

Renewable Energy Policy Review

Denmark

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1. General Information

Population and Geography

Denmark consists of the peninsula of Jutland and 406 islands, of which 79 are inhabited (1999). Of these, the largest and most densely populated are Zealand on which the capital of Copenhagen is situated, Funen and the north Jutland island. The North Sea defines Denmark to the west, while the islands divide the Baltic from the Kattegat. The proximity of Germany has traditionally orientated the country south in an economic and political sense, but close co-operation with Sweden, Norway, Finland and Iceland, with which Denmark enjoys a passport union, also ties Denmark to the North. The country has a coastline totaling 7300 km in all and a 68-km-long frontier with Germany.

The population stands at c. 5.33 million, and the population density is 125 per square kilometre. Foreign immigrants amount to c. 290,000; in addition there is a small German minority in southern Jutland. The greater Copenhagen region accounts for 1.1 million inhabitants. The second city is Århus (215,000 inhabitants).

Region	Population
Århus County	0.63m
Bornholm County	0.04m
Copenhagen County	0.61m
Frederiksborg County	0.5m
North Jutland County	0.5m
Ribe County	0.22m
Ringskøbing County	0.27m
Roskilde County	0.23m
South Jutland County	0.25m
Stirstrøm County	0.26m
Vejle County	0.35m
Viborg County	0.23m
West Zealand County	0.30m

(Source BSSSC Secretariat)

Denmark is a parliamentary democracy with a royal head of state. The country entered the European Union in 1973.

Administratively, the country is divided into 14 counties (amt) and 275 local authorities (kommuner), two of which (Copenhagen and Frederiksberg) are not included in the counties. The state and other public authorities, however, exercise a considerable regulatory control and provide comprehensive services for the citizens.

The different types of Governmental provisions are in a hierarchical order :

- Acts of Parliament
- Governmental Orders
- Circulars and Guides.

The Act of Parliament is the set of rules governing the various fields of ministries and enable the minister to regulate further within the law by Orders. Acts and Orders are directed towards both the administration and the general public.

All legislation in Denmark is passed and approved at the national level. Parliament has only one chamber and the government is often a minority government. The law is Parliament's most important instrument.

Denmark has a small open economy highly dependent on foreign trade (Foreign trade accounts for approximately 2/3 of GDP) and therefore a strong interest in the free exchange of goods and services across its borders. Consequently, Denmark has joined international economic organisations such as the EU, OECD and WTO, and within the framework of these has striven to remove obstacles to free trade. The main trade partners of Denmark are the United Kingdom, its Scandinavian neighbors and Germany.

Due to the crucial importance of foreign trade, the main objective of economic policy has always been to maintain a stable exchange rate. The public sector plays an important role in the Danish economy. Around 33% of the workforce is employed in the public sector, public expenditure amounts to almost 25% of GDP and the tax incidence is around 50% of GDP. These are some of the highest figures in the entire OECD area.

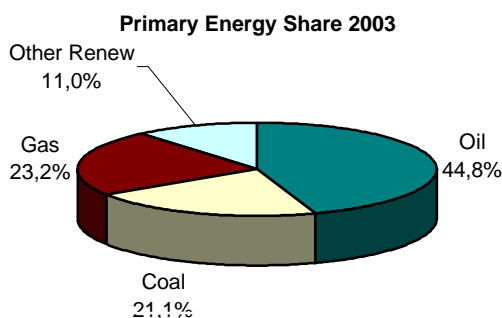
2. Renewable Energy Policy

Energy and Renewable energy country profile

Population	5.35	Millions
Area	43,094	km ²
Total Primary Energy Supply	19.52	Mtoe
Electricity Production	37.71	TWh
Electricity Production by source		
Fossil Fuel	82.91	%
Hydro	0.08	%
Nuclear	0.00	%
Renewables	17.02	%

Source: CIA World Factbook 2001

Sources EUROSTAT 2002



Source: EUROSTAT (2001)

Since the first oil crisis in 1973, energy policy has occupied a relatively significant position in the political debate in Denmark. The focus of the problem was of security of supply, but gradually it extended to domestic energy production (North Sea oil and gas, renewable energy etc.), on energy supply and distribution (the natural gas grid, CHP etc.), and on energy savings (insulation, labelling schemes etc.). Since 1997, Denmark has been self-sufficient in energy, mainly as a result of the production of oil and natural gas in the North Sea. The production of hydrocarbons has a positive impact on the Danish economy, as it favourably affects the Danish balance of payments and generates revenue for the state.

