

## INFORMATION NOTE

### Renewable Energy in Denmark

#### 1. Production and consumption of renewable energy

1.1 When the Danish government formulated its first energy plan in 1976, the focuses were on securing the domestic supply of energy and reducing the dependence on imported oil. Environmental issue was not a major concern then. At that time, both the production and consumption of renewable energy were at a relatively low level. However, the government's stance has changed in the last decade with the ratification of the *Kyoto Protocol*<sup>1</sup>: Denmark is committed to reducing the emission of greenhouse gases<sup>2</sup>. In 2004, the production and consumption of renewable energy accounted for 9.1% and 15.3% of the total energy production and consumption respectively. Tables 1 and 2 show respectively the production and consumption of energy in Denmark in selected years.

**Table 1 – Energy production in Denmark in selected years**

Source of energy (PJ) <sup>(1)</sup>	1980	1990	2000	2004
Crude oil	13	256	765	828
Natural gas	*	116	310	356
Renewable energy	28	53	89	118
<b>Total production</b>	<b>41</b>	<b>425</b>	<b>1 164</b>	<b>1 302</b>
<i>Share of renewable energy production to total energy production (%)</i>	<i>68.3</i>	<i>12.5</i>	<i>7.6</i>	<i>9.1</i>

Remarks: (1) PJ refers to Peta Joule, unit of measurement of energy.

\* Figure less than 0.1.

Source: Danish Energy Authority. (2004) *Energy Statistics*.

<sup>1</sup> The *Kyoto Protocol* is an international agreement made under the *United Nations Framework Convention on Climate Change*. Countries ratifying this protocol commit to reducing their emission of carbon dioxide and five other greenhouse gases, or engaging in emission trading if they maintