs, the obligation to purchase production and specific agreements between government and interested parties. More recently, in June 2002 the Government entered into an agreement with several political parties on the future conditions for wind turbines. Under the agreement, consumers' obligations to purchase electricity from wind turbines will be phased out and replaced with financial support corresponding to the CO_2 tax on electricity. The sum of the financial support and the market price will be capped. The final three offshore wind farms will probably be subject to a tender procedure.

Denmark is the world leader in the export of wind turbines. It is also a major exporter of DH and cogeneration technologies. Altogether, energy technology exports represent 5% of total Danish exports. Wind turbines represent 60% of the total.

The Government, in its liberalisation reforms, is seeking more competitive Danish energy prices compared with other countries. Relatively high-energy prices in Denmark have been an important lever in promoting energy efficiency, the expansion of CHP and renewable energy as well as in achieving environmental goals, particularly related to climate change. However there is concern that there can be adverse effects on Danish competitiveness.

Non-market based energy prices are controlled by the Danish Energy Regulatory Authority (DERA), an independent body within the Ministry of Economic and Business Affairs. End-use prices are largely influenced through the tax system. Taxes were reformed in the early 1990s, leading to the Green Tax Package, which was introduced in 1996 for the commercial sector and industry. The Green Tax Package includes three separate taxes: CO_2 taxes, energy taxes and SO_2 taxes. CO_2 taxes can vary if companies participate in a long-term agreement with the Government. Households and commercial sector pay both energy and CO_2 taxes while industry only pays CO_2 taxes.

Energy efficiency policy

In May 2000 a new Energy Conservation Act (Act 450) was approved by Parliament, as part of a political agreement for the reform of the electricity sector. This Act provides a framework for co-ordination and the priority to be given to both centralised and decentralised initiatives in the future and includes some new elements.

There has been a re-orientation by the Government to link energy efficiency policies and programmes with more than climate change strategies, as had been largely the case over the past decade. Energy efficiency programmes have changed in the past two years and continue to change. Many subsidy programmes are being phased out. Emphasis is put on cost-effectiveness, competitiveness and on implementing programmes to meet EU requirements.

For the Government, the objectives for energy efficiency policies and measures are: to ensure cost-effectiveness based on socio-economic calculations; to be a part of a cost-effective climate change strategy; to reduce energy costs to consumers; to focus on market based instruments; to avoid new taxes or subsidies from the state; and to focus on EU initiatives where there are higher savings at lower costs and no negative effects for the competitiveness of Danish industry. Energy efficiency is included in the Climate Change Strategy, published in February 2003 and the August 2002 *National Strategy for Sustainable Development*.

The core of Denmark's programmes in the household sector are regulatory, many of which are driven by EU requirements. EU legislative requirements cover appliance labelling and efficiency standards, boiler efficiency, the development and revision of building codes, and building labelling. Denmark has a variety of innovative information and market transformation programmes through the Danish National Energy Information Centre and the Danish Electricity Saving Trust (DEST). The Information Centre is closing in June 2003 due to budgetary concerns and no alternative is yet in place. The DEST is an independent agency within the Ministry of Economic and Business Affairs, created in 1996. With a budget of about 90 million Danish Krone (DKK) annually, funded through a special tax on electricity in public and household sectors, this agency promotes conversion of electrically heated houses and low electricity consuming appliances and equipment.

Under the Electricity Supply, Gas Supply and Heat Supply Acts and their executive orders, energy companies are required to promote end-use energy efficiency. The funds come directly through the electricity bill and total about 200-250 million DKK per year.

The Energy Conservation Act called for the creation of local energy savings committees. These committees are designed to be a framework for co-operation and co-ordination at the local level and energy companies are responsible for their creation. Energy companies are encouraged to include the recommendations of these committees as much as possible in their energy savings plans. To date, there are 32 of these committees in operation.

While there are some EU directives that pertain to the industrial sector (boiler efficiency, energy-labelling of buildings, etc.), the main energy efficiency initiatives in industry have been taken by the Danish Government using voluntary agreements and, as mentioned above, taxation. The agreements were brought in with the Green Tax Package. Those participating in the agreements receive a rebate on CO_2 taxes. By 2001, about 330 companies had entered into agreements with the DEA.

The services sector has no separate measures, although many of the legislative measures (e.g. energy-labelling of buildings) apply to this sector. The DEST initiatives are potentially important for this sector and it is now piloting a monitoring of electricity consumption on a 24-hour basis of a number of public buildings in order to improve feedback and to better identify energy management opportunities.

Related to road transportation Denmark participates in the EU strategy, including the agreement with manufacturers on fuel efficiency and the obligation to have labelling on new cars at point of purchase. Taxation plays an important role, both on fuels and on motor vehicle registration fees. There are initiatives to support public transport, walking and cycling and inter-modal shifts.

The Government is firmly committed to meeting its obligations under the Kyoto Protocol. One of the hallmarks of the previous government in climate change policy was to do as much as possible domestically to meet the Kyoto targets. The current government has taken a different approach, based on cost-effectiveness and putting emphasis on the use of market mechanisms with full recourse to the flexible mechanisms of emissions trading, Joint Implementation (JI) or the Clean Development Mechanism (CDM).

General assessment

The overall assessment of the review team is positive. Denmark has achieved impressive results in improving energy efficiency at both the end-use and transformation stages. It is viewed as one of the world's leading countries in promoting energy efficiency and sustainable energy development and has provided an important example and inspiration to PEEREA countries.

Although much has been done to create an energy-efficient economy, there is still a significant cost-effective potential to be exploited for improving energy efficiency. From the energy or environmental policy documents that have been published in the

last year, it appears that energy efficiency may require more attention. To achieve the cost-effective potential there will have to be a strong commitment from government to employ the most effective mechanisms.

The government has now launched a more market-based, competitive energy policy, in order also to meet the requirements of the EU energy policy. It should be recognised that there are limits to the opportunities for competition in the large infrastructure of DH and CHP, in which Denmark has heavily invested. There is a labyrinth of taxes, price supports, purchase obligations and other measures that has kept the current system stable. Energy market liberalisation will have a long-lasting impact because it is requiring greater competition, not only within a member state but also amongst EU Member States. Denmark's system was not designed for the dynamics of competition, yet there are safeguards in the EU directives on renewables, on CHP (proposed) and energy efficiency, as well as in the new proposals of the Government, which should facilitate the management of the transition.

IN-DEPTH REVIEW OF ENERGY EFFICIENCY POLICIES AND PROGRAMMES OF DENMARK

1. Introduction to the PEEREA Review

In April 2003, a team of representatives from the Working Group of the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects reviewed the energy efficiency policies and programmes of Denmark. The role of the in-depth energy efficiency review undertaken on a peer basis by the Working Group is to enhance the level of co-operation amongst contracting parties (Article 3.1). The in-depth review is also being used to assess progress, promote continuous dialogue and transfer information.

The Review Team, representing four Energy Charter Member States, consisted of Mr. David Taylor of Ireland, who chaired the review team, Mr. Sergey Bevz of the Ukraine, Mr. Damir Stanicic of Slovenia and Mr. Floor van Nielen of the Netherlands. Professional support was provided by Mr. Tudor Constantinescu of the Charter Secretariat and Mr. Rod Janssen, consultant to the Secretariat.

Organisations visited are included in Annex 4 of this report.

The Review Team wishes to express its thanks to all Danish organisations and their representatives who participated in meetings for the period of the review.

Special thanks go to officials of the Danish Energy Authority who undertook all the preparation of the mission, completing the PEEREA questionnaire and providing background papers and other information as requested.

The report is based on material provided by Denmark as well as data and analyses from various other sources, including the International Energy Agency and other related materials. Statistical data are presented according to the most current data available.

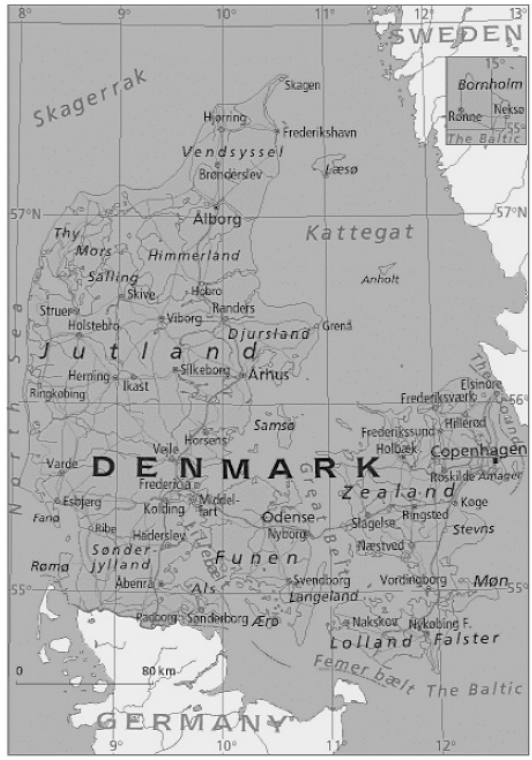
2. Overview

Denmark is a small, northern European kingdom with a population of 5.3 million, excluding Greenland and the Faeroe Islands, and a landmass of 43,000 square kilometres [1]. While it is relatively small, it has a long coastline of 7,314 km. There are

[1] For this review, Greenland and the Faeroe Islands are not included.

three main areas: the islands of Zealand in the east and Funen in the centre, and the peninsula of Jutland to the west. There are also many other islands, the largest being Bornholm in the Baltic Sea.

FIGURE 1: DENMARK



Source: Royal Danish Ministry of Foreign Affairs, www.um.dk

The capital of Denmark, Copenhagen, is also the largest city, with a population of 1.78 million in the metropolitan region. Other main cities include Aarhus (280,000), Odense (180,000) and Aalborg (160,000).

While being situated approximately between 55 and 57 degrees north, the climate is relatively mild due to the influence of the ocean, resulting in cool summers with a mean temperature of around 16°C and winters that have a mean temperature of around 0.5°C. There is a good deal of wind, strongest in the winter and weakest in the summer.

Denmark has a multi-party political structure, with several parties in Parliament (the Folketing). Governments are traditionally made up of coalitions of parties, with the last single party government in 1909. Denmark is a member state of the European Union, having joined in 1973. It has not adopted the Euro, opting instead to remain with the Danish Kroner as its currency [2].

In November 2001 a new liberal-conservative coalition, led by the liberals, was elected. This replaced a centre-left coalition which, in various combinations, had been in power since 1993. The new liberal-conservative coalition has profoundly affected economic policy as will be shown throughout this report.

Municipal authorities consist of 14 county councils (*amtskommuner*) and 275 city or district councils (*primærkommuner*), including the two metropolitan areas of Copenhagen and Frederiksberg.

Denmark has the highest GDP per capita in the European Union and the fourth highest in the OECD region although only sixth in terms of productivity. [3]

Denmark's economy is largely based on the production of high value industrial products for export. Foreign trade accounts for approximately two-thirds of GDP and most foreign trade is with other EU countries. Its main trading partner is Germany, followed by Sweden and the United Kingdom. Outside the EU, Japan, Norway, and the US are also important trading partners. In the past decade, economic relations with Central and Eastern Europe have increased rapidly.

The most important export goods are machinery and instrumentation for industry, followed by chemical products and industrially processed agricultural products. Wind turbines are also an important export, and Denmark is the world leader in wind turbine manufacture and export. For example, in 2000, wind turbine exports amounted to just over DKK 12 billion, which represented just under 60% of total exports for the energy sector. DH and cogeneration technology exports accounted for a further DKK 2.7 billion. Agricultural products, which used to dominate exports, have decreased in importance, yet there are important exports of meat and meat products, dairy products and fish. There is not much energy-intensive industry in Denmark. [4]

[2] 1 Euro = 7,4 DKK
[3] Government of Denmark, The Danish Growth Strategy, September 2002, p. 19.
[4] Source: www.eu2002.dk

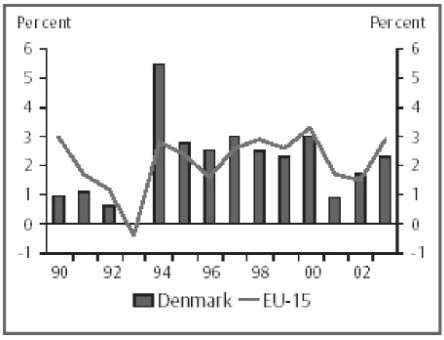
The public sector plays an important role in the Danish economy. Around one-third of the workforce is employed in the public sector and public expenditure amounts to almost 25% of GDP. These are some of the highest figures in the entire OECD area. [5]

Industry accounts for about 25% of GDP, while agriculture adds a further 3.8%. The services sector, which includes the public sector, accounts for about 72% of GDP.

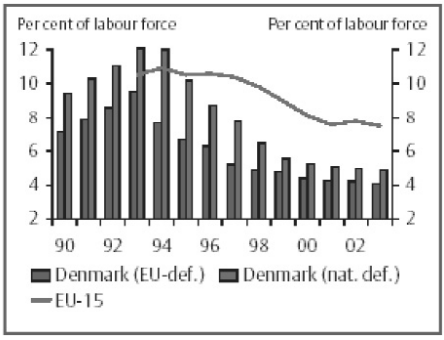
The evolution of GDP growth since 1990 is shown in figure 2. The first graph shows real GDP growth throughout the 1990s to the present. Except for 1994, Denmark has tracked the EU average growth rate reasonably well. Unemployment, at about 5.4%, is significantly below the EU average and below Denmark's average throughout the 1990s, which stood at 7.3%.

FIGURE 2:

(A) REAL GDP GROWTH IN DENMARK



(B) UNEMPLOYMENT RATE AND EU (EU-DEFINITION) IN DENMARKAND THE EU



Note: "EU-def" means the EU's definition for unemployment and "nat.def." means the Danish definition.
Source: www.fm.dk

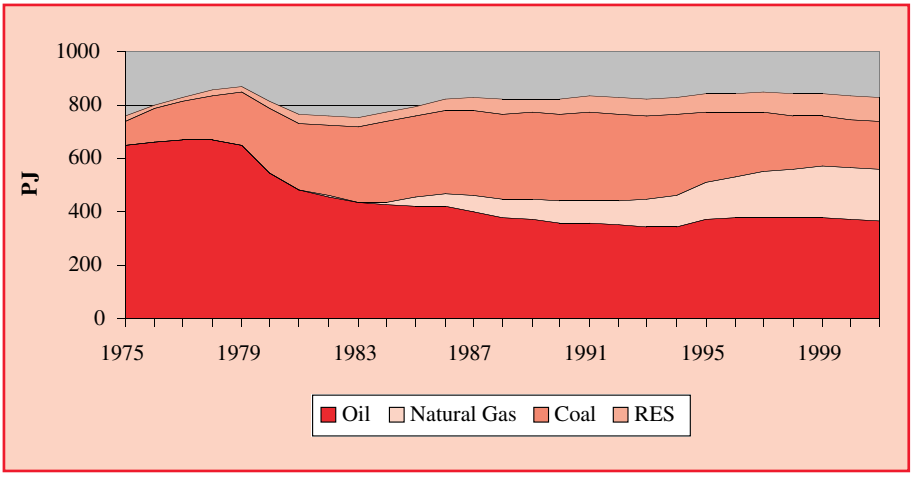
Concerning the energy sector, Denmark is self-sufficient in energy, although it is dependent on imports of coal, which represent a high share of total primary energy requirements. Domestic oil and natural gas production have increased significantly since the early 1980s and now Denmark exports production. Denmark is part of the Nord Pool, an electricity sharing arrangement with Finland, Norway and Sweden.

[5] Source: www.denmark.dk

Nord Pool - The Nordic Power Exchange - is the world's first international commodity Exchange for electrical power. Nord Pool organizes trade in standardized physical (Elspot) and financial power contracts including clearing services to Nordic participants, and provides customersupport in Sweden, Finland, Norway and Denmark. Being the Nordic Power Exchange, Nord Pool plays a key role as part of the infrastructure of the Nordic electricity power market and thereby provide an efficient, publicly known price of electricity, both in the spot and the derivatives market.
Source: www.nordpool.com

Figure 3 shows the evolution of Total Primary Energy Supply (TPES) in Denmark from 1975. Overall, TPES has not changed significantly, although the share of oil has decreased over the entire period and natural gas and renewable energy have increased their shares. Coal made important gains from the late 1970s as Denmark switched away from oil; however, because of environmental considerations, coal is gradually being replaced.