In 1998, some 20% of Denmark's total energy consumption was supplied by natural gas. The total reserves in the Danish sector of the North Sea have been calculated at 123,000m cubic metres, corresponding to 16 years' production at present levels.

As a result of popular resistance, due partly to fears about the safety of nuclear power and uncertainty about radioactive waste deposits, the Folketing, in the early 1980s, decided that no nuclear power plants were to be built in Denmark.

Denmark has a national target of reducing carbon dioxide emissions by 20 per cent by 2005, compared with their 1988 levels. In the context of the EU's burden sharing arrangements, Denmark has committed itself to reducing its average emissions of greenhouse gases by 21 per cent between 2008 and 2012 compared with their 1990 levels.

Renewable energy contributed 10.4% of Denmark's total energy supply and 16.4% of total electricity supply in 2001 compared to EU averages of 5.8% and 15.5% respectively. (IEA Renewables Information 2003)

In the early 1970s, Denmark was totally dependent on imported fuel: 94% of the fuel consumption was oil. A mere 20 years later the country was a net exporter of oil and in 1997 the import of energy equalled its exports: Denmark had become self-sufficient in energy. This remarkable development is due to a radical reform of virtually every area of energy production and consumption. The price rises after the oil crises in the 1970s triggered off a series of initiatives which have now made Danish energy development a success story. The keywords have been energy saving and greater efficiency.

Renewable energy use more than tripled in the period 1970-1990. Renewable energy use has increased over the 1990s and contributed 10.4% (or 2.05 Mtoe) to Denmark's TPES in 2001 largely from biomass and wastes (is this still true for 2001?).

The stated goal from the Danish Energy Authority is for the renewable share to increase from 17% in 2000 to 29% by 2004/2005

(source Biomass Research and Development Initiative Biomass Spotlight: Denmark)

Renewable energy technology in 2003 in capacity

Denmark	
Population	5.3 mill
SPV (MWc)	
Grid connected	1.68
Off grid	0.22
Total	1.89
STH (square meter installed)	292.990 m2
Average surface for 1000 (figures for 2001 Sun in Action 2 ESTIF)	55m2
SHP (2001 figure)	10MW
Biogaz (Mtep) (2002 figure)	62
Wood (Mtep) (2002 figure)	0.81%
Wind (MW)	3110

Source Eurobserv'ER (2003)/Sun in Action 2/EWEA

Hydro

Denmark has a very small (10 MW) hydro resource producing around 19 GWh in 1996. Potential markets for wave power are relatively more promising in the long term - two offshore 45 kW converters have undergone trials. SHP installed capacity has been stable over the the period 1990 to 2001 rising slightly from 9MW to 10MW while the country's electrical installed capacity has increased by 40%. As a result, the contribution of SHP to the total installed capacity went down over the reference period. SHP electricity generation in Denmark grew by 7% from 27GWh in 1990 to 29 GWh in 2001. In Denmark, SHP contributed 100% to electricity generated from hydropower in this period.

(source ESHA Report on Small Hydropower Statistics: General Overview of the Last Decade (1990-2001))

Biomass

A number of utility-owned biomass plants (fired by wood, woodchips or municipal solid waste) have been in operation since 1989. Over the last few years, additional biomass units have been constructed and a certain amount of biomass use for electricity generation is mandated in the *Biomass Agreement*

To encourage the use of biomass, Denmark offers incentives including construction subsidies for biogas plants. This has resulted in over 20 large-scale biogas plants and 35 farm scale biogas plants. In February of 2003 Denmark released its proposal for a Climate Strategy. This proposal suggested implementing initiatives for biomass plants and biogas central plants, increasing the use of biofuels, and participating in multi-country

programs such as the Joint Implementation and the Clean Development Mechanism. Denmark also has coordinated and participated in a number of biomass research projects independently and with the European Union. These include:

- Using biomass for small-scale combined heat & power (CHP) production in villages close to biomass production sites as well as in the wood processing industries.
- Demonstrating a patented tire pyrolysis process with energy and by-product recovery, first in a cement plant and subsequently in a full-scale 17 MW tire-to-energy power plant.
- Demonstrating a novel reactor system for the utilization of unprocessed biomass and waste fuels to replace fossil fuels. The project's objective is to introduce a novel technology, which makes it possible to increase use of unprocessed biomass and solid waste fuels in high-energy consuming European industries.

(source Biomass Research and Development Initiative Biomass Spotlight: Denmark)

Compared to 2002 figures of the 875 GWh share of electricity consumption for straw and wood and the figure of 233 GWh for biogas, the ongoing conversion schemes are expected to increase the share of electricity produced from straw and wood and biogas by 3-4% in the period up to 2005. (source Report on Trends in electricity production from renewable energy sources, Danish Energy Authority, 2003)

Helped by these initiatives, biomass use has been growing steadily over the last few years in all applications (direct use, electricity generation and heat production). Biogas use has also increased sharply. In 1996, electricity production was 418 GWh (double the level of 1993), **To be updated heat production was 10.9 PJ (up from 8.8 in 1992) and direct use was 509 ktoe - more than double its level in 1990.**

Waste

Over a third (38%) of renewable TPES is produced from municipal waste, and energy from waste combustion increased by almost 70% between 1990-1996. *Energy 21* aims for energy from waste to become increasingly important by 2005. Of the 13m tonnes of waste produced in 2000, 65% was recycled, 24% incinerated and 11% deposited on refuse dumps. 95% of the incinerated waste was used for energy production (source Royal Danish Ministry of Foreign Affairs, Factsheet Denmark, Waste

http://www.um.dk/english/faktaark/fa10/fa10_eng.asp#Anchor-Renewable-39842) Expansion of waste-based CHP is under way. This is expected to increase waste-based electricity's share by about 1% by 2005. . (source Report on Trends in electricity production from renewable energy sources, Danish Energy Authority, 2003)

Wind

One of the main political objectives in the energy area in the 1990s was to promote the use of renewable energy. Denmark has a long tradition of exploiting wind power. Research and development of new kinds of wind turbines from the late 1970s, combined with favourable government grants towards wind power production, have created a Danish success story. In 2002, almost 14% of Danish electricity consumption was supplied by wind power as opposed to 2% in 1990. 2002 was a slightly below average wind year, and production would therefore be a little higher in a normal wind year. (source Report on Trends in electricity production from renewable energy sources, Danish Energy Authority,2003) Concurrently, Danish wind turbines have become a major export commodity with currency earnings of approximately DKK 12 billion in 2001. (source Royal Danish Ministry of Foreign Affairs, Factsheet Denmark, Renewable Energy http://www.um.dk/english/faktaark/fa10/fa10_eng.asp#Anchor-Renewable-39842)

Wind power installed capacity had reached 2,916 MW by June 2003 (Source EWEA). Expansion was partially helped by the technological breakthrough brought about by variable speed turbines. Most of this expansion has been in the non-utility sector Installed turbines are now almost exclusively 600 kW or larger. The 1500 MW target for installed onshore capacity by 2005 is around half the European Commission estimate of the technical potential. Since an agreement was reached between the Danish Ministry of Energy and Environment and the utilities to expand offshore wind capacity as well (750 MW by 2008), expansion of wind electricity will continue The first of two large offshore windfarms, each with a capacity of about 150 MW, came on stream in late 2002, and the next is expected to become operational before the end of 2003. The likely expansion in land-based windfarming and the above-mentioned offshore windfarms are expected to boost electricity production from wind energy by about 2 TWh, in a normal wind year, by 2005. This corresponds to a 5-6% increase in wind energy's share of gross electricity consumption. (source Report on Trends in electricity production from renewable energy sources, Danish Energy Authority,2003)

As of the 20th May 2003, the Order on the connection of wind turbines to the grid and on the Settlement of charges for electricity generated for wind turbines, entered into force. It stipulates thz grid operator has the responsibility for expanding or strengthening the grid when a land-based turbine requests to be connected to the grid. Cost sharing arrangements for offshore connection, settlements of charges for existing and new wind turbines are also laid out.

Solar thermal

At the end of 2001 a new government stopped all activities in the field of renewable energy. This was done overnight, and was not clearly stated. The market waited for 4 months until the new budget was approved in April 2002. Customers and plumbers almost entirely forgot solar thermal. No statisticsexist for 2002, as there are no support schemes and no registration of sales. The estimated number of systems sold in 2002 is about 600.

In 2002, there are about 16 suppliers of systems in the market, of which some are importers. 7 companies are members of the Danish Solar Industry Association. In 2001, the government submitted a new law that all public buildings and publicly supported dwellings should install a solar thermal system if feasible within 20 years. This law had to be con.rmed by the EU and, when it came back approved by the EU, the new government decided to cancel it. This was the last action by the government concerning solar thermal. The Danish Solar Industry Association is lobbying for the integration of solar thermal into the building regulations, but as for now, the government isn' t showing any interest in changing these regulations. Over the years, several high-visibility projects were developed in Denmark, amongst them the district heating solar thermal system in Marstal. With a collector area of 9.000m2 it is one of the largest systems ever built.