FIGURE 3: EVOLUTION OF TOTAL PRIMARY ENERGY SUPPLY IN DENMARK



Source: DEA, 2003

Denmark has traditionally used a planned approach to the provision of energy services such as heat, electricity, gas and CHP. The country boasts one of the highest shares of DH and CHP in Europe (see Chapter 6). Renewable energy has made significant

advances in the past decade, in large part due to government policies and measures for the development and deployment of wind power and biomass utilisation. Denmark now has a world leading wind turbine industry.

Notwithstanding its relatively small size Denmark has a highly developed and complex energy infrastructure. For example, there are about 400 DH companies which work on a non-profit basis. The complexity is increased by the interweave between the monopoly and competitive sectors. The following box provides a useful illustration of how complex for example the electricity sector can be.

The Electricity Industry

The industry is divided into Monopoly and Competitive activities

Monopoly Activities

Grid companies: 133 which maintain, expand and operate the distribution grids

Transmission companies: 14 which maintain, expand and operate the transmission grids

System operators: 2 which monitor the physical stability of the overall electricity grids and ensure the functioning of the electricity market. In charge of security of supply and the balancing and distribution of environmentally friendly electricity generation.

Supply obligation companies: 50 that must offer electricity on reasonable terms and at reasonable prices to all consumers who do not have market access or do not want to exercise it.

Competitive Activities

Generation companies: 2, which produce and offer electricity on commercial conditions.

Sales and wholesale companies: 32, which trade and offer electricity on commercial conditions.

Independent producers: a large number of decentralised and industrial CHP producers as well as owners of wind turbines, whose power generation is granted priority on the grid, and whose generation consumers are obliged to buy. This generation accounts for about 40% of electricity consumption.

Business companies: companies that carry out related activities that are not covered by economic regulation under the Electricity Supply Act.

Source: Danish Government, *Liberalisation of the Energy Markets, The Danish Growth Strategy*, Copenhagen, September 2002.

Denmark has been amongst the global leaders in promoting energy efficiency, both in terms of its success in improving energy efficiency nationally and in developing energy-efficient technologies and systems, many of which are exported. Denmark enjoys a strong reputation for energy efficiency, its commitment to both meeting climate change goals and for striving towards sustainable development as well as its goal of having environmentally appropriate energy systems.

Since the late 1970s, energy policy has been re-formulated several times to reflect changing priorities and approaches. Energy policy is the responsibility of the Ministry of Economic and Business Affairs and its Danish Energy Authority. Several other ministries and agencies have important and complementary roles to play in energy efficiency policy and programmes.

Energy policy is, in large part, being driven by EU energy policies. EU policies include electricity and gas liberalisation, a renewable energy directive and several directives on energy efficiency. The EU is also playing a central role in the climate change response strategy and in the burden sharing arrangement to meeting commitments under the Kyoto Protocol.

In March 1999 a majority of the parties in the Parliament entered into an agreement for a reform of the electricity sector, which became the framework for the way in which consumer protection, environmental consideration and security of supply are to be conducted in a liberalised electricity market. Following this agreement, the Electricity Supply Act No. 375 was approved in 1999, followed by an Executive Order on the Act in 2001.

While the liberal-conservative coalition government has provided a more market-based orientation to energy policy, the Government is committed to EU-wide energy policies and other international obligations that are having a major impact on the energy sector.

3. Main Energy Policy Highlights

Both energy and energy efficiency policies are evolving in response to circumstances both within Denmark and outside while reflecting the interplay between the two. The existing energy system and its associated infrastructure gradually developed since the first oil crisis from a need to switch away from the high dependence on oil. This was first articulated in Danish *Energy Policy 1976*, which was the country's first energy plan. It focused on energy security in the wake of the first oil crisis, since Denmark was so highly dependent on imported oil.

The first priority was to switch from oil to coal for electricity production while promoting energy efficiency. The second major intervention was the expansion of DH in tandem with the domestic production of natural gas. The Heat Supply Act of 1979 laid out a framework whereby communities chose between natural gas or DH. Once the choice was made, there was no reversing it. This has led to Denmark having one of the highest shares of DH in Western Europe (about 50% of heat demand). There were still many regions in Denmark that remained on oil heating, but they were primarily in areas of low population density.

The 1976 plan was followed by *Energy 81* and then *Energy 2000* in 1990. Both of these strategies included many energy efficiency initiatives and environmental considerations. *Energy 2000* introduced the goal of sustainable development in the energy sector. *Energy 2000* introduced the national CO_2 reduction target of 20% by 2005 compared to the 1988 level, which has been the main guidance for the energy policy development until superseded by the Danish EU/Kyoto-commitment which was adopted relatively recently. *Energy 2000* was followed by *Energy 2000-follow-up* in 1993 and then *Energy 21*, the action plan for energy in 1996. *Energy 21* laid down the framework for energy policy that lasted until the change in government.

The change in government in November 2001 brought about a re-orientation of objectives and movement towards a more market-based, competitive energy system. Symbolically, this started with the split of the Ministry of Environment and Energy into two separate ministries. While a distinct ministry deals with environment, energy merged into a multi-dimensional one, the Ministry of Economic and Business Affairs. This integration of energy issues into more general economic concerns is similar to what has happened in many other European countries. The structuring has changed the role of the Danish Energy Authority (even changing its name from the Danish Energy Agency), and many of its responsibilities in climate change policy have been re-assigned.

The Government has provided a more market-oriented policy framework, as formulated in several published reports to date. The Government wants the energy sector to be better prepared for EU-wide energy liberalisation and competition. The process had already started. For example, the 1999 Electricity Supply Act provided for accelerating the liberalisation process, compared to the EU timetable.

Changes were already occurring prior to the new government, through a variety of legislation on electricity, gas, heating and energy efficiency that has influenced the move towards market liberalisation but now the steps are being accelerated by the government's initiatives.

Today, the main energy policy objectives in Denmark are:

- The energy sector shall contribute to economic growth and welfare;
  - low energy prices and energy costs,
  - liberalisation of energy markets,
- A stable and secure energy situation;
  - security of supply,
  - reduce the dependency of increasing oil prices,
- Protect the environment;
  - fulfil international obligations in the most cost-effective way.

In its September 2002 report on *Liberalisation of the Energy Markets, The Danish Growth Strategy*, the Government plans to focus on four key action areas to meet its objectives of liberalising the energy sector:

- A wider choice for consumers;
- Increased competition and efficiency;
- High security of energy supply; and
- Cost-effectiveness in achieving environmental goals.

The report focuses on competitiveness, and preferably lower energy prices to help stimulate the economy.

The Government also has several objectives for energy efficiency policies and measures to:

- Ensure cost-effectiveness based on socio-economic calculations;
- Be a part of a cost-effective climate strategy;
- Reduce energy costs to consumers. This means that investments in energy efficiency shall be economically attractive for the consumers;
- Focus on market based instruments;
- Avoid new taxes or subsidies from the state; and
- Focus on EU initiatives - higher savings, lower costs and no negative effects for the competitiveness of Danish industry.

Energy efficiency policy is based on its benefits to the economy as a whole and not solely identified with environmental policy. The Government sees increasing energy efficiency and reducing energy demand as a way to:

- Reduce the energy costs and improve the competitiveness of the economy;
- Improve the security of supply;
  - Influencing demand is a very important element in improving the future security of the energy supply,
- Protect the environment;
  - An element in a cost-effective strategy to fulfil the Kyoto commitment.

Energy efficiency policy is integrated into the reforms in the energy sector. It is included in the reform of the electricity sector, including an obligation on local grid companies (and natural gas and district heating companies) to promote energy efficiency through non-commercial activities. These non-commercial activities will be described later.

Energy efficiency is included in the *Climate Change Strategy*, published in February 2003 and the August 2002 *National Strategy for Sustainable Development* although in a historically more toned-down manner than previously. The sustainable development strategy states that the easy solutions" "to reduce energy consumption and CO_2 emissions have been implemented" and "it is crucial to ensure a higher degree of economic efficiency when planning new action and introducing new instruments".

Although *Energy 21* in 1996 set an overall improvement of 20% in energy intensity between 1994 and 2005, this target has been terminated by the liberal-conservative government, according to government officials.

Sectoral energy conservation targets to 2005 were set in a political agreement in 2001. These targets are in table 1 compared with the actual final energy consumption and the latest "business as usual" forecast.

TABLE 1: ENERGY CONSERVATION TARGETS 2005

Sector	Final Energy Consumption		Energy Conservation Targets 2005			Final Energy Consumption
	2001 (PJ)	BAU forecast 2005 (PJ)	(PJ)	Target (% of forecast)	CO_2 Reduction (1000 tonnes)	Result in 2005 (PJ)
Households	187	187	8	4	940	179
Public Sector	24	24	2	-8	330	22
Commercial	56	60	3	-5	490	57
Industry	169	177	2	-1	380	175
Total excluding transport	**436**	**448**	**15**	**-3**	**2140**	**433**

Source: DEA, 2003

District heating (DH) and combined heat and power (CHP) have been important elements of Danish energy policy for more than two decades. There has been considerable success, with about half the country's heat demand provided by DH and CHP providing a high share of total electricity production (see Chapter 6). The expansion of DH and CHP has come at a high cost, according to the liberal-conservative government of the system is said to lack flexibility, and the Government is looking at ways of improving competitiveness and cost-effectiveness.

Renewable energy has also been an important element of Danish energy policy for more than two decades. The 1996 action plan, Energy 21, stated that the "long-term perspective over a period of 30 years is the development of an energy system in which an increasing proportion of the energy consumption is covered by renewable energy. The assumption is that there will be a gradual phasing in of renewable energy as technological and economic conditions make the various renewable energy solutions commercially viable". [6] The plan estimates that renewable energy can contribute 12-14 % of total gross energy consumption by 2005.

Renewables and decentralised CHP were encouraged, in large part through feed-in tariffs, the obligation to purchase production and specific agreements between government and interested parties. In 1993 there was a Biomass Agreement, whereby central power stations were to use 1.4 Mt of straw and wood by 2000, substituting 6% of coal-fired production. A political agreement has been made to ensure that the target of 1.4 Mt biomass yearly is reached by 2005. The agreement comprises provisions and incentives to fulfil the target within the frame of liberalised energy markets. There was also an agreement between the previous government and Danish utilities to establish five offshore wind farms of 150 MW capacity each before 2008. More recently; in June 2002 the Government entered into an agreement with several political parties on the future conditions for wind turbines. Under the agreement, consumers' obligations to purchase electricity from wind turbines will be phased out, replaced with financial support corresponding to the CO_2 tax on electricity. Total support plus the market price will be capped. The final three offshore wind farms will probably be subjected to a tender procedure.

[6] Ministry of Environment and Energy, *Energy 21, The Danish Government's Action Plan for Energy 1996*, Copenhagen, 1996, p. 39.

There was a plan for green certification for renewables that has now been abandoned. The plan, proposed in the 1999 Electricity Act, would have issued certificates to electricity producers. Consumers would have been required to purchase a minimum amount of their electricity from renewable energy suppliers. This system was designed to provide more transparency to the renewable energy market.
Effectively, the Government wants to remove the obligation to purchase electricity produced by decentralised CHP plants and wind turbines. The purchase obligation would be replaced by restructuring existing subsidies financed through electricity bills. [7]

4. Energy Pricing and Taxation

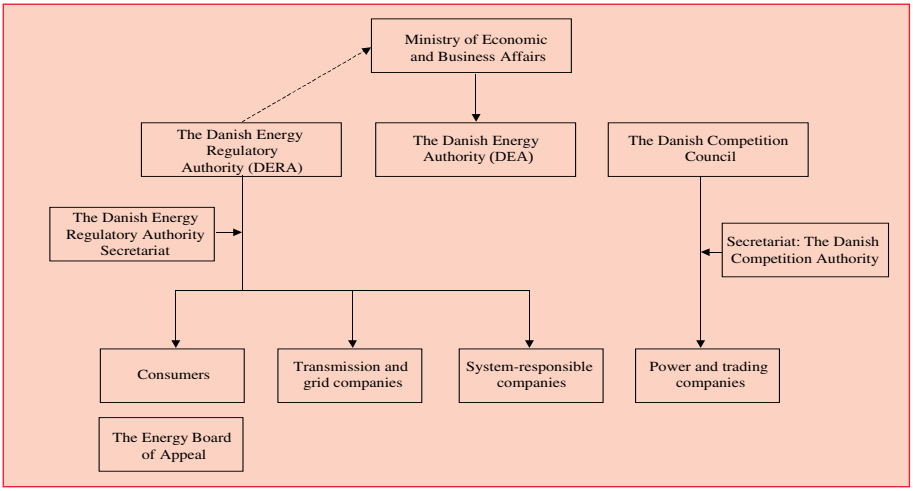
For households and the public sector, energy costs only constitute 25% of the total energy cost. These sectors pay both energy taxes and VAT which constitute the remaining 75% of the consumer price. The industry and commercial sectors only pay environmental taxes.

The Government, in its liberalisation reforms, is seeking more competitive Danish energy prices compared with other countries. Relatively high-energy prices in Denmark have been as an important lever in promoting energy efficiency, the expansion of CHP and renewable energy as well as achieving its environmental goals, particularly related to climate change. The price system is a combination of competitive and monopoly elements together with a wide range of environmental taxes.

Energy price formulation varies on the degree of competition. Oil product prices, while highly taxed, are fully competitive and the government has no role. The same is not true for most electricity and gas, where there are monopoly considerations. For these, the Danish Energy Regulatory Authority (DERA), an independent body within the Ministry of Economic and Business Affairs, which was set up three years ago, plays a major role, as shown in Figure 4.

[7] Danish Government, *Liberalisation of the Energy Markets, The Danish Growth Strategy*, Copenhagen, September 2002, p. 9.

FIGURE 4: ORGANISATIONAL STRUCTURE OF THE DANISH ENERGY REGULATORY AUTHORITY (ELECTRICITY)



Notes : there is no direct governmental ownership in the Danish electricity sector
Cases determined by DERA and DEA may be appealed to the Energy Appeal Board
The Danish Competition Authority and the Danish Energy Authority Secretariat assistance to DERA is supplied by staff from the Danish Competition Authority and the Danish Energy Authority.

Electricity prices, before taxes are included, for example, consist of four elements [8] :

- Market electricity: power from conventional power producers is paid at a price determined by the electricity market;
- Additional cost of electricity generation subject to a purchase obligation: decentralised CHP plants and renewable energy provide about 40% of Danish consumption of electricity. This electricity is subject to a purchase obligation and paid at regulated prices;
- Surcharge/PSO (Public Service Obligation): payment for public service obligations, including the maintenance of a certain security of supply; and
- Grid tariffs, etc., including subscription fee.

In addition to the above elements, there are the energy taxes and the VAT that determine the end-use prices.

Non-market based energy prices are controlled by DERA, which replaced the Electricity Prices Board and the Gas and Heating Prices Board. These include prices

[8] Ibid., p. 28.

for DH, for example. DERA's tasks are laid down in the legislation on the energy sector. These tasks can be divided into four main areas, with the principal objective of encouraging efficiency and reducing consumer energy costs:

- Supervision of distribution prices and connection charges, whether for local distribution grids or major, cross-border transmission systems;
- If prices or supply conditions are not in accordance with energy legislation, DERA is obliged to intervene and is empowered to order the companies concerned to make the necessary changes;
- Transparency of prices and supply conditions. The consumer must be given the opportunity to compare such information from the various suppliers;
- Handling of complaints in the monopoly areas - complaints from consumers (households and private and public companies) and from energy companies about other energy companies;
- Efficiency-improving initiatives - among other things to ensure that those monopoly companies not subject to competitive pressure still give continuous efficiency improvement a high priority.

End-use energy prices are shown in Annex 3.

End-use prices are largely influenced through the tax system and there has been a long history of taxes on energy in Denmark. However, taxes began to play an ever-increasing role in energy and environmental policy from the mid-1980s when taxes were increased to stabilise falling oil prices in order to provide consumers with fairly steady end-use prices.

Energy and Environmental Taxes

Taxes have evolved considerably since 1977. Then taxes were introduced on oil products (other than petrol which had already been taxed) and electricity in 1977. This was followed in 1982 by taxes on coal. Taxes were implemented to raise state revenue, reduce energy consumption and meet environmental goals. When oil prices fell in 1986 the Government raised taxes in order to stabilise consumer prices.

The 1990 energy strategy, *Energy 2000*, proposed the plan to introduce environmental taxes on SO_2 and CO_2, altering taxes on electricity and CHP and introducing environmental taxes on the commercial sector's energy consumption "so as to stimulate energy conservation and the shift to more environmentally acceptable energy sources". The Government wanted to lower the aggregate tax burden and set a target of balancing the new energy-tax system against other taxes and duties. The Government also wanted the taxes to be set with reference to an international context

so as to not penalise Danish industry and it planned to make a special allowance for energy-intensive companies. Following the 1990 energy plan, energy and environmental taxes were introduced in 1991.