(Souce Sun in Action 2 ESTIF 2003)

Solar photovoltaic

The installed solar photovoltaic capacity in Denmark in 2000 was 1.5 MW (more than three times the existing capacity in 1997). 1.3 MW of this capacity is non-grid connected. A "300 rooftop" project, known as "SOL 300" was launched in 1998, and by the end of 2000 all 300 rooftop solar systems had been brought into operation. In the period 1997- 2000 the installed capacity increased from 422 kWp in 1997 to 1460 kWp in 2000. A 1 000 rooftop programme was launched late 2001 as a follow up; this programme targets a mix of general cost reductions, increase in end-user payment and promotion of small roof-tops. Only a few weeks after the announcement of the programme, the SOL 1000, more than 3 000 house owners had registered their interest. By the end of 2002, the programme reported a portfolio of some 1 500 house owners expressing firm interest in the programme and by end 2003, about 250 kW have been implemented, stimulated by an investment subsidy of 40 % of the turnkey system cost; the average turnkey system cost being EUR 4,50/W.

A special support programme for PV applications in the commercial sector, funded by the CO₂ tax on electricity, was set up early 1998. The support includes a subsidy of up to 40 % for the turnkey system costs. The calculation of the actual subsidy will be in favour of high yield installations. This programme has so far not been very successful, as the commercial sector seems to regard an incentive of 40 % as inadequate, and during the last few years no projects have been implemented using this support mechanism. Net-metering for privately owned PV systems was established in mid-1998, for a pilot-period of four years. In late 2002, the net-metering scheme was extended another four years, up to the end of 2006. Net-metering has proved to be a cheap, easy to administrate and effective way of stimulating the deployment of PV in Denmark. (source Denmark Photovoltaic technology status and prospects Flemming Kristensen, Energimidt, Denmark Peter Ahm, PA-Energy A/S, Denmark, on IEA Photovoltaic Power Systems website, Annual Reports, 2003)

Geothermal

Plans to utilise Denmark's low enthalpy geothermal energy resources via a new demonstration plant have been put forward under *Energy 21*. One research plant is already in operation at Northern Jutland and produced 32 TJ of heat in 1996.

RE Policy Outlook

Every year, renewable energy sources represent an increasing part of the total energy consumption. In 1980 it was 3%, in 1990 6% and more than 9% in 1998. In 2001, renewable energy accounts for 10.4% of TPES., biomass supplying X% of the renewable energy production, waste Y% and wind power Z%.

- Denmark aims to almost double the importance of renewable energy from its 1988 value by 2005. This will be achieved with:
- the Government's original *Energy 2000 Plan* (published 1990),
- the *Energy 2000 Follow-Up Plan* (published 1993) and
- *Energy 21* (Spring 1996).

A mandatory target of doubling the share of renewable electricity to 20% by 2003 was adopted. Thus, the utilization of renewable energy in Denmark will be raised from the level of around 8% (1996) to 12-14 %, by 2005 and 35 % by the year 2030. The quantitative target for 2005 is 1,500 MW of wind power capacity and replacing 6% of coal with straw and wood. The long-term target for wind power is 5,500 MW in 2030, which would mean that it would meet 50 % of the country's electricity consumption needs. This strategy reinforces the governments aim to reduce the national CO₂ emissions by 20% from 1988 levels by 2005.

The Danish energy policy cannot be understood without taking into account the long tradition of Danish Energy Plans, which has all been followed up continuously, partly through political agreements and legislation. The aim of the first energy strategy, *Danish Energy Policy 1976*, was to secure Denmark against crises in supply such as the energy crisis of 1973-74. The following plan, *Energy 81*, could build further, given the drastic price rises of energy after the crisis in 1979-80; it also emphasised socio-economic and environmental considerations. After a period of building up large projects for facilities and markets for natural gas and heat and power generation, the action plan, *Energy 2000*, followed in 1990, introducing the goal of sustainable development of the energy sector. *Energy 21* is the fourth and current energy plan. It lays down the energy-policy agenda for the coming period. Currently the most pressing issue in the Danish energy policy is to reform of the electricity, heating and gas sectors in order to meet the requirements of the control instruments of energy policy in relation to the liberalisation of the electricity and gas markets. The reform work has already started with the submission of the new Electricity Supply Act and the following lengthy negotiations and final agreement with the European Commission.

The main incentive provided by Danish policy in favour of RES is the internalisation of external costs of non RES through taxation. Taxes and fees are used to affect the consumption of fossil fuels and renewable, and subsidies are used to increase the biomass-utilization for electricity production and heat. Investment subsidy is another economic means to promote biomass and other types of RES.

Investment subsidies are granted via three programs.