Taxes were reformed in the early 1990s, leading to the Green Tax Package that was introduced in 1996 for Danish trade and industry. This tax package, however, had two potentially conflicting objectives. It was designed to have taxes high enough to have an effect on emissions. However, there was also the aim to have taxes not so high as to adversely affect the competitiveness of companies. These goals were accomplished through redirecting additional tax revenue directly back to the sector, increasing tax rates gradually to give companies time to improve their energy efficiency and switch to fuels with lower emissions, and by applying different rates depending on the scale and use of energy. This measure was designed to help energy-intensive production.

The Green Tax Package includes three separate taxes: CO_2 taxes, energy taxes and SO_2 taxes. CO_2 taxes can vary if companies participate in a long-term agreement with the government (see Chapter 7). Sulphur taxes were included because of the problem of acidification and Denmark's commitment to sulphur emissions limits under various international agreements. Taxes in the Green Tax Package were increased in 1998 from the original proposal through an agreement called the Whitsun package.

It should be noted that households and the commercial sector pay both energy and CO_2 taxes while industry only pays CO_2 taxes.
The CO_2 tax is differentiated according to heavy processes, light processes and space heating.

TABLE 2: CO_2 TAXES EURO/TONNE CO_2

	1996	1997	1998	1999	2000	2001
Heavy process, no agreement	0.7	1.3	2.0	2.7	3.4	3.4
Heavy process, with agreement	0.4	0.4	0.4	0.4	0.4	0.4
Light process, no agreement	6.7	8.0	9.4	10.7	12.1	12.1
Light process, with agreement	6.7	6.7	6.7	7.8	9.1	9.1
Space heating	13.4	13.4	13.4	13.4	13.4	13.4

Source: DEA, *Green Taxes in Trade and Industry - Danish Experiences,* Copenhagen, June 2002.

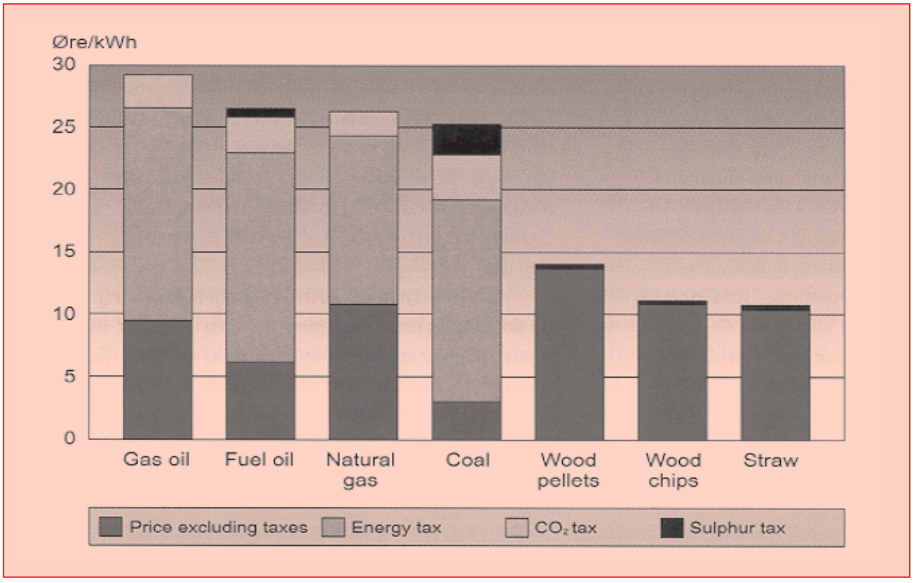
TABLE 3: TOTAL OF GREEN TAXES FOR VARIOUS ENERGY SOURCES FOR DIFFERENT ENERGY USE IN 2000

Energy Source	Unit	Sulphur Content	Heavy Process no agreement	Light Process no Agreement	Space Heating
Electricity	Euro/MWh		5	14	87
Natural gas	Euro/1000 m3	0	7	27	244
Gas oil	Euro/m3	0.1	10	34	269
Fuel oil	Euro/t	0.5	21	49	315
Coal	Euro/t	0.6	22	43	221

Source: DEA, Green Taxes in Trade and Industry - Danish Experiences, Copenhagen, June 2002.

Figure 5 provides a graphic illustration of energy prices and taxes.

FIGURE 5: ENERGY PRICES AND TAXES FOR HOUSEHOLDS AND PUBLIC SECTOR



Source: DEA, 2003

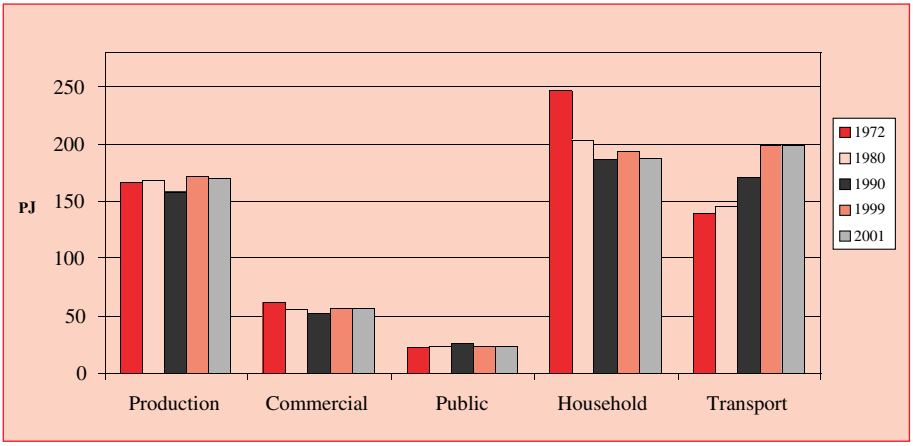
There are also VAT and excise taxes. VAT, which is not included in prices for industry, electricity generation and automotive diesel, has been at the rate of 25% since 1992. Excise taxes vary according to the fuel. For example, for unleaded gasoline the excise tax is 3.97 DKK per litre and for electricity it is 0.505 DKK/kWh.

Annex 3 provides selected energy prices and taxes.

5. End-Use Sectors

Figure 6 shows how energy consumption in the end-use sectors has evolved since the first oil crisis. The largest end-use sector is the household sector. In the 1970s, industry was second but it has been replaced in the 1990s by the transport sector. The biggest decrease in energy consumption has been in the household sector since the 1970s, while the transport sector has shown steady growth until recently. The industrial (called production in Figure 6) commercial and public sectors have shown little change in energy consumption during the past three decades.

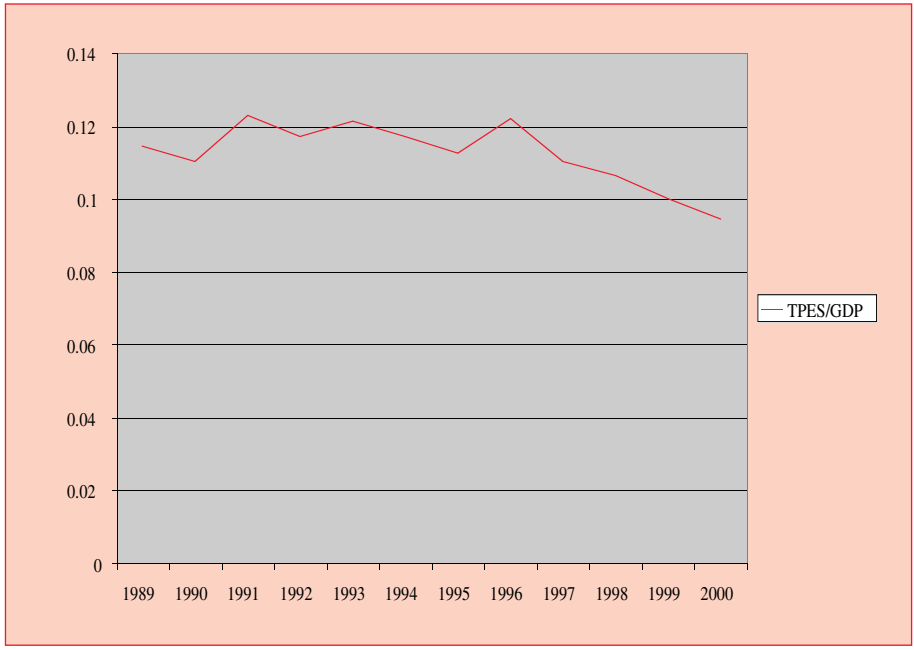
FIGURE 6: EVOLUTION OF TFC IN END-USE SECTORS 1972-2001 (PJ)



'Production' includes: Agriculture and Forestry; Horticulture; Fishing; Manufacturing (refineries are not included); and Construction
Source: DEA, 2003

Figure 7 shows the evolution of primary energy intensity (TPES/GDP) in Denmark since 1989. The overall trend is downwards. Denmark has one of the lowest energy intensities of EU countries.

FIGURE 7: PRIMARY ENERGY INTENSITY 1989-2000
TPES/GDP (TOE PER THOUSAND 95 $US)

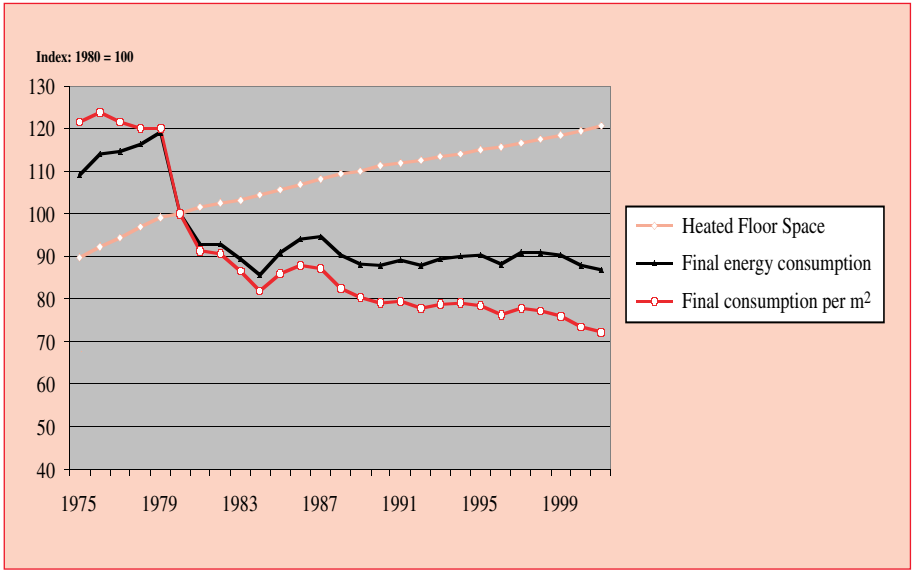


Source: IEA, Energy Balances of OECD Countries, 1999-2000, OECD, Paris, 2002

Residential

The residential sector is the largest end-use sector in Denmark. In 2001 there were 2.759 million dwellings of which 1.707 million were single-family houses and 1.051 million were apartments. A total of 1.491 million dwellings were connected to DH. Energy consumption in the residential sector has continued to decrease since the late 1970s, in large part due to the expansion of DH. While the total space being heated has increased about 30% since the mid 1970s, consumption per square metre has decreased by about 50% and final energy consumption for the sector has decreased about 30%.

FIGURE 8: FINAL ENERGY CONSUMPTION 1975-2001

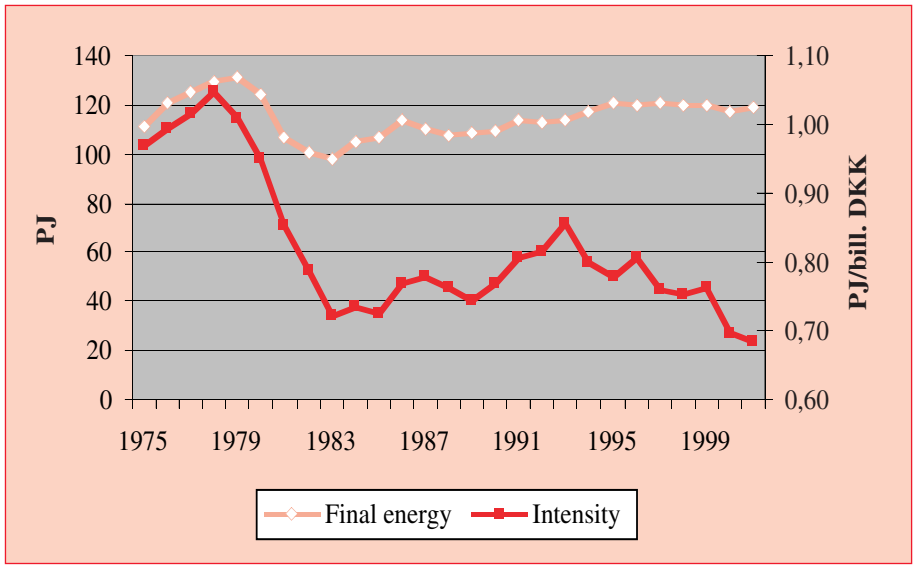


Source: DEA, 2003

Industry

In terms of energy consumption, the industrial sector is smaller than both the residential and transport sectors. This is, in part, because there is little energy-intensive industry in Denmark due partially to the fact that, until the last two decades, Denmark had few domestic energy resources. The sector is very export-oriented, focusing on machinery and instrumentation for industry, chemical products, agricultural products and, importantly for the energy sector, wind turbines. Total energy consumption in the industrial sector has not changed significantly in the past decade. However, between 1994 and 2001, energy intensity has decreased at a rate of 2.7% per year, much better than the average decrease of 1.2% per year between 1975 and 2001.

FIGURE 9: INDUSTRIAL ENERGY CONSUMPTION AND INTENSITY



Source: DEA, 2003

Services

The services sector is relatively small in terms of energy use but contributes about 72% to GDP. As shown in Figure 6, consumption for the sector (in the graph, it includes both commercial and public) has remained fairly steady over the past three decades. As in other industrialised countries, the expanded use of electricity continues and, in the services sector, while electricity consumption per employee has increased from 5,155 kWh in 1990 to 5,524 kWh in 2000, energy intensity (energy consumption per employee) has decreased from 0.98 to 0.94. Consumption per unit of value added has decreased from 31.00 units in 1990 to 26.00 units in 2000. [9]

Transport

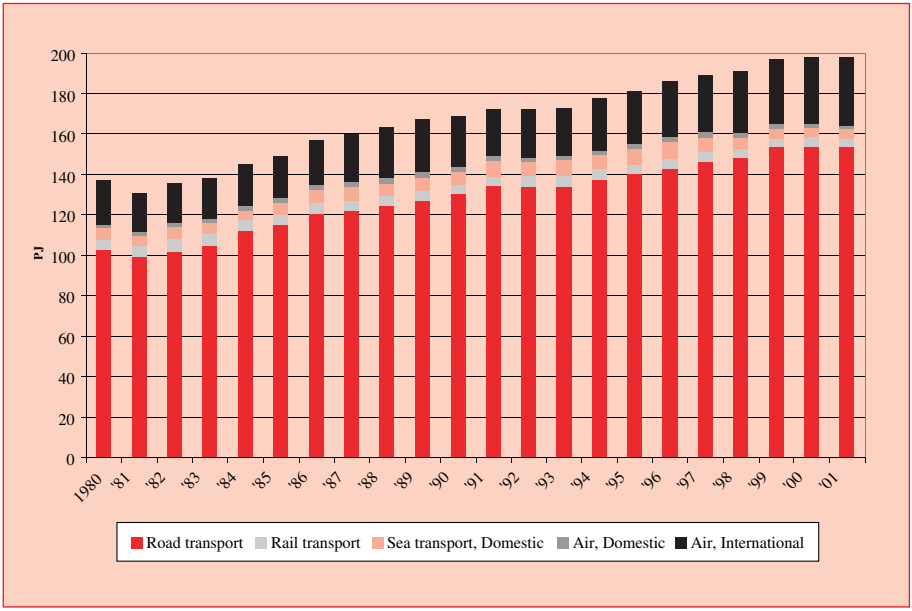
As shown in Figure 6 above, the transport sector is the only sector that has shown strong growth in energy consumption over the past three decades. The sector is dominated by road transport. In 2001, there were 1.872 million private cars and 13,954 buses, 96,131 new car registrations and also a total of 343,450 vans and 36,801 trucks.

[9] www.odyssee-indicators.org.

Rail is split between public and private, although the public sector dominates rail. In 2002, there were 1878 registered ships, with almost half being fishing vessels. The total tonnage was 6.918 million gross tonnes.

As shown in figure 10, road transport represents over 70% of total consumption for the sector. This comes to over 93% when international air travel consumption is removed.

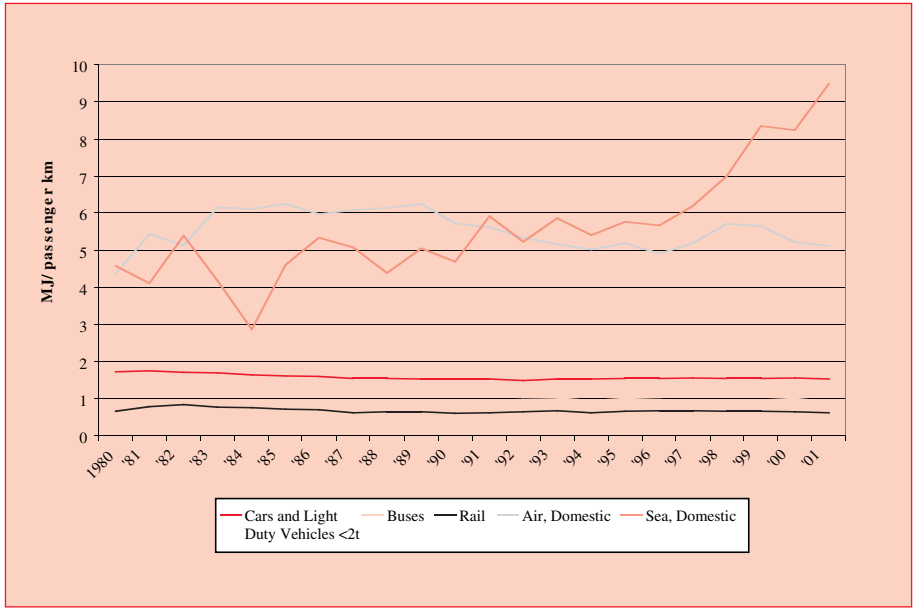
FIGURE 10: ENERGY CONSUMPTION FOR TRANSPORT MODE 1980-2001



Source: Danish Ministry of Transport

In terms of energy intensity, cars, buses and rail have shown little movement. The biggest increase in intensity has been in sea transport, although sea transport represents less than 3% of total consumption in the sector.

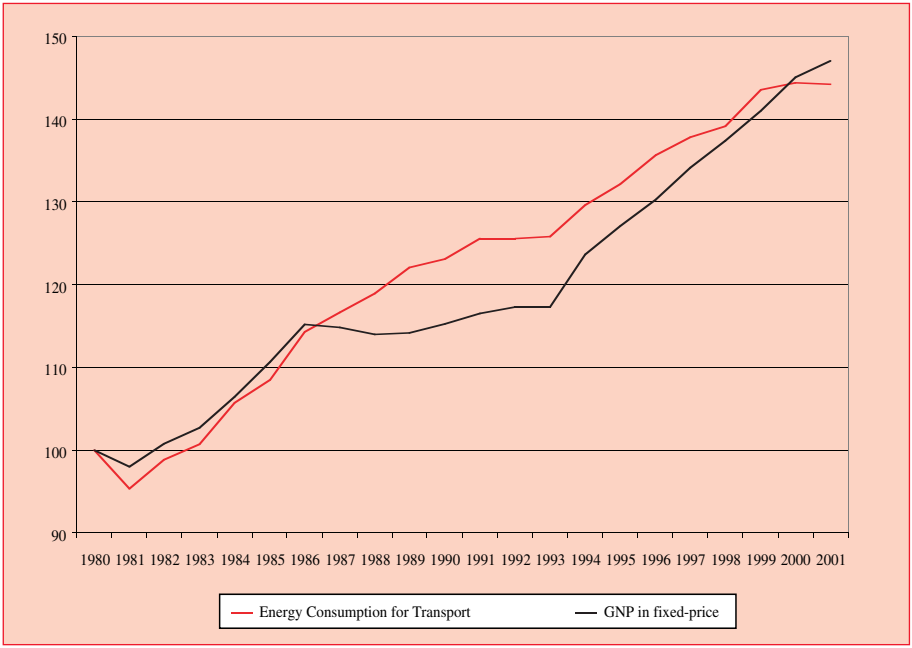
FIGURE: 11: ENERGY INTENSITY OF PASSENGER TRANSPORT



Source: Danish Ministry of Transport

Since the mid 1980s, transport energy consumption has outpaced the growth in GNP, meaning that energy intensity has deteriorated. This reversed in 2000; however, it appears premature to state whether this trend will continue in the future.

FIGURE: 12: DEVELOPMENT IN GNP AND TRANSPORT ENERGY CONSUMPTION



Source: Danish Ministry of Transport

6. Combined Heat and Power (CHP), District Heating (DH) and Renewable Energy

CHP and DH

CHP and DH play important roles in Denmark. Denmark has one of the highest shares of households heated by DH, at about 50%. This has expanded since the implementation of the Heat Plan in the late 1970s and early 1980s. Now more than 1.5 million homes, representing 58% of the total number of households, are supplied with DH. Decentralised CHP, in particular, has been encouraged since 1990.

DH and CHP have been important pillars of Danish energy policy over more than two decades. They have received considerable policy and financial support to reach their current state. DH has been promoted since the late 1970s and early 1980s, when urban areas were divided between district heat and individual gas heating (as part of the introduction of North Sea gas into the domestic market). DH companies were encouraged to convert heat only boilers to CHP and access to the grid was made easier. Small-scale CHP plants and industrial CHP were also given favourable treatment.

Now, both DH and CHP have virtually reached saturation point. DH provides about half of the total heat demand and CHP provides about 55% of total electricity supply. It is believed that most of the cost-effective potential for CHP has been achieved.

The government's *Liberalisation of the Energy Markets*, (September 2002), states that its aim is to make it easier for decentralised CHP plants to contribute to security of supply. It added that there is a need to restructure subsidies to decentralised plants and there is a need to remove restrictions on operation.

FIGURE 13: SHARES OF DH IN HEATING IN WESTERN EUROPE

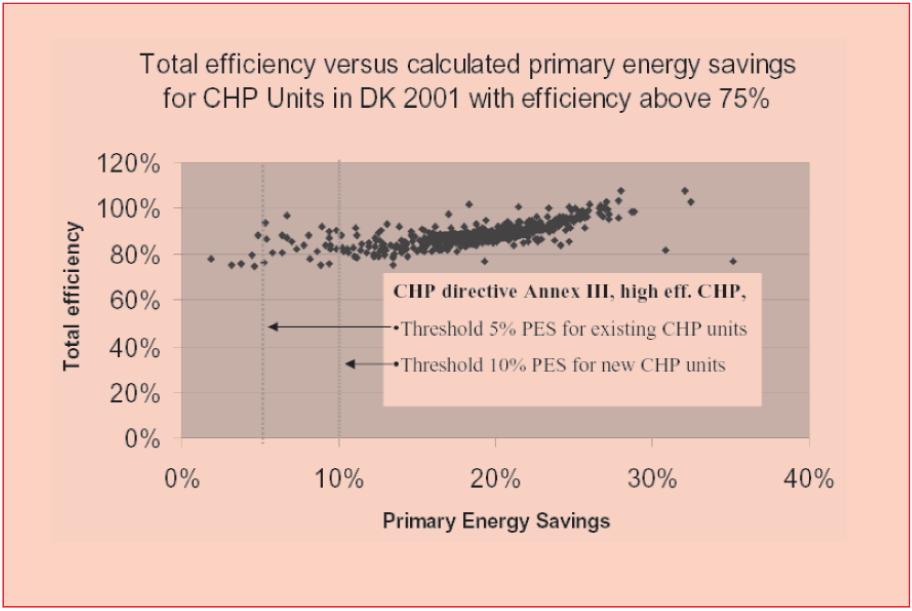
Source: DEA, 2003

There are approximately 400 DH plants throughout Denmark. About 350 are consumer-owned (co-operatives), while the rest are municipally owned. The Danish District Heating Association represents the companies.

The share of CHP in DH has increased from 29% in 1972 to 55% in 1988 to over 81% in 2000. Electricity from CHP has grown from 18.6% in 1980 to almost 55% of production in 2000.

The majority of the CHP plants have a global efficiency of over 80%, as shown in Figure 14, which includes all plants with an efficiency over 75%.

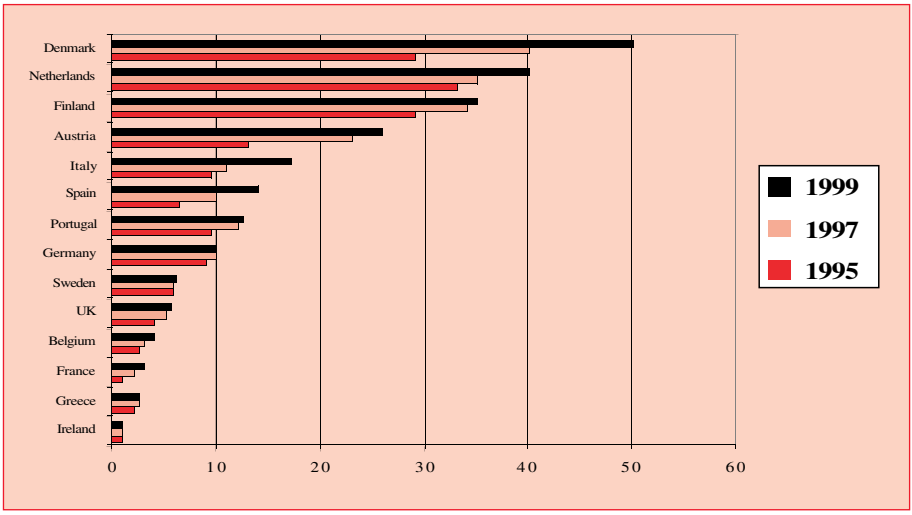
FIGURE 14:
TOTAL EFFICIENCY VERSUS CALCULATED PRIMARY ENERGY SAVINGS FOR CHP UNITS IN DK 2001 WITH EFFICIENCY ABOVE 75%



Source: DEA, 2003

Figure 15 shows that electricity from CHP has increased significantly in Denmark in the late 1990s and the country is leading other EU countries. The next highest country, the Netherlands, is a full 10% behind Denmark.

FIGURE 15:
CHP IN THE EU15
PERCENTAGE OF NATIONAL ELECTRICITY PRODUCTION
1999/1997/1995



Source: DEA, 2003

Government analysis shows that around 30% of the fuel for electricity and heat production was saved by CHP compared with separate production. This has also lowered GHG emissions by 10%.

Electricity from decentralised CHP is supported by favourable feed-in tariffs and a purchase obligation. Decentralised CHP production was first promoted in the 1990 energy strategy, *Energy 2000*. Municipalities are also obliged to ensure the development of CHP if it is socio-economically viable. CHP must supply a minimum of 90% of the local heat market, although this obligation is to stop in mid-2003.

The conversion of existing stations to CHP was in three phases in the 1990s:

- 1990-94: large DH plants from coal/gas to CHP (gas);
- 1994-96: remaining larger coal/gas DH plants to CHP; small DH plants outside the gas grid converted to biomass;
- 1996-98: small gas heat plants to CHP.

The new approach being developed is to have decentralised CHP plants face increased competition by, first, reacting to market prices. There should be no financial burdening

of DH customers (i.e. cross subsidies), evident environmental benefits and no burden on the state budget. What the new model will look like is still not certain; however, it will most likely have a fixed capacity payment and a market-based feed-in tariff. This will lead to reduced decentralised production and lower the costs of feed-in. This will result in electricity requirements coming from other production facilities. In periods of low rainfall, prices in the Nord Pool will certainly be high on the electricity market, and the decentralised CHP plants will therefore produce as much electricity as possible (which is equal to what they produce today).

The future of CHP will also depend on the final form of the proposed EU directive on CHP.

In 2002, the European Commission published a draft cogeneration Directive to promote wider use of cogeneration:

The overriding objective of this proposal is to create a framework, which can support and facilitate the installation and proper functioning of electrical cogeneration plants where a useful heat demand exists or is foreseen. This overall objective translates into two specific aims:

– In the short term, a cogeneration Directive should serve as an instrument to consolidate existing and, where feasible, promote new high-efficiency cogeneration installations in the internal energy market. In order to create a level playing field, regulatory certainty and in some cases financial support are vital for cogeneration. This applies to the current transitional phase of the liberalisation process, where the internal energy market is not fully completed and where internalisation of external costs is not reflected in energy prices.

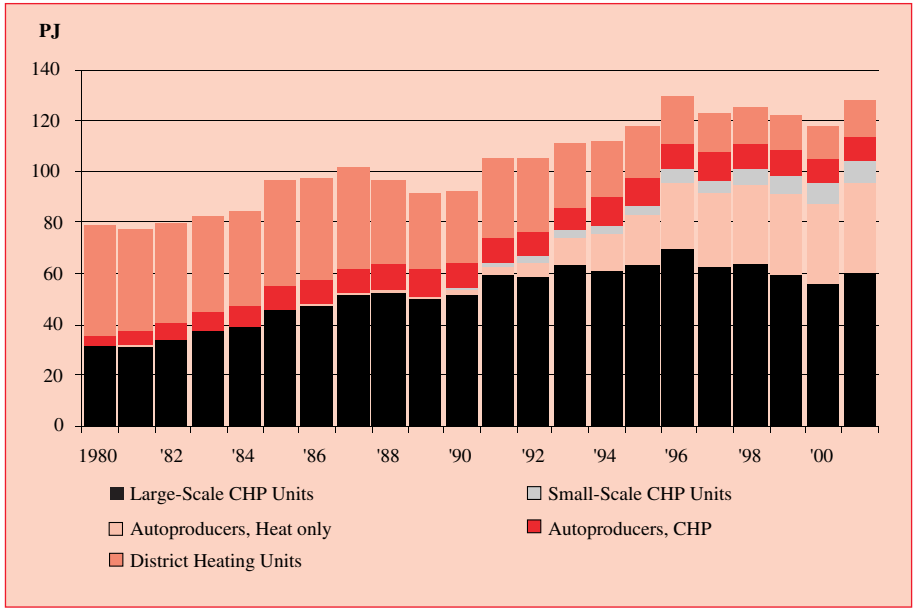
– In the medium to long term, a cogeneration Directive should serve as a means to create the necessary framework that will ensure that high-efficiency cogeneration, alongside other environmentally friendly supply options, constitutes a key element when decisions on investment in new production capacity are made. By creating a supportive framework, such cogeneration can contribute to the establishment of more diversified and energy efficient supply systems in the Community.

The Danes were pioneers in designing a CO_2 quota scheme (combined with a system of trading certificates), which started operating in 2001. This scheme affects only the electricity sector - and in this sense it differs from the emissions trading scheme planned at EU level. The system maintains an incentive for CHP electricity production.

The 1999 Act on CO_2 Quotas for Electricity Production introduced a quota scheme for electricity producers binding until 2003. The Act laid down the aggregate annual quotas for 2000 to 2003 (which decrease every year). On the basis of these quotas the Ministry of Economic and Business Affairs allocated an annual CO_2 emissions permit to electricity producers. If the permit is exceeded, they pay a penalty of 40 DKK/tonne CO_2 (5.8 Euro/tonne CO_2)

Figure 16 shows the sources of heat production in Denmark.