- The “fund for Development of New Renewable Energy Technologies” established in 1997.
- The “CHP-fund Combined Heat and Power-fund” set up in 1992,
- The “Development and Demonstration Program for Renewable Energy” initiated in 1992

In 1997 a new sub-programs for promotion of renewable energy were launched. One of them is the “Renewable energy island program”. According to measures proposed by the Danish Government, in the long term, the major renewable sources will still be waste, wood, straw, energy crops, and wind power, with a less significant role ascribed to biogas. The responsibility of matters concerning energy has recently been moved to the Danish Ministry of Economic and Business Affairs. The Department serves the Minister and the Government. Until november 2001 energy was under the administration of Ministry for Environment and Energy and before that the Ministry of Energy.

The Danish Energy Agency was established in 1976. The Energy Agency refers to the Ministry of Economic and Business Affairs.

The Agency prepares and administers energy legislation, undertakes analysis, evaluations and follow-up on governmental energy policy. It has responsibilities in overall planning of electricity, heat and natural gas supply and administers the Acts on Heat Supply, Electricity Supply and Natural Gas Supply and legislation. (source OPET Energy in Denmark: An Introduction into Energy Policy in Denmark <http://www.opet.dk/endkuk.htm>)

Since the early nineties the local competence in the field of energy has rested with the municipalities. There is however no economic or fiscal competence specifically in the area of renewables in the municipal system. All taxes related to energy production and use is decided on national level. This is also true for the management of all the different grant and subsidy schemes. The implications of this in Denmark in terms of regional development are far from marginal. It is obvious that the municipal economy in the remote areas in the Western part of Denmark where the wind turbine industry is located and where the main wind farms are established plays an important role in

Electricity

RES share of gross electricity consumption rose from 6% to 20% during the 1995-2002 period and in 2002 it was about 3% higher than 2001. The RES-E Directive sets the national indicative target for the share of gross electricity consumption to be met from renewable energy sources at 29% in 2010;

Since 1 January 1998, distribution companies and large industrial consumers have been able to trade freely on the electricity market. New Acts on electricity supply and carbon dioxide quotas were passed in June 1999. Some parts of the Acts are subject to EC approval. Under the Acts all other consumers – business enterprises as well as domestic consumers – were able to make a free choice of electricity supplier by the end of 2002. The electricity production sector has been freed from the existing non-profit principle and is now selling electricity on ordinary market terms.

Electricity compensation scheme – incentives

The compensation system in Denmark for electricity produced from RES is based on feed-in tariffs. The Electricity Act of May 1st 1996 set up feed-in tariffs for geothermal, small hydro (? 10 MW), biomass, tidal, solar PV and wind onshore in the range of 5.06 cents €/kWh to 6.73 cents €/kWh. This amount includes the net feed-in (i.e. it does not include the price of electricity) plus a production subsidy and a carbon tax refund.

In 1999 the Danish Parliament entered into an agreement on a comprehensive electricity reform. A mandatory target of doubling the share of renewable electricity till 20% by 2003 was adopted. Thus, the utilization of renewable energy (**in the electricity sector**) in Denmark will be raised from the present level of around 8% to 12-14 %, by 2005 and 35 % by the year 2030¹.

In a first time and in order to achieve the objectives, the Electricity Reform established the scrapping of the feed-in principle and aimed at introducing green certificates trading by 2003. A TGC system was proposed and was originally supposed to enter into force in 2004 for the following technologies: wind, geothermal, biomass, small hydro and solar PV. The penalty to the consumer for failing to fulfil the purchase obligation was set to be 3.7 cents €/kWh. The minimum price to be paid by the supply-obligation companies for a certificate when issued to be 1.4 cents /kWh. Nevertheless, many complications like the small size of the green market, the strong opposition from green producers, and the uncertainties in future certificate prices have drastically reduced investments in Danish wind power since 2001. After another evaluation of the situation the Trading of certificates was postponed until 2005. The existing biomass plants will continue to receive the electricity production subsidy (Law 377 of 2 June 1999). The new plants, which are constructed before the end of 2002 will obtain a fixed feed-in tariff for a ten year period.

Quotas for carbon dioxide emissions by electricity producers have been introduced, in part to address growth in emissions from net exports of electricity generated by thermal plants. For the period 2001-2003, a ceiling has been set for total carbon dioxide emissions from the electricity sector, which will be reduced gradually from 22 million tonnes of carbon dioxide in 2001 to 20 million tonnes in 2003.