FIGURE 16: PRODUCTION OF DISTRICT HEATING 1980-2000

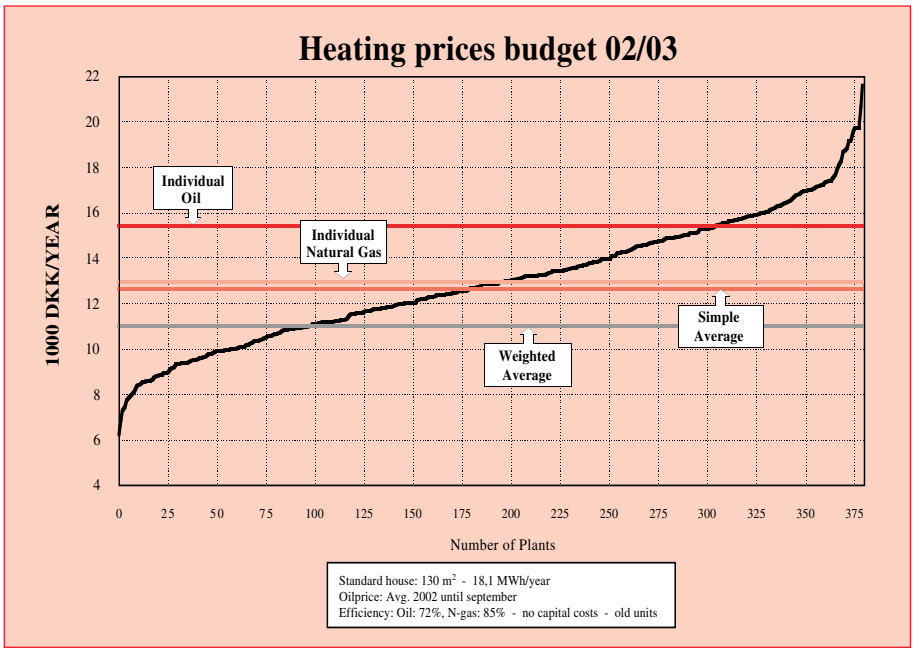


Source: DEA, 2003

According to the Danish District Heating Association most of the existing DH systems supply heat at more favourable cost than individual oil or even gas boilers. In fact the average cost (both weighted for the size of the various systems and simple

average) of the heat supplied by DH is below the cost of heating an equivalent standard house with individual oil or gas boilers. Only for a limited number of DH systems, in general recent small ones, supplying about 25000 customers, is the cost of DH higher compared with other alternatives. This small proportion of less efficient small DH/CHP systems actually represents the overshooting of previous policy measures. Tackling this problem should however not hamper the major part of cost efficient DH and DH/CHP systems.

FIGURE 17: DH-EXPENDITURES DENMARK



Source: Danish District Heating Association.

Renewable Energy

Renewable energy plays a significant role in energy policy in Denmark and together with energy efficiency policy has worked well to form the basis of a strong sustainable energy strategy. Renewable energy has focused on biomass for heat and electricity and on wind energy. Denmark's wind industry is the world's largest, with the domestic industry accounting for half of the world's market in 2001. Over 20,000 are employed in Denmark, with a further 20,000 outside the country. Employment includes design and manufacture of turbines and components, consultancy and engineering services. The industry has overtaken the fishing industry in size.

Table 4 shows the rapid acceleration of capacity expansion throughout the 1990s. Total capacity grew by almost 23%, led by wind.

TABLE 4:
NET GENERATING CAPACITY OF RENEWABLE AND WASTE PRODUCTS (MW)

	1990	1995	1996	1997	1998	1999	2000	2001	Avg. annual percent change 90-00
Total Capacity	413	836	1093	1371	1681	2130	3183	3259	22.7
Hydro	10	10	10	10	11	11	10	10	-
Geothermal	-	-	-	-	-	-	-	-	-
Photovoltaic	-	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-	-
Tide, Wave	-	-	-	-	-	-	-	-	-
Wind	343	616	842	1130	1443	1771	2417	2556	23.4
Ind. Waste	-	-	-	-	-	-	-	-	-
MSW	-	153	181	171	167	198	233	242	-
Solid Biomass	40	40	40	40	40	110	86	133	8.0
Gas from Biomass	20	17	20	20	20	40	40	48	7.2
Comb. Ren. Non-Specified	-	-	-	-	-	-	-	-	-
Solar Collectors (1000 m^2)	57	144	184	213	230	246e	246e	271	15.7

e - estimate
* by the end of 2002, installed capacity had reached 2880 MW.
Source: IEA, *Renewables Information (2002 Edition),* OECD, Paris, 2002, p. 76.

In 1990, renewables accounted for 8.8% of TPES and by 2001 it achieved 11.6%. In 1990, renewables provided 3.2% of electricity generation, while by 2000 that had increased to 17.6% (preliminary data show it achieved more than 20% in 2002).

In heat production, in 1990, renewables accounted for 882 TJ in CHP plants. That increased to 16,839 TJ in 2000, an annual increase of 34.3%. In heat only plants, renewables decreased slightly from 18,636 TJ in 1990 to 17,787 TJ in 2000.

Renewable energy has been promoted in Danish energy strategies since the 1970s. In 1996, specific targets were provided, as shown in the table below.

TABLE 5: TARGETS FOR RENEWABLE ENERGY FROM ENERGY 21 (PJ)

	1996	2000	2005	2010	2030
Wind	4.4	8.6	13.8	22.7	59.8
Photovoltaics	0	0.6	1.0	1.4	3.0
Biomass	61.4	73.4	84.9	95.9	145.7
- of which electricity	6.5	11.5	15.5	18.0	31.3
Other sources of RE (geothermal, hydro, etc.)	3.5	0.7	1.9	2.8	26.4
- of which electricity	0.1	0.1	0.2	0.3	1.0
RE incl. Waste	69.3	86.4	101.6	122.8	234.7
- of which electricity	11.0	20.8	30.5	42.4	95.1
RE electricity of total el. consumption incl. waste	**9%**	**17%**	**25%**	**35%**	**85%**
Total RE excl. Waste	43.9	63.7	79.0	100.2	212.6
- of which electricity	7.1	15.8	24.7	36.6	89.0
RE electricity of total electricity consumption	**6%**	**13%**	**20%**	**30%**	**79%**

Source: www.ecd.dk

The principal measures used to promote renewable energy included a combination of subsidies, feed-in tariffs, purchase obligations, agreements with utilities and technology development.

The importance of technology development should not be underestimated. There has been a well-structured approach ranging from support to applied research through to commercialisation. The emphasis of the liberal-conservative government is to focus government support on research - and less on commercialisation - and for NGO involvement. The philosophy is that industry should take a greater role in financing the development of the market for new energy technologies.

The R&D framework includes:

- a reduced Energy Research Programme for applied R&D (from 100 million DKK in 2001 to 40 million DKK per year in 2004-08);
- a new more basic energy research programme for 2003-2005 dedicated to renewable energy technologies (110 million DKK for the period 2003-05);
- Public Service Obligation (effectively paid for by electricity consumers) R&D programme which has existed since 1998. The priority for and level of funding is approved by the DEA. The funding is 100 million DKK per year - primarily for the development of renewable energy technologies;
- New overall incentives for private sector R&D as outlined in the Danish Growth Strategy 2002.

The Riso National Laboratory, universities and industry undertake much of the research. Denmark participated in the EU's 5th Framework Programme for R&D as well as the

new 6th Framework Programme. EU participation is considered a high priority for Denmark.

7. Energy Efficiency Policies and Programmes

Chapter 3 described the main energy efficiency policies in Denmark. Energy efficiency policies and programmes have a long tradition in Denmark. Integrating energy efficiency into overall energy policies is very much the norm in Denmark. As shown by analysis undertaken by the Energy Charter Secretariat in 2002, this is not always the case in most PEEREA countries. Denmark is considered by many to be a role model for its promotion of energy efficiency.

There has been a re-orientation by the liberal-conservative government to link energy efficiency policies and programmes with more than climate change strategies, as had been largely the case over the past decade. The Government wants energy efficiency to be an important element of energy policy but to meet other objectives as well: energy security, competitiveness, employment etc.

Energy efficiency programmes have changed in the past two years and continue to do so. Subsidy programmes have almost entirely been phased out. There is an emphasis on cost-effectiveness and on implementing programmes to meet EU requirements.

In May 2000 a new Energy Conservation Act (Act 450) was approved by Parliament, as part of a political agreement for reform of the electricity sector. This new Act provides a framework for co-ordination and priority to be given to both centralised and decentralised initiatives in the future and also introduces some new elements.

The Act needs to be viewed in connection with the role of supply enterprises in the area of energy savings. The Electricity Supply Act of 1999 states that grid enterprises should continue to deliver the saving initiatives (see below), developed in the electricity sector over several years. Also, the Natural Gas Supply Bill and amendments to the Heat Supply Bill contain regulations concerning the DSM initiatives which natural gas and DH enterprises must take.

Act 450 also created local energy conservation committees, which are designed to co-ordinate energy efficiency activities of various local players (see below).

The act also contains regulations concerning initiatives for energy conservation in the public sector. The government believes that public institutions must exhibit exemplary

behaviour when it comes to energy efficiency and thus contribute to shaping developments by setting a good example.

The following represents the major programmes in the various end-use sectors.

Residential

With the termination of subsidy programmes, the core of Denmark's programmes in the household sector are regulatory, many of which are driven by evolving policy and directives at the EU level. The inset box below shows the extent of legislative requirements through the European Union. The requirements cover appliance labelling and efficiency standards, boiler efficiency, the development and revision of building codes, building labelling etc.

In terms of building labelling and building codes, Denmark has a long history of developing and implementing initiatives ahead of any requirement to do so by the EU.

The following legislative measures related to energy efficiency in the residential sector that have been adopted by the European Union since 1992:

1. Council Directive 92/42/EEC on "efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels".
2. Council Directive 92/75/EEC on "the indication by labelling and standard product information of the consumption of energy and other resources by household appliances".
3. Council Directive 93/76/EEC on "to limit carbon dioxide emissions by improving energy efficiency (SAVE)".
4. Commission Directive 94/2/EEC implementing Council Directive 92/75/EEC "with regard to energy-labelling of domestic electric refriger ators, freezers and their combinations".
5. Commission Directive 95/12/EC implementing Council Directive 92/75/EEC concerning energy-labelling of clothes washers.
6. Commission Directive 95/13/EC implementing Council Directive 92/75/EEC concerning energy-labelling of clothes dryers.
7. Council Directive 96/57/EC on energy efficiency requirements for house hold electric refrigerators, freezers and combinations thereof.

8. Commission Directive 96/6/EC implementing Council Directive 92/75/EEC concerning energy-labelling of household dishwashers;
9. Commission Directive 97/17/EC of 16 April 1997 implementing Council Directive 92/75/EEC with regard to energy-labelling of household dishwashers;
10. Commission Directive 98/11/EC implementing Council Directive 92/75/EEC concerning energy-labelling of household lamps.
11. Directive 2000/55/EC of the European Parliament and of the Council of 18 September 2000 on energy efficiency requirements for ballasts for fluorescent lighting.
12. Commission Directive 2002/31/EC of 22 March 2002 implementing Council Directive 92/75/EEC with regard to energy-labelling of household air-conditioners.
13. Commission Directive 2002/40/EC of 8 May 2002 implementing Council Directive 92/75/EEC with regard to energy-labelling of household electric ovens.
14. Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.

Denmark's energy-labelling programme for buildings embodies approaches designed separately for small and larger (above 1500 square metres) buildings.

In the programme for small buildings, every house owner may have an audit of his building, describing the present energy conditions with recommendations for possible energy saving measures in the building shell and heating equipment. At the point of sale of the building, the vendor is obliged to present a current audit certificate. The result of the audit is an Energy Label describing the energy condition on a scale from A1 to C5 (A1 is best). Heating, electricity and water consumption are rated on the basis of a standard calculation - not actual consumption because it is linked to the particular seller's household (number of persons and behaviour). Another part of the audit is an Energy Plan informing the buyer which measures could be worthwhile carrying out in the short or long run to save energy.

An evaluation of the scheme in 2000 concluded that there is a large energy saving potential in existing buildings. Forty-five per cent of the owners of labelled houses actually invested in heat saving measures. Even though the scheme is mandatory, an energy certificate covered only 60% of the traded houses. On the basis of other

conclusions about the early experience of setting up of the scheme, changes were made in mid-2001 to empower the steering committee of the scheme to take over more responsibilities for the success of the scheme.

Results from energy-labelling of small buildings: [10]

- 40-45,000 small buildings are labelled every year;
- Every year new investments for more than 1 billion DKK (nearly 200 million Euro) are identified in the energy plans;
- Possible to reduce energy costs with more than 150 million DKK per year (20 million Euro);
- Payback time is 7 years on average; and
- Savings last for more than 25 years on average.

The energy-labelling of large buildings pertains to buildings in the services sector as well as to buildings in the residential sector larger than 1,500 sq. metres (including apartment blocks).

5-700 specially trained consultants carry out the annual supervision of larger buildings. About 25,000 buildings are concerned. Every month all buildings, except industrial buildings, with a surface of more than 1,500 m2 must register their consumption of heat, electricity and water.

Annually, a consultant makes an audit comprising an Energy Label and an Energy Plan. The Energy Label evaluates the consumption of heat, electricity and water on scales from A to M (A is best) in comparison with average figures for comparable buildings. The Energy Plan informs the building owner about relevant measures for energy saving in the short and long run. This new scheme runs parallel to the above-mentioned scheme concerning smaller buildings.

This scheme was evaluated in 2000 and the major conclusions were that the scheme works very well for those who participate in it, but around half of the buildings still do not fulfil the requirements. The energy savings in the buildings following the scheme are larger than in those outside the scheme. Furthermore, the investments in energy savings are more focused in buildings participating in the scheme and those responsible for energy are more aware of the results of investments.

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[10] Presentation by Mr. Jens Laustsens, Danish Energy Authority, to Workshop on Integrated Methodologies and Harmonisation of Certification Schemes to Support the Implementation of the new EU Directive on Energy Performance of Buildings, Brussels, March 31, 2003.

The energy-labelling programme for both small and larger buildings will be revised to meet the requirements under the new Directive on Energy Performance of Buildings (see box below on the directive).

Denmark has until January 2006 to implement the Directive on Energy Performance of Buildings. This means that the building code and the energy-labelling of buildings programme will have to be revised by then. The building code is already scheduled to be revised by 2005. *Energy 2000* stated that there would be a 25% reduction in 1995 and a further 25% reduction in 2005, both in relation to the code before 1990. These reductions will be fulfilled. The number for the coming reduction in 2005/6 should consequently be 33% compared to today's level. But it is only 25-30%. The reason is, that the new code/directive is covering more energy transformation within the building (includes all boilers, pipes, storage, losses etc.). If the old method were to be used the reduction would still be 33% compared to the today's level.

From the EU Directive on Energy Performance of Buildings

From Article 1:

This Directive lays down requirements as regards:

- the general framework for a methodology of calculation of the integrated energy performance of buildings;
- the application of minimum requirements on the energy performance of new buildings;
- the application of minimum requirements on the energy performance of large existing buildings that are subject to major renovation;
- energy certification of buildings; and
- regular inspection of boilers and of air-conditioning systems in buildings and in addition an assessment of the heating installation in which the boilers are more than 15 years old.

Denmark is working with other EU member states to develop a common methodology for implementing the Directive on Energy Performance of Buildings. Initial efforts are on developing a common methodological framework for energy calculations that would be used for the energy certification of buildings.

Denmark also has a variety of information and market transformation programmes through the Danish National Energy Information Centre and the Danish Electricity Saving Trust (see Chapter 8 for more information).

Under the Electricity Supply, Gas Supply and Heat Supply Acts and their executive orders, energy companies are required to promote end-use energy efficiency. The funds come directly through the electricity bill and total about 200-250 million DKK per year. While companies decide on their activities, the DEA sets the framework and must receive the company plans. The plans are often developed through the industry associations and discussed at the local energy savings committees (see below). The activities must be non-commercial and should concern energy consulting and information to consumers. There is evidence of local co-ordination amongst the electricity, gas and heating companies as well as with the Electricity Saving Trust, to some extent.

Industry

While there are some EU directives that pertain to the industrial sector (boiler efficiency, energy-labelling of buildings, etc.), the main energy efficiency initiatives in industry have been taken by the Danish Government and are concerned with the use of voluntary agreements and, as shown above, taxation. Voluntary agreements were first promoted in the government's 1996 action plan, *Energy 21*. The agreements were brought in with the Green Tax Package. Those participating in the agreements would receive a rebate on CO_2 taxes, as shown above. By 2001, about 330 companies entered into agreements with the DEA. This represented more than 50% of total industrial energy consumption. DEA estimates show that the agreements will lead to a 6% reduction in the sector's CO_2 emissions by 2005, half of which would result from better energy management.

The agreements cover a three-year period and are based on estimates of potential savings and investments in the agreement period. The agreements call for the undertaking of all measures with a four-year payback. After the three-year period, agreements are re-negotiated. The companies must agree to undertake energy management and special investigations (which are supplements to energy mapping and focus on primary production processes).

Target groups for the agreements are energy-intensive companies, which are defined as companies with heavy processes or companies with light processes if their yearly tax on their energy use amounts to at least 4% of their value added. As of July 1, 2002, there are also agreements on space heating for companies with agreement on either light or heavy process if their tax on space heating and hot water is at least 2% of value added. In 2003, space heating-only agreements were reached with hotels, conference centres and holiday centres.

Monitoring is done through annual progress reports and reports on special investigations. Verification of improvements is carried out by an independent verification

bureau approved by the DEA. In case of non-compliance, the agreement is rescinded and the company must pay back any obtained tax rebates and will be subject to full CO_2 taxation.

The energy-labelling of larger buildings also pertains to industrial buildings.

Services

The services sector has no separate measures. EU directives apply to this sector. The DEST initiatives are particularly important for this sector and DEST is now piloting a monitoring of the electricity consumption on a 24-hour basis of a number of public buildings in order to improve feedback and to better identify energy management opportunities.

Article 4 of Council Directive 93/76 relates to third party financing (TPF) in the public sector:

> Member States shall draw up and implement programmes to permit third party financing for energy efficiency investments in the public sector. For the purposes of this Directive, 'third-party third party financing' means the overall provision of auditing, installation, operation, maintenance and financing services for an energy efficiency investment, with recovery of the cost of these services being contingent, either wholly or in part, on the level of energy savings.

A February 2000 evaluation of the Council Directive [11] made the following comments on Denmark:

> For regional and local authorities, third party financing is considered a form of borrowing funds for energy savings projects and there is a government regulation that permits those levels of government to access loans. Municipalities have had the opportunity to access such financing mechanisms through Article 2(I)(7) of Interior Ministry Order No. 343 of 5 May 1994. Regional authorities have had the opportunity in the 1992-1995 period.
>
> State institutions cannot use loans to finance energy savings projects and thus there is no possibility to access third party financing. The Ministry of Finance continues to believe that if the project is worthwhile, then it can be financed internally. The state sector can undertake energy savings projects through subsidies, energy management programmes, reporting data and establishing energy plans.

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[11] *Study on the Application of Council Directive 93/76/EEC of 13 September 1993 to Limit Carbon Dioxide Emissions by Improving Energy Efficiency (SAVE), Final Report*, February 2000.

As shown above under industry, long-term agreements for hotels and other service industries are starting to come into force.

The energy-labelling of larger buildings also pertains to buildings in this sector.

Transport

The transport sector is included in the August 2002 national strategy for sustainable development. Two of the benchmarks for monitoring progress towards sustainable development relate to energy efficiency: average energy efficiency for passenger transport and freight transport, and energy efficiency of new cars.

Denmark, without its own vehicle manufacturing industry is limited in the instruments it can use. It participates in the EU strategy, including the agreement with manufacturers on fuel efficiency. Taxation also plays an important role, both on fuels and on motor vehicle registration fees.

Energy-labelling of new passenger cars, as required under EU directive 1999/94/EC is important. The label is required at the point of sale and must include information on fuel consumption and specific emissions of CO_2 that have been determined in accordance with harmonised EU standards. Unlike EU labels for appliances, however, the format is left to the individual member states to design. Even before the EU requirements, Denmark had a voluntary agreement with car dealers and importers on a guide and a website. Rules for the labels were established in 2000 and revised in 2003.

Denmark invests in the public transport system, has developed logistical tools in freight transport, has supported promotional schemes such as Green Mobility Week and European Mobility Week, supported carpooling and car-sharing, and has promoted the continued or expanded use of cycling in cities.

There was a proposal to revise car registration fees to encourage "greener" vehicles, but this was rejected in April 2003. Nevertheless, the current system still encourages smaller cars than in most other EU countries. The high registration fees, however, slow down the rate of scrapage leading to an older, more energy-inefficient fleet than might otherwise be the case.

8. Organisation of Energy Efficiency Activities

Energy efficiency activities are undertaken by many organisations, both within and outside government. Overall energy efficiency policy is the responsibility of the

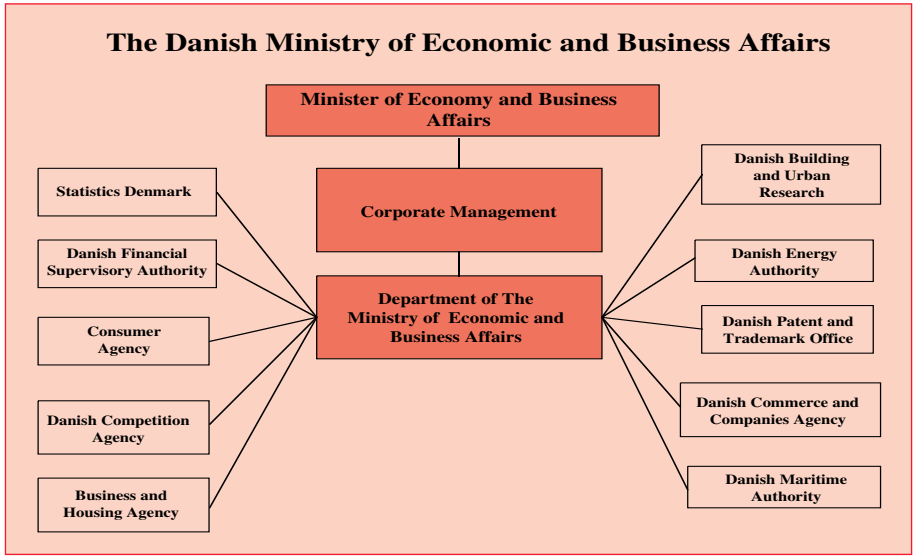
Ministry of Economic and Business Affairs and its Danish Energy Authority (formerly the Danish Energy Agency until November 2001). Previous to the election of the current liberal-conservative government, the responsibility for energy efficiency policy was under the Ministry of Environment and Energy. Environmental policy is now under the Ministry of Environment.

The DEA, created in 1976 and with a staff of about 200, carries out tasks, nationally and internationally, in relation to the production, supply and consumption of energy. It is responsible for the whole chain of tasks linked to the production of energy and its transportation through to the provision of energy services by the consumer.

The DEA advises the minister and assists other authorities in administering Danish energy legislation and conducting analyses and assessments of the development in the field of energy, nationally and internationally.

As shown in Figure 18, the DEA is one of 10 agencies in the Ministry of Economic and Business Affairs. Three other agencies within the Ministry - the Danish Agency for Enterprise and Housing, Danish Building and Urban Research and the Danish Energy Regulatory Authority (DERA) - are also directly involved in energy efficiency matters. The Danish Agency for Enterprise and Housing is responsible for the building code, while the Danish Building and Urban Research provides much of the research for the development of the standards. DERA was described previously.

FIGURE 18: ORGANISATION CHART



One of the principal vehicles for providing information and advice on energy efficiency technologies and techniques in the residential sector is the Danish National Energy Information Centre which was created in 1998. The Centre is contracted out to a private consulting firm. It provides information and advice to private consumers, public institutions, research and education institutions and energy and environmental offices by disseminating various types of publications, a telephone hotline, a website, exhibitions and consultancy in communication. The Centre averages 90-110 enquiries a day. About half of the enquiries are on renewable energy. The Government has decided to terminate the Centre in June 2003. There are no plans for an alternative information and dissemination system.

Also under the Ministry of Economics and Business Affairs is the independent Electricity Saving Trust that was established in 1996 to promote electricity savings in households and the public sector, in accordance with socio-economic and environmental considerations. With a budget of about 90 million DKK annually, funded through a special tax on electricity bills, this independent agency promotes conversion of electrically heated houses and low electricity consuming appliances and equipment. For conversions, the target is to convert 50,000 houses over 10 years to DH or natural gas. This is done through a negotiated package of a lower connection fee, reduced installation costs and subsidies to consumers. For public organisations such as public housing associations and state and municipal institutions, the DEST set up the A-club (the A representing the most efficient equipment under the EU labelling scheme). Under this scheme, bulk purchasing of energy-efficient equipment is undertaken to lower costs. There are over 150 members of the A-club, covering more than 250,000 households. The DEST also sets procurement guidelines and sets up framework contracts for reducing the price of equipment. This is aided by a website, newsletters, demonstrations and subsidies. The DEST also sets up promotional campaigns to market more energy efficient products and demonstration projects for such as ventilation systems in schools, lighting in schools and so on.

The DEST is a small organisation of six staff, supplemented by many consultants. Law in its size restricts the DEST. A Board of nine members, six representing supply companies, commercial activities, municipal and county authorities and energy/environment organisations head the DEST. The DEST receives administrative support from the DEA. The DEST works in partnership with energy industry associations, consumer groups and others.

There are other government ministries and agencies that have a direct role in energy efficiency. These include the Ministry of Finance, Ministry of Taxation, Ministry of Environment and its Environmental Protection Agency (EPA), and the Ministry of

Transport. The Ministry of Environment and EPA have responsibility for implementing the climate change strategy as will be shown below.

Energy supply companies play a major role in energy efficiency. Important are the three industry associations, representing electricity, gas and heating supply. These include DGC (Dansk Gasteknish Centre), DFF (the Danish District Heating Association) and Danskenergi, (the Association of Danish Energy Companies).

One important association is the Danish Energy and Environment Association, established in 1982. It promotes energy efficiency and provides a forum for debate and knowledge sharing. It organises 20-25 seminars and conferences annually, and publishes an energy guidebook for professionals as well as a quarterly magazine of activities of the association. There are approximately 500 members, split equally between the public sector, industry and services, and advisors and consultants. The association participates in many of the local energy-savings committees described below.

The Danish District Heating Association (DFF), established in 1957, represents 405 DH plants and the membership covers more than 98% of total DH generation. Membership fees are based on annual heat generation or heat purchase of the individual plants. The DFF organises national and regional meetings, thematic days, training courses and publishes management guidelines and a regular magazine. The DFF also provides statistics on degree days to help individual member plants to calculate consumption and budgets. It also prepares fuel price statistics.

Act 450 also called for the creation of local energy savings committees. These committees are designed to be a framework for co-operation and co-ordination at the local level and energy companies are responsible for their creation. Energy companies are encouraged to include the recommendations of these committees as much as possible in their energy savings plans. Mandatory members include representatives of the energy distribution and grid companies. Municipalities and other organisations (private companies, consumer and environmental groups, building and housing associations) are encouraged to participate. To date, 32 local committees have been established. The composition of these committees is shown in Table 6.

TABLE 6: LOCAL ENERGY-SAVING COMMITTEES

Member Category	Number	Percentage of Members (%)
District heating	308	48
Electricity	87	14
Natural Gas	28	4
Municipalities	129	20
Counties	11	2
Others	75	12
Total	**638**	**100**

Source: DEA

Energy and environmental NGOs have also taken an active role in energy efficiency and renewable energy policy development in Denmark. The government has also provided support to NGOs such as INFORSE, which has promoted renewable energy and sustainable energy development internationally.

The technical research and development community have been central to the underpinning of Danish Energy Policy and Programmes. Riso National Laboratory is world-renowned and has helped in the development of the wind turbine industry. Other important technical organisations include among others the Danish Technical Institute, the Danish Technical University and Danish Urban and Building Research under the Ministry of Economic and Business Affairs.

9. Energy Efficiency and the Environment

The government is firmly committed to meeting its obligations under the Kyoto Protocol. This has been a long-standing commitment for Denmark, which first developed climate change programmes in 1990. The Government recently published its *Proposed Climate Strategy for Denmark* in February 2003 and the strategy has since been approved by Parliament.

The separation of energy and environment ministerial responsibilities in November 2001, by the new government some weeks after coming into office, signalled that there would be new directions in the approach taken.

Denmark has an ambitious target under the 1998 EU Burden Share Agreement approach to the 1997 Kyoto Protocol. The commitment is to reduce the annual GHG emissions in the budget period 2008-2012 by 21% compared to the base year of 1990,

although there are formal reservations about the base year since Denmark has said it was an abnormal year that unduly penalises it and has asked for a re-consideration [12]. This is to be ruled upon in 2006.

One of the hallmarks of the previous government in climate change policy was to do as much as possible domestically to meet the Kyoto targets. The current liberal-conservative government has taken a different approach, based on cost-effectiveness. The government's analysis shows that there is greater cost-effectiveness through the use of the flexible mechanisms of emissions trading, Joint Implementation (JI) or the Clean Development Mechanism (CDM).

JI and CDM mean that a country can finance projects abroad and use the emissions reductions (called credits) created to fulfil its own commitments. JI projects are established in host countries that have reduction commitments (Annex 1 countries, primarily in Central and Eastern Europe and CIS countries) and credits may be achieved from 2008. CDM projects are established in host countries that do not have reduction commitments (non-Annex 1 countries, primarily developing countries but including some CIS countries). Credits may be achieved from 2000.

Energy efficiency projects for end use and for supply side projects (such as cogeneration) qualify as eligible projects under these mechanisms. Renewable energy projects also qualify.

Recent analysis projects that for the budget period 2008-2012 Denmark will be in excess of its Kyoto commitment by 25 million tonnes CO_2 equivalent per year (based on its legal commitment under the EU Burden Share Agreement) and not corrected for the base year problem. The government believes that this 25 million tonnes of CO_2 represents a considerable challenge. About 10 million tonnes of CO_2 are due to expected increases in electricity exports.

[12] In 1990, Denmark's CO_2 emissions were considerably lower than normal because there was a significant import of electricity due to abundance of cheap hydropower from Scandinavia. Actual emissions were approximately 79 million tonnes CO_2 equivalent, whereas actual emissions corrected for electricity imports were approximately 76 million tonnes CO_2 equivalent. This difference of 6 million tonnes CO_2 in the base year means a difference of approximately 5 million tonnes CO_2 in the permitted emissions for the period 2008-2012.

The initiatives to meet the target include the EU quota trading system, which will see a quota system operating by 2005, as well as Joint Implementation and the Clean Development Mechanism.

The EU Directive on GHG trading is expected to be adopted in 2003. The system will allow for states to authorise companies or individuals to trade quotas throughout the EU. An enterprise covered by the directive will receive a quota allocation at the beginning of each year. After the year ends, the enterprise must hand over quotas to the state corresponding to the year's actual emissions. If the enterprise exceeds its allowance, it must pay a tax of 40 Euro per tonne CO_2. The trading system will initially start with carbon emissions, and will gradually include other GHG emissions. For Denmark, this will replace a national carbon quota system for the electricity generation sector that has been in place for the past two years. Under the national scheme, the 1999 Energy Act introduced a quota for annual CO_2 emissions of utilities of 22 Mt in 2001, 21 Mt in 2002 and 20 Mt in 2003 (see also Chapter 6).

The government has also prepared an indicative list of potential domestic initiatives. However, the strategy implicitly states that there are not likely to be enough cost-effective measures to meet the target. The government has set a threshold of 100 DKK/t of CO_2 emissions reduction. At that level flexible mechanisms are considered more cost effective [13]. Domestic initiatives that are below the threshold and have high potential for CO_2 reductions include heat pumps where they replace certain decentralised CHP, and reduction of electricity production. Domestic measures that have low potential and are below the threshold include window standards, oil and gas boiler standards, flare gas recovery, heat pumps that replace oil-fired DH and establishment of biogas central plants. The options presented in the strategy are indicative and not intended to be exhaustive. Nevertheless, the strategy states that offshore wind turbines and biomass plants are very expensive. The list includes few energy efficiency measures. This runs counter to the plans in most other Annex 1 countries and the EU where its Climate Change Strategy envisages that energy efficiency measures are among the most cost-effective means of achieving the Kyoto target.

[13] In the climate change strategy, the Government set an indicator of DKK 120 per tonne CO_2 to be used as a basis for implementing domestic initiatives outside the area covered by the EU quota system. 100DKK is the expected maximum price for quotes in 2008-12, the 120DKK is the quote price calculated into the consumer price level included taxes.

The government earmarked DKK 130 million (approximately 17.5 million Euro) in 2003 for JI projects in Central and Eastern Europe. The Environmental Protection Agency has responsibility for Joint Implementation (JI) and Clean Development Mechanism (CDM) projects.

First Danish Joint Implementation Project in Eastern Europe

Romania and Denmark recently made an agreement about a JI project in Romania. The project aims at replacing oil and natural gas by wood waste products in DH plants in five Romanian cities. The project will provide Romania with new technology that will enable cheaper DH supply in poor urban areas and reduce emissions. Denmark finances part of the investment, and can, in return, over a number of years transfer almost 720,000 tonnes of CO_2 equivalents in the Danish climate accounts.

This is the first Danish JI project in Eastern Europe. Denmark and Romania have been quick in adopting the agreement, and the Danish EPA will follow the project closely to see how it meets the aims.

Denmark is committed to pay about 20% of the investment costs related to the project, a total of DKK 19.6 million (Euro 2.6 million). The EU and local funds will finance the remaining project costs. Already in the previous government period, Denmark contributed approx. DKK 8 million (Euro 1.08 million) for preparation of the project, which was launched as an assistance project. It has been agreed that Danish funds will be directed primarily towards investments in Danish equipment. These favourable conditions have been achieved among other things because the Danish funds are paid out at the start of the project.