Under the new electricity legislation the share of electricity generated from renewable sources (principally wind turbines) is expected to rise to 20 per cent by the end of 2003. Market mechanisms are to be introduced for trade in renewable energy to safeguard cost-effective development. This renewable energy market will be introduced in stages with a view to the market being functioning fully in 2003. All electricity consumers will be obliged to purchase a growing share of renewable energy from the renewable energy market. Other recent initiatives concerning renewable and non-conventional fuels include: replacement of old and poorly situated wind turbines.

As in other countries, there are other complementary instruments aim at promoting RES-E. Investment subsidies are given to biomass, CHP, solar PV and wind. This subsidies vary between 15 and 30% of the construction costs for standardised RE-equipment and up to 50% for development projects. Investment subsidies for tidal electricity cover between 30% and 100% of total investment costs. Concerning financial and fiscal incentives, wind energy (onshore) may benefit from tax exemptions (deduction from taxable profits of between 60% and 100%).

¹ DANISH ENERGY AGENCY, *Renewable Energy in Denmark*, (s.l.e), 2001, p.23.

14 The regional government of the Brussels region has also manifested in favour of a TGC system, although the policy proposal is not as advanced at the time of writing as those of the other two regional governments.

15 These percentages can be accumulated to the 25% investment subsidy provided by Electrabel (see below).

Heating and cooling

A large part of the increase in energy efficiency in Denmark is due to the development of and conversion to power plant heating, partly through the establishment of large transmission networks, partly through the construction of smaller decentralised combined heat and power plants, and finally through the conversion of district heating stations into combined heat and power plants. In 1980, just under 40% of district heating was produced alongside electricity and 19% of the electricity production was produced alongside district heating. The comparable figures in 1998 were 80% and 54% respectively. In 1998, 56% of all Danish homes were heated by district heating

A new code for new buildings entered into force in 1996 (large buildings) and 1998 (small buildings) which will cut an additional 25% off net heating demand, reducing it to about 70 kWh per square metre per year. The code also sets limits on electricity consumption for ventilation and will enforce low temperature heating systems to increase the efficiency of various heat supply systems, such as district heating systems, condensing boilers, solar energy and heat pumps. A further reduction to 45 kWh per square metre is scheduled to enter into force around 2005. Buildings respecting this limit through combined exploitation of passive solar techniques, insulation and coated glazing are already being built.

Energy labeling for smaller 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. When dealing in real estate, an audit is required if the building has an area of 1 500 m² or less.

The result of the audit is an Energy Label describing the energy condition on a scale from A1 to C5 (A1 is best). This mandatory scheme was implemented in 1 January 1997. The scheme was evaluated in 2000 and the conclusions were 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, only around 50% of the traded houses were covered by an energy certification. On the basis of other conclusions about the set-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.

Since 1981, there has been a parallel scheme in operation for larger buildings of more than 1 500 square metres. The participation levels are also around 50%, partly due to lack of awareness of its existence. The DEA has developed an action plan to improve the implementation of both schemes as well as further measures.

Individual metering of the use of electricity, district heating, gas and water in buildings has been mandatory in new buildings since 1996 and in existing buildings since 1997.

Since March 1994, the government has extended the *Heat Supply Act* ban on electric heating to the conversion to electric heating of existing buildings located within a district heating or natural gas supply network. By 2005, this amendment is expected to reduce the number of electrically heated homes by about 7 000.

*Source IEA Energy Efficiency Report 2003)

Transport

The March 2000 Report

Based on a re-evaluation of targets, policies and measures (including a cost evaluation) and the fact that emissions from the sector had been continuously rising – they were about 14% higher in 1999 than in 1988 – Denmark proposed additional measures in a March 2000 report entitled *Limitation of CO₂ Emissions from the Transport Sector - Possibilities, Policies and Measures*. Without new initiatives, it was estimated that CO₂ emissions would be 27% higher in 2005 and 31% higher in 2010 than in 1988. Policies have not been successful in halting the upward trend in transport emissions, owing in part to higher than anticipated economic growth and commensurate increases in transport needs.

The April 2001 Action Plan

In April 2001, the Danish government published a new Action Plan for reducing CO₂ in the transport sector, drawing on earlier recommendations. The targets were revised significantly downward. CO₂ emissions are now to be reduced 7% in 2010 below business-as-usual trends (previous reduction target in Action Plan 1996 was an 8% reduction by 2005) This new target actually represents an increase in emissions of 22% over 1988 levels or 19% over 1990 levels). The 2030 target remained as established earlier – 25% below actual 1988 levels. The two main strategies in the Action Plan are increased energy and transport efficiency. The first strategy is being implemented through:

- A feasibility study on promotion of environmentally-friendly transport technology through adaptation of the tax system.