The project will be implemented within the overall climate co-operation agreement made between Denmark and Romania in January 2003. The Danish Minister for the Environment has also made agreements on climate cooperation with Russia, Ukraine, Poland, Estonia, Bulgaria, Latvia and the Czech Republic. The Ministry for the Environment is presently preparing a number of JI projects in Eastern Europe.

Table 7 provides some CO_2 indicators in Denmark since 1990.

TABLE 7: CO_2 INDICATORS

	1990	1995	1997	1999	2000	2001
CO_2 Emissions (1000 tonnes)	52,724	59,572	63,259	56,469	52,478	53,854
CO_2 Emissions, adjusted*	60,903	59,117	57,683	55,494	54,479	53,772
CO_2 Emissions/cap (ton)	12	11	11	10	10	10
CO_2 Emissions per kWh Sold (gram per kWh)	945	802	720	641	627	612
CO_2 Emissions per consumed unit of DH (kg per GJ)	57	45	42	40	39	37

*Climate adjusted and reduced with fuels for net export of electricity.
Source: DEA, www.ens.dk

10. Assessment of Progress

Government Policy and Strategy - Overall Assessment

Over the past two to three decades, Denmark has achieved impressive results in improving energy efficiency at both the end-use and transformation stages. It is viewed as one of the world's leading countries in promoting energy efficiency and sustainable energy development and has provided an important example and inspiration to PEEREA countries.

However, Denmark now is in a major transition from a well-planned and tightly implemented energy policy to a more market-based, competitive system brought in by the liberal-conservative government but also reflecting changes in EU energy policy. This transition poses both challenges and opportunities.

There is a definite transition because Denmark has created, and heavily invested in, a large infrastructure of DH, and CHP in particular, that cannot be dismissed or scrapped without serious economic cost and yet within that infrastructure the opportunities for competition are more limited. There is a labyrinth of taxes, price supports, purchase obligations and so on that kept the current system stable. Undoubtedly, EU energy liberalisation will have a long-lasting impact because it requires greater competition, not only within a member state but amongst member states. Denmark's system was not designed for such a dynamic approach. Yet there are still safeguards from other EU directives on renewables, CHP (proposed) and energy efficiency, not to mention from new proposals of the government, which should soften the transition.

Since the late 1970s, the various energy strategies have built upon one another, adding layers of measures and changing priorities. Throughout the 1990s environmental issues and sustainable development were major drivers in energy efficiency policy. This is completely understandable, given regional and global commitments to meeting GHG emissions targets. Yet, as the Energy Charter Secretariat has stated in policy papers, energy efficiency to be most effective must be integrated into the other government priorities. The liberal-conservative government effectively re-states that. Looking at Denmark from the outside, it appears that energy efficiency was already well integrated into other government priority areas, although it is always useful to re-state the benefits of energy efficiency in other government priorities from energy security to industrial competitiveness to the environment.

From the energy or environmental policy documents that have been published in the last year, it appears that energy efficiency is being given a lower priority. There are many references to the easy measures having been taken and the next generation of measures being more costly, possibly too costly. Even so, the Government states that energy efficiency is important, and it may be too soon to really appreciate government intentions.

Denmark has done so much to create an energy-efficient economy. From all indications, there is still significant cost-effective potential for improving energy efficiency that should be exploited. However, to achieve the cost-effective potential there will have to be a strong commitment from government, but that commitment appears to be waning.

Energy Pricing and Taxation

High end-use energy prices have been one of the most effective instruments used in Denmark since the early 1990s to meet many energy and environment goals. These prices, in large part made up of environmental and energy taxes, have contributed to improvements in energy intensity and energy efficiency.

The price and taxation system is complex and difficult to render in an easily understood way. The government came into power with the determination to hold the line on (if not lower) prices to ensure that Danish business is not unduly penalised.

From this review's point of view, it is important to understand how the system is contributing to improved energy efficiency.

In the residential sector and the service sector, consumers are paying a certain premium for the obligatory purchase of electricity from renewables and decentralised CHP. Heat and electricity prices are high because of taxes.

In the industrial sector, there are many taxes but these can be partially offset by entering into agreements with the government to undertake energy efficiency measures. The system is tax neutral.

New challenges may arise with actions to change the system to increase competition and to make decentralised electricity production more market-sensitive.

Sectoral Policies and Programmes

Denmark has a wide range of energy efficiency programmes, although the range has narrowed with the termination of subsidy schemes. Other countries have done likewise and that of itself should not be a major problem, if compensated for through the use of other instruments. By and large, those other instruments are available, in large part due to EU directives. Denmark appears totally committed to fulfilling its obligations for these directives and that is important. Some of the new directives, such as the Directive on Energy Performance of Buildings, require extensive preparatory work and that comes at some expense in time and commitment. This can partially be offset by greater Community-wide co-operation.

There is concern about the closing of the Energy Information Centre in June 2003. This is a concern that the Government might opt out of providing valuable information to consumers and others. A market-based strategy has to appreciate market barriers and one of the main barriers could lack of appropriate information. The Government states that the Centre is closing because of budget concerns. There are other lower-cost options that could be explored. Regardless, a new information/ communications strategy must be developed, that could include integrating information provided by energy companies and industrial associations.

There are some concerns about effectiveness of some of the programmes. Officials have already identified problems with the energy-labelling of buildings and say that these hopefully will be rectified in the revisions that will have to come about through the implementation of the EU Directive on Energy Performance of Buildings. The scheme had already been overhauled completely in the 1990s and still fallen somewhat short of its potential. This is an area of high priority.

The building code is due to be revised by 2005 under the *Energy 21* strategy. It also has to be revised by 2006 as part of the implementation of the Directive on Energy Performance of Buildings. So the timing is good.

Utilities have been assigned an important role in promoting energy efficiency through an obligation to provide non-commercial measures. In an increasingly competitive

industry, DSM activities are hard to ensure. The EU is proposing an Energy Services Directive to require some form of energy efficiency services delivery and Denmark could be well placed if the DSM activities in Denmark succeed. To do so, the local energy savings committees will have to live up to their potential and the energy companies from the heat, gas and electricity sectors will have to find common approaches which provide consumers with consistent, effective signals to promote energy efficiency.

Linked to DSM is the DEST. While it has not been in existence a long time, it has shown some effective, market-based and innovative approaches, which include working with other relevant organisations (including, among others, the energy industry) that will contribute to bring long-term benefits if continued.

In the industrial sector, there is concern because, from all indications, the voluntary agreements are likely to underachieve the results that could be expected. The results are positive - about a 6% decrease in CO2 emissions to 2005 - but results from other countries indicate that more could be achieved. How the programme could be strengthened is difficult for the review team to determine. More forceful targets would help. Benchmarking and best practice programmes could also help. Businesses with negotiated agreements are already receiving strong support through reduced taxes under the Green Tax package. These benefits could be translated into better energy savings.

Transport energy efficiency is promoted in large part through consumer information for the purchase of new vehicles. However, the mean fleet efficiency is hampered by high registration fees which discourage consumers from replacing older, more fuel-inefficient vehicles on a more regular basis.

CHP and DH

CHP and DH market penetration rates have been the pride of Danish energy policy for a considerable time; however, this is quickly changing. DH is not really the concern. There are a few small DH systems that are costly to operate but, by and large, they can be dealt with. DH has probably reached its saturation point, given that the heat market was divided between DH and natural gas. It is impossible for either to encroach on the other's territory, so the main expansion possibility would be where there is oil or electric heating. But the densely populated areas have been addressed and so expansion is limited.

There is a challenge for CHP, particularly decentralised CHP. The electricity produced from decentralised systems has a guaranteed market at above-market prices. This was

done to switch heat-only plants to CHP in the 1990s in particular in order to meet environmental goals. If Denmark could have continued with its "closed system" there would be no major problems, as long as consumers were willing to pay a supplement. However, with EU energy liberalisation and the commitment of the government to encourage more competition, there is a potentially difficult transition to be managed.

Energy Efficiency and the Environment

Improved energy efficiency throughout the energy cycle and environmental concerns has been tightly connected since 1990. The two government policy areas were brought together in 1994 and then separated again in November 2001. The Government appreciates what energy efficiency can do for the environment, and especially climate change, but it wants energy efficiency to be judged more on its benefits to the economy than to the environment alone.

The Government published and the parliament has now approved the *Climate Strategy for Denmark*. The concern raised in the report was how to reduce the expected excess emissions in order to meet the Kyoto Protocol obligations. The plan is to use the flexible mechanisms provided for in the Protocol itself: emissions trading, Joint Implementation (JI) and the Clean Development Mechanism (CDM). The Government believes, on the basis of projection and analysis, that this is the most cost effective approach for the country to take. Until now, the Danish approach was to maximise what could be done nationally. The use of flexible mechanisms has many advantages. Many of the international projects can have reasonably low costs per tonne of GHG emissions. There can be a transfer of technology and techniques. But, there are costs and uncertainties. These are new systems that have not been proven, systems that have bureaucratic and technical issues that require capacity building in the recipient countries. And recipient countries may not be willing to have foreign countries invest in the lowest cost projects. They may want to save them for their own investments and ask foreign governments to invest in the more complex, costly projects.

Many of the JI and CDM projects will undoubtedly be oriented towards energy efficiency and renewable energy. How the Ministry of Environment and its Environmental Protection Agency intend to use the DEA - the agency in the government with expertise in these areas - was not obvious. The responsibilities could be better shared to maximise the benefits to the government as a whole.

However, there is a concern that the government may be overlooking cost-effective energy efficiency possibilities domestically. The indicative list of projects in the

climate strategy appeared to almost dismiss domestic energy efficiency. This runs counter to the findings in most other western countries. To be sure that the right approach is being embarked upon, more analysis - or, at least, more reflection of existing analysis - needs to be undertaken.

At this point in time, with the target so challenging, no option should be dismissed, least of all related to energy efficiency.

Institutional Arrangements

The split between energy and the environment was described above and needs no more attention here. The DEA's role has changed and this is partially because the link between energy efficiency and the environment has changed. This will work itself out over time, but it takes a while. It will take time to have an effective level of activity and programme co-ordination.

Over the years and decades, a good network of companies and organisations has developed, in some cases more informally and on a personal basis than through structures. This is not unhealthy and can work in a country such as Denmark where there is a tradition for energy efficiency.

The local energy savings committees are a new feature from Act 450, and a good one. The creation of a vehicle to discuss possible local actions and to get feedback on them is welcome. The committees have not yet lived up to their potential but they are young and having teething problems. Maybe the expectations were too high. There were concerns that municipal authorities were not participating sufficiently. It is hard to initially comment on why that is happening or how to change it. The committees have to evolve into dynamic fora for active discussions and debate. They cannot be simply for "rubber stamping" the pre-determined plans of energy companies and it does not appear that they are.

The Electricity Saving Trust is a welcome institution. It has a good budget but has the bureaucratic flexibility for innovation and co-operation with outside interests. There is concern that its overall cost-effectiveness could be enhanced through some more administrative flexibility.

Renewable Energy and Technology Development

Denmark has gained such a high global profile because of its wind turbine industry and the success it has had in increasing overall generating capacity from renewables. It has achieved its target for renewables share of generating capacity and more than

reached its target for wind. The one weak point has been in not achieving the biomass target.

Renewable energy has to face the reality of electricity liberalisation and this is increasing the emphasis on its overall competitiveness. Costs have come down and many of the technologies are more competitive than gas-fired systems. It appears that the rapid expansion cannot continue, at least until the full effects of energy liberalisation are understood. The government's policy instruments are being scaled back and this will undoubtedly have some adverse repercussions. If handled properly, this may lead to a stronger, more robust industry in the future. Time is on its side. Renewable energy is not going to rise and slip away as it did in the late 1970s and early 1980s.

This period can be used as an opportunity for the development of the next generation of technologies and the R&D efforts should reflect that. Government must work closely with industry, and government must also ensure that the export-oriented wind turbine industry maintains its world status. This can be done through the Kyoto Protocol flexible mechanisms and through normal export industry support instruments. Once a country has a world-leading reputation in anything, everything should be done to ensure that it stays. The renewable energy technology industry in Denmark is a major employer and a major source of exports. It is a "high tech" industry that is bringing Denmark much recognition and benefits beyond renewables.

11. Recommendations

General Recommendations

The Government should implement its energy policy by paying due attention to defining energy efficiency objectives and targets and develop adequate national strategies and programmes compatible with the priority given for liberalisation of the energy markets.

The Government should analyse and define the potential for cost-effective energy efficiency measures in the various sectors of the economy with a view to contribute to climate change targets, security of supply and increased industrial competitiveness.

The Government should take steps to ensure that the public and private sector investment in energy efficiency and renewable energy continues to support industrial policy and the realisation of the future potential for Danish export sales growth.

A clear statement on the importance, role, benefits and objectives/targets of energy efficiency should be provided so that all actors receive clear, consistent signals

compatible with the re-orientation of the energy efficiency strategy towards a more market-based approach.

On-going monitoring and evaluation should be rigorous and comprehensive for all elements of energy efficiency policy, including specific programmes such as industrial voluntary agreements as well as legislative requirements such as the obligations of energy companies to undertake DSM activities.

Sectoral energy efficiency policies and programmes

The Government should aim to make the building labelling scheme more customer friendly and investigate if there is a possibility to develop a relationship with DSM activities in order to lower the costs of its application; the Government should also implement appropriate marketing of the building labelling scheme to improve its perceived value to the target audience.

The Government should take advantage of international co-operation to develop a methodology for the certification of buildings in compliance with the EU Directive on Energy Performance in Buildings.

The Government should investigate the possibilities of further energy efficiency measures in buildings and identify the CO2 reduction potential of each measure.

The Government should pay attention to the future position of the industrial voluntary agreements in the period of transition to emission trading and integrated pollution prevention control (IPPC) licensing; the Government should evaluate whether more stringent energy efficiency targets are possible within the framework of the extension of such agreements.

The Danish Energy Authority should prepare new consumer-oriented information strategies for all sectors to include alternative delivery options, given the decision to terminate the Energy Information Centre in 2003.

While it has been decided not to change the new car registration fee at the present time, the option to introduce more "green" registration fees should remain a valid option for consideration in the future.

Energy efficiency and the environment

In implementing the climate change strategy, the Government should re-visit the potential for energy efficiency improvements by undertaking cost-effective measures

in the various sectors of the economy; this should effectively complement the uncertainties inherent in the use of flexible mechanisms.

Within the current allocation of responsibilities for the flexible mechanisms the government should ensure that the most appropriate Danish institutional and industrial expertise is involved to maximise the effectiveness of the mechanisms and the benefits to the Danish economy.

Monitoring of the national strategy for sustainable development should provide for additional indicators on energy efficiency and renewable energy to better reflect and guide their future contribution to sustainable development.

At the first review of the national strategy for sustainable development the opportunity should be taken to incorporate more energy efficiency and renewable energy indicators to guide further developments in the energy sector, and, in an effort to develop national consensus, possibly present it to Parliament or the appropriate Parliamentary Committee for approval.

Energy prices, taxation and market functioning

Taxes on electricity and energy in the industrial sector should be maintained until such time as the emissions trading scheme is fully operational and the price of permits is predictable.

The functions of the Danish Energy Regulatory Authority (DERA) should be focused on its core responsibilities of regulating tariffs of natural monopolies and access to the networks; energy efficiency responsibility should be under a separate authority, such as with the DEA.

While supporting the government aim to ensure consumers' easy access to complaint in the energy sector, the Government should take steps to secure the smooth functioning of the DERA in the sense of minimising the number of unjustified complaints.

CHP and District Heating

In the process of phasing out the existing CO2 quota system and adapting to the forthcoming emission trading directive of the EU, the Government should adopt market regulation and taxation policies which would include justified incentives for maintaining the cost-efficient and environmentally-friendly CHP and DH systems in operation.

The Government should develop a medium to long-term strategy on how to deal with CHP/DH systems in the evolving liberalised market, taking into account cost-effectiveness criteria, environmental benefits, and respecting EU and other international obligations.

Institutional Framework

The Government should identify effective ways of supporting the local energy saving committees in playing a more active and catalytic role by bringing together energy utilities, municipalities and other local actors.

Building on the positive experience and effective results achieved during its operation, the Electricity Saving Trust (DEST) should continue to seek to balance the use of internal and external resources for the cost-effective fulfilment of its objectives.

There has been an impressive market alignment of several of the initiatives taken by the DEST. The potential for similarly aligned programmes should be examined in the light of the DEST experience.

The government should support local authorities in developing the necessary managerial and institutional capacity to handle energy efficiency initiatives and projects at the municipal level.

Renewable Energy

In case that the current energy situation and market structure in Denmark cannot sustain further capacity expansion of renewables, the option for renewable energy in the long-term should be maintained and supported through R&D and long-term policy commitment.