- An information campaign about new cars' energy efficiency to supplement the energy labelling on new cars has been in place since April 2000.
- Eco-driving and enforcement of speed limits.

The second strategy is to be implemented through information programmes including promotion of public transport, bicycling and environmentally-friendly freight transport, and other pilot projects.

The rise in energy consumption has been greatest for road traffic and aviation. The government estimates that the new measures in the Action Plan, when implemented, will allow the achievement of the 7% reduction from business as usual by 2010.

Another new initiative also mentioned in the Action Plan is a proposal to develop a national road pricing scheme with the main objective of reducing motor traffic in major Danish cities. Energy labelling of new cars has also been established.

In 1997 there were some changes in taxation for pick-ups, vans, private cars and electric vehicles. The purpose was to encourage people to change from less energy-efficient pick-ups and vans to more energy-efficient passenger cars (when the use is only for passenger transport).

On 1 January 2000, the registration fee (purchase tax) for cars was changed in order to provide more incentive to purchase new, more energy-efficient vehicles. The registration tax for fuel-efficient gasoline cars consuming less than 4 litres/100 km and for diesel cars consuming less than 3.6 litres/100 km has been reduced. In connection with this decision, the range of diesel cars qualifying for the annual 'green owner fee' has also been expanded. (source IEA Energy Efficiency Report 2003)

Research and Development

Energy efficiency in industry is promoted by the “green tax package”. Revenue from the tax is allocated to funding of energy saving measures and to industry-related energy technology development and demonstration measures. The development of integrated technologies and systems comprises optimisation of energy systems with complex consumption and supply structure, control technologies and methods of process optimisation. Funds for energy research activities flow mainly from the Danish Energy Research Programme (ERP) and the Danish Programme for Development of Renewable Energy (DPRE). The ERP budget available in 2003 amount to DKK 40,7 million DKK. In 2004 the overall budget is expected to be approx. 70 million DKK. In addition, a 4-year nationwide solar cell project, SOL 1000, is being implemented. See the web site at www.sol1000.dk.

Ongoing development and demonstration projects under the Development Programme for Renewable Energy (Udviklingsprogrammet for Vedvarende Energi) (UVE) and special programmes for hydrogen, solar energy, geothermics and wave energy will be continued and are expected to be completed in 2004 at the latest. Moreover, the system operators [ELTRA](#) and [ELKRAFTSYSTEM](#) grant subsidies (available in 2003: 100 million DKK) to research and development projects concerning environmentally-friendly production of power and heat.

Further ELFOR grants subsidies (available in 2003: 25 million DKK) to research and development projects concerning the efficient use of electricity. Further information on www.elfor.dk Finally the Ministry of Science, Technology and Innovation offers grants for strategic renewable energy projects (available in 2003: 35 million DKK). Further information on www.forsk.dk/forskpro/index.htm

From 2004, an extra amount of DKK 47 million will be allocated to research, development and demonstration activities in order to promote exploitation of new energy-efficient technologies. The extra efforts involve a permanent annual increase of DKK 15 million, from 10 to 25 million per year in the financial framework for grid company research and development activities, and an increase of DKK 25 million in allocations to the energy research programme, which will be provided annually over a 5-year period starting from 2004.

Furthermore, DKK 7 million will be earmarked annually for type approval and quality assurance of renewable energy technologies. A legislative amendment will seek to raise financing of state initiatives through taxes expected to be received under the existing CO2 Quota Act when CO2 quotas are exceeded.

Financing through CO2 taxes will be an additional supplement to existing funds, e.g. the DKK 110 million allocated to research into renewable energy under the Danish Research Councils for 2003- 2005. Demonstration activities based on strong research environments within renewable energy, new energy technologies, and energy-efficient technologies, must be given extra focus.

(source Energy Policy Statement 2003 by the Minister for Economic and Business Affairs pursuant to the Act on Energy Policy Measures May 2003)

3. RES Highlights

Biomass power

Community heating systems are common in Denmark, and biomass is often used as a fuel for them. These systems may be heat only, but increasingly they are being converted or developed to operate as combined heat and power (CHP) systems, with power exported to the grid. The Masnedø CHP plant produces heat for Vordingborg's district heating network and electricity for eastern Denmark's grid. The plant has a capacity of 8.3 MW of electricity and 20.8 MW of heat. It went into operation in 1996 as one of 10 small-scale CHP plants in eastern Denmark which use indigenous fuels: straw, wood (wood chips), waste and natural gas. The Masnedø CHP plant consumes 62,000 tonnes straw annually, together with natural gas. Wood chips can replace part of the straw if needed.