The government should deliver on its commitment to develop a labelling scheme for electricity produced by renewables so as to facilitate consumer choice and provide an indication of demand for green energy.

Technology Development

The energy research portfolio balance should be the subject of regular reviews to manage the application of funds and research effort to maximise national benefits.

A greater concentration on basic research and capacity building could result in a gap between research and implementation. The DEA should keep this under review and take the initiative to secure private sector involvement.

Research commissioned by the transmission/grid operator and funded through a PSO has the potential to ensure effective take-up of results. While the DEA approves all such programmes, there may be merit in consulting other stakeholders in the research community.

Role of Utilities

The effectiveness of DSM programmes financed by PSO and delivered by the grid companies should be the subject of regular reviews.

While appreciating the effective DSM programmes developed so far by the energy utilities, the Government should analyse the opportunity of separating the management and delivery of energy efficiency services in order to improve market transparency, competition and efficiency.

The balance between centralised and decentralised activities in DSM programmes should be monitored to ensure subsidiarity and overall effectiveness; complementarity and co-ordination with the DEST should be further examined.

Arrangements to improve the effectiveness of services in all energy areas should be considered along the lines of an integrated customer focused approach.

ANNEX I : ENERGY SITUATION IN DENMARK

In 1999 Denmark achieved net energy self-sufficiency, although it was in 1991 that Denmark achieved self-sufficiency in oil and natural gas. The primary domestic sources of energy are oil, natural gas and renewables (primarily biomass and wind). Denmark's energy system was transformed with the exploitation of oil and natural gas from the North Sea. Gas production started in 1981. Now, almost half of Denmark's oil production is exported and 38% of gas production is exported.

Almost 21% of TPES comes from the use of coal which is used primarily for electricity production. After the first oil crisis, power generation switched from oil to coal for energy security concerns. Then, largely because of environmental concerns, the switch away from coal began. Coal, however, is still heavily used in electricity production and 85% of coal used for electricity production is in CHP plants.

In 2000, renewable energy contributed 11.3% of TPES. The shares of all the energy sources were:

Coal	20.7%
Oil	44.9%
Gas	22.9%
Ren.	11.3%

Final energy consumption in 2000 was divided by sector, as following [14]:

Industry	21.5%
Transport	32.4%
Other	46.1%

[14] IEA

TABLE A1.1
SELECTED ENERGY PRODUCTION, SUPPLY AND CONSUMPTION STATISTICS

	1990	1996	1997	1998	1999	2000
Total Primary Energy Production (Mtoe)	10.30	17.79	20.32	20.49	23.89	27.87
Net imports (Mtoe)	8.56	5.25	3.52	1.24	-3.67	-7.53
Total Primary Energy Supply (TPES)(Mtoe)	18.07	22.57	21.02	20.80	19.97	19.46
Total Final Consumption, (Mtoe)	13.88	15.90	15.55	15.49	15.43	15.03
Total Electricity Consumption (TWh)	30.56	35.24	35.05	34.56	34.67	34.61
GDP (billion 1995 US$)	163.49	184.78	190.26	195.50	199.67	206.08
TPES/GDP	0.1105	0.1221	0.1105	0.1064	0.1000	0.0944
Population (millions)	5.14	5.26	5.28	5.30	5.32	5.34
Electricity consumption per capita (kWh/cap)	5947	6705	6639	6517	6515	6484

Source: IEA, Energy Balances of OECD Countries, 1999-2000

TABLE A1.2
TOTAL FINAL ENERGY CONSUMPTION BY END-USE SECTOR (MTOE)

	1990	1996	1997	1998	1999	2000
Residential	4.02	4.49	4.62	4.63	4.61	4.52
Industry	2.71	3.06	3.07	3.04	3.03	2.94
Services	1.73	1.89	1.91	1.88	1.92	1.91
Transport	4.11	4.71	4.78	4.85	4.91	4.76
Agriculture	1.01	1.00	1.02	1.02	1.01	1.01
Non-specified	0.01	0.01	0.01	0.01	0.01	0.01
Total TFC	13.88	15.90	15.55	15.49	15.43	15.03
TFC/GDP toe/1,000 US$)	0.85	0.86	0.82	0.79	0.77	0.73

Source: IEA. Data Services

TABLE A1.3.
CO_2 EMISSIONS 1990 - 2001

	1990	1996	1998	1999	2000	2001
Total CO_2 emissions (10^3 tonnes/year)	52724	73002	59431	56469	52478	53854
Share residential sector (%)	9.3	7.2	7.8	7.9	7.5	7.7
Share industrial sector (%)	14.8	11.3	13.4	14.1	14.6	14.3
Share transport sector (%)	23.6	18.8	23.7	25.7	27.6	26.9
Share service (%)	2.6	1.6	1.4	1.5	1.5	1.4
Share Transformation. extraction and refining	49.7	61.1	53.7	50.8	48.8	49.7
Total CO_2/GDP (kg CO_2 per USD '95)	0.31	0.38	0.29	0.27	0.24	-
Total CO_2/capita (tonnes/inhabitants)	9.84	13.48	10.83	10.17	9.38	-
Total CO_2/ TFC (tonnes/toe)	3.80	4.59	3.82	3.65	3.40	3.58

Source: IEA. Data Services

ANNEX II : SELECTED END-USE DATA TABLES

TABLE A2.1.
TOTAL FINAL ENERGY CONSUMPTION BY SOURCE RESIDENTIAL SECTOR
(MOTE)

	1996	1997	1998	1999	2000	2001
Total	4.49	4.62	4.63	4.61	4.52	4.47
a. Electricity	0.89	0.89	0.89	0.90	0.89	0.88
b. Heat	1.47	1.54	1.60	1.58	1.57	1.58
c. Oil products	1.06	1.04	0.99	0.97	0.85	0.82
d. Gas	0.65	0.68	0.70	0.72	0.71	0.70
e. Coal	0.00	0.00	0.00	0.00	0.00	0.00
f. Combust. Renew. & Waste	0.40	0.45	0.42	0.43	0.48	0.47
g. Others	0.02	0.02	0.02	0.02	0.01	0.01
Floor Area (1.000 m^2)	289,332	290,952	295,499	297,134	299,096	300,731
No. of dwellings (x 1.000)	2679	2694	2711	2726	2744	2759
Residential use per dwelling (toe/dwelling)	1.83	1.88	1.87	1.85	1.80	1.77
Residential use per surface (toe/1.000m^2)	9.27	9.24	9.22	9.19	9.18	9.17

Source: IEA and DEA

TABLE A2.2.
FINAL ENERGY CONSUMPTION BY INDUSTRY SECTOR/ENERGY SOURCE 2000

	mining and quarrying	Manufacturing							Construction	Total
		production of other non-metallic mineral products	food processing, beverages and tobacco	production of wood and wood products	textile, leather and clothing industry	chemical industry	pulp, paper and printing industry	other industries		
Coal	0.2	0.19	0.06			0.01				0.28
Oil shale										
Crude oil										
Shale oil										
Petroleum products	0.03	0.23	0.17	0.02	0.00	0.03	0.01		0.15	0.76
Gas	0.01	0.15	0.27	0.00	0.03	0.08	0.05		0.00	0.79
Nuclear	-									
Hydro	-									
Geothermal. Solar etc.	-	0.00	0.00	0.00	0.00	0.00	0.00	0.007		0.007
Combust. Renew. & Waste	0.00	0.00	0.00	0.06	0.00	-	0.00			0.09
Other fuels										
Electricity	0.01	0.08	0.19	0.03	0.02	0.11	0.06		0.03	0.86
Heat	0.00	0.00	0.02	0.00	0.01	0.03	0.05		-	0.15
Total	0.08	0.65	0.72	0.11	0.06	0.25	0.17		0.18	2.94
Value added per sector mill. 1995 USD*	2783	1301	5499	820	879	3967	2898	7077	8755	40900
Energy/value added {PJ/[mill 1995 USD]}	1.17	19.99	5.8	9.52	2.76	2.84	2.46	0.86	4.32	4.03

TABLE A2.3.
FINAL CONSUMPTION OF SERVICES BY ENERGY SOURCE (MTOE)

Service sector	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Total	1.89	1.91	1.88	1.92	1.91	1.91
a. Electricity	0.80	0.81	0.83	0.84	0.86	0.87
b. Heat	0.63	0.67	0.69	0.69	0.69	0.70
c. Oil products	0.17	0.17	0.15	0.17	0.15	0.12
d. Gas	0.23	0.20	0.17	0.17	0.16	0.15
e. Coal	0.00	0.00	0.00	0.00	0.00	0.00
f. Combust. Renew. & Waste	0.04	0.05	0.04	0.06	0.06	0.05
g. Others	0.00	0.00	0.00	0.00	0.00	0.00
No. of employers (mil.)	1.83	1.87	1.91	1.96	1.99	2.00
Floor area (1000m^2)	96,193	97,692	98,931	100,483	102,005	103,620
Value added in basic prices (MUSD)	104,763	107,398	110,475	114,160	118,845	121,736
Energy/value added (MJ/MUSD)	754,746	743,210	712,597	702,696	673,645	656,633
GJ/Employee	43.31	42.72	41.17	40.96	40.29	40.00
GJ/m^2	0.82	0.82	0.79	0.79	0.78	0.77

TABLE A2.4.
TRANSPORT INDICATORS 2000

	Freight	Travel	Total
TFC (Mtoe)	1.32	3.38	4.76
10^9 tonne-km	0.34		0.34
TFC/10^9 tonne-km	3.9		3.9
10^9 Person-km		2.38	2.38
TFC/person-km (TFC/10^9 person-km)		1.42	1.42
Number of passenger cars/1000 inhabitants	64	350	414

ANNEX III : ENERGY PRICES AND TAXES

TABLE A3.1.

CO_2, energy and sulphur taxes - Dkr/GJ

Use	Energy type	Heating value	Unit	CO_2	Energy				Sulphur (approx. val., dep. on S-%)
				from 1996	2000	2001	2002-08	2009	2000-07
Transport	diesel oil	0.0359	GJ/l	7.53	71.93	76.95	76.95	76.95	0
	light diesel oil	0.0359	GJ/l	7.53	69.14	74.16	74.16	74.16	0
	ultra light diesel oil	0.0359	GJ/l	7.53	66.63	66.63	66.63	66.63	0
	low sulphur diesel oil[4)]	0.0359	GJ/l	7.53	64.12	69.14	69.14	69.14	0
	Naphta	0.0348	GJ/l	7.76	74.14	79.31	79.31	79.31	0
	natural gas	0.0399	GJ/m3	5.51	65.66	70.68	70.68	70.68	0
	LPG (for cars)	0.0248	GJ/l	6.44	64.81	69.65	69.65	69.65	0
	LPG	0.046	GJ/kg	6.52	63.70	63.70	63.70	63.70	0
	leaded petrol	0.0329	GJ/l	0.00	137.60	140.64	143.68	143.68	0
	unleaded petrol[1)]	0.0329	GJ/l	0.00	117.81	120.85	123.90	123.90	0
Other purposes	gas oil 0.2% S	0.0359	GJ/l	7.53	48.23	49.63	51.02	51.02	0.95
	heavy fuel oil 1% S	0.04065	GJ/kg	7.87	47.97	49.20	50.68	50.68	4.92
	heating tar 1% S	0.0364	GJ/kg	7.69	48.35	49.73	51.10	51.10	5.49
	Naphta	0.0348	GJ/l	7.76	49.71	51.15	52.59	52.59	0.00
	LPG	0.046	GJ/kg	6.52	48.26	49.57	51.09	51.09	0.00
	refinery gas	0.052	GJ/kg	5.58	42.69	43.85	45.19	45.19	0.00
	orimulsion[2)]	0.02764	GJ/ton	8104.20	47.00	49.00	51.00	51.00	1953.69
	hard coal, coke	26.5	GJ/ton	9.13	47.00	49.00	51.00	51.00	6.11
	petro coke	29.3	GJ/ton	11.02	47.00	49.00	51.00	51.00	8.87
	brown coal	18.3	GJ/ton	9.73	47.00	49.00	51.00	51.00	8.85
	natural gas	0.03999	GJ/m3	5.50	40.01	49.01	50.51	50.51	0
	town gas	0.01688	GJ/m3	5.50	22.51	49.01	50.51	50.51	0
	el. for space heating	0.0036	GJ/kWh	27.78	130.83	135.00	139.17	139.17	n.a.
	other electricity	0.0036	GJ/kWh	27.78	148.89	153.06	157.22	157.22	n.a.
	waste incinerated at CHP plants (waste tax)[3)]	10.5	GJ/ton	0	26.67	26.67	26.67	26.67	0.86
	waste incinerated at heat plants (waste tax)	10.5	GJ/ton	0	31.43	31.43	31.43	31.43	0.86
	waste for deposition	10.5	GJ/ton	0	0.00	0.00	0.00	0.00	0.00
	heat supply from waste plants				7.60	10.20	12.90	12.90	0.00
	straw	14.5	GJ/ton	0	0.00	0.00	0.00	0.00	1.38
	wood pellets (w. sulphur)	17.5	GJ/ton	0	0.00	0.00	0.00	0.00	2.29
	other wood pellets	17.5	GJ/ton	0	0.00	0.00	0.00	0.00	0.57
	wood	14.7	GJ/ton	0	0.00	0.00	0.00	0.00	0.75

1) Less than 0,013 g lead per litre petrol
2) More than 27% water. 90% sulphur cleaning assumed.
3) More than 10% of the production must be electricity.
4) Sulphur content max. 0,005%

Source: DEA

TABLE A3.2.
ENERGY PRICES IN 2000 (IN US DOLLARS)

	Unleaded premium gasolin	Light fuel oil	Diesel	Heavy fuel oil	Natural gas	Electricity	Steam coal
	litre	1000 litres		litre	10^7 kcal	kWh	tonne
Industry	1.033	379.2		0.72	n.a.	0.058	84.9 (1995)
Households	1.033	690.6		0.877	735.1	0.197	
Elec. Gen.							n.a.

Source: IEA, *Energy Prices & Taxes, 4th Quarter 2001*, OECD, Paris, 2002.

ANNEX IV : ORGANISATIONS VISITED BY THE REVIEW TEAM

Association of Danish Energy Companies (Dansk Energi www.danskenergi.dk)
Confederation of Danish Industries (Dansk Industri www.di.dk)
Danish District Heating Association (Danske Fjernvarmeværkers forening DFF www.fjernvarmen.dk)
Danish Energy Authority (Energistyrelsen www.ens.dk)
Danish Energy Regulatory Authority (Energitilsynet www.energitilsynet.dk)
Danish Electricity Saving Trust (Elsparefonden www.elsparefonden.dk)
Danish Environmental Protection Agency (Miljøstyrelsen www.mst.dk)
Danish Urban and Building Research (Erhvervs- og Boligstyrelsen www.ebst.dk)
Dansk Gasteknisk Center a/s (Dansk Gasteknisk Center A/S www.dgc.dk)
Ministry of Economics and Business Affairs (Øknonomi og Erhvervsministeriet www.oem.dk)
Ministry of Taxation (Skatteministeriet www.toldskat.dk)
Ministry of Transport (Trafikministeriet www.trafikministeriet.dk)
Riso National Laboratory (Risø www.risoe.dk)
Road Safety and Transport Agency (Færdselsstyrelsen www.fstyr.dk)
Naturgas Midt-Nord (a representative of a company that is on local energy saving committee - Naturgas Midt-Nord www.midtnord.dk)

GLOSSARY

CDM	Clean Development Mechanism
CHP	Combined heat and power, also known as co-generation
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DEA	Danish Energy Authority
DEST	Danish Electricity Saving Trust
DKK	Danish Krone
DSM	Demand-side management
EC	European Commission
EPA	Environmental Protection Agency
EU	European Union
Eurostat	Statistical Office of the European Communities
€	Euro
IEA	International Energy Agency
GDP	Gross Domestic Product
GHG	Greenhouse gas
GJ	Giga Joule
JI	Joint Implementation
kcal	Kilocalorie
kt	Kilotonne
ktoe	Thousand tonnes of oil equivalent
kW	Kilowatt
kWh	Kilowatt hour
LPG	Liquified Petroleum Gas
m^2	Square metre
m^3	Cubic metre
MJ	Mega Joule
Mt	Million tonne
Mtoe	Million tonne of oil equivalent
MW	Megawatt
NGO	Non Governmental Organisation
NOx	Nitrous Oxide
OECD	Organisation of Economic Co-operation and Development
PEEREA	Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects
TPES	Total Primary Energy Supply

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