Success factors:

- **Political:** *Denmark has a national energy plan with targets for increased use of biomass*
- **Legislative:** *Premium-set tariffs combined with an obligation to purchase provide a stable market to renewable electricity producers*
- **Fiscal:** *Biomass power benefits from favourable taxation*

One component of the beneficial tariffs available for renewable energy projects, including biomass, is a subsidy through the CO2 tax. This is worth DKK 0.1/kWh (EUR 0.013/kWh). Biomass power is, however, subject to SO2 tax (with some compensatory refunds, depending on the size and type of the project).

- **Financial:** *A wide range of subsidies and grants are available for the biomass sector*

A range of economic incentives is available for the development of biomass projects. These include a fund established in 1992 to support the conversion of district heating plants to biomass-fired CHP plants, which provide 10–25 % of the costs of conversion. Other support is given as subsidies towards the construction of renewable energy projects (up to 30 %), towards demonstration projects and to support the dissemination of commercially available technologies.

Regional or local best practice

Denmark — Wind energy

Many of the wind power installations in Denmark have been developed through the cooperative system, or by local farmers or groups of individuals wishing to develop their own renewable energy power systems. Many of the original turbines are now being updated or replaced with larger machines. One example is the Avedøre wind energy cooperative, which was established in 1993. Twelve turbines, each of 300-kW capacity, were developed, six of which are owned by the local utility and the other six by a cooperative of citizens from Copenhagen. The wind energy cooperative organised the project and offered Copenhagen citizens the opportunity to become shareholders. The scheme has been successful and has been replicated across the country.

Success factors:

- **Political: Long-established political support towards renewable energy development**

- **Legislative: Premium-set tariffs combined with an obligation to purchase provide a stable, commercially favourable market to renewable electricity producer**
- **Fiscal: Taxation is favourable towards renewable energy**

A CO₂ tax is levied on electricity production from fossil sources. Renewable energy receives compensation from this, in order to internalise the external costs of fossil fuels (see above). *Denmark has led the way in exploiting wind energy over the past 20 years, and until the mid-1990s had the greatest use of wind energy in Europe.*

In 1993: 1 034.2 GWh

In 1999: 3 029.0 GWh

Increase 1993–99: 1 994.8 GWh, 193 % **(to be updated)**

For cooperative operations, no income tax is payable on dividends up to DKK 3 000 (EUR 400).

- **Financial: Subsidies were available to establish a strong domestic wind energy market**

The Danish government provided subsidies of up to 30 % towards wind turbine installation costs, although these were discontinued in 1989. This early support helped to establish a strong home market and associated indigenous industry. Grants for replacement of old wind turbines are also available.

- **Administration: Positive municipal support combined with active involvement of local utility**

- **Technological development: Early government support helped establish a strong indigenous wind energy manufacturing industry**

During the late 1980s the Danish government provided financial support to development projects in the emerging Danish wind energy industry, which is now the strongest in Europe, with successful domestic and worldwide export sales. Domestic wind developments (such as the Avedøre scheme) benefit from this success by having ready access to high-quality Danish turbines, components, sales and service. Some subsidies are still available from research funds, including the programme for new renewable energy technologies, which supports non-commercially sustainable renewable energy technologies, including wind, and the energy research programme, which supports the implementation of Danish energy policy.

- **Information, education and training: High level of public awareness of environmental issues combined with traditional Danish approach of forming cooperatives**

The concept of cooperatives is well established in Denmark: dairy and other farming cooperatives have been operating for over a century. It has therefore been relatively straightforward to transfer the cooperative concept to the newly emerging wind industry. The Danish Wind Turbine Manufacturers Association has been actively supporting uptake of wind energy for nearly 20 years and offers a high level of support and education to prospective developers, especially farmers and other individuals wishing to develop wind energy schemes. In addition, there is a high level of environmental awareness among Danish citizens, who see renewable energy as a safe and clean energy supply option. This supportive attitude has helped to raise interest in the environmental benefits

4. Websites

Name	Description	Website
Ministry of Economics and Business Affairs	Responsible for matters concerning energy	www.em.dk
Danish Energy Authority (est. 1976 under authority of the Ministry of Economics and Business Affairs)	The Danish Energy Authority carries out tasks, nationally and internationally, in relation to the production, supply and consumption of energy.	www.ens.dk
Royal Danish Ministry of Foreign Affairs		http://www.um.dk
Europa website	EU Commission website	http://europa.eu.int
European Commission – Directorate General for Transport and Energy		http://europa.eu.int/comm/energy/index_en.html
Managenergy	Information services for local and regional energy actors	www.managenergy.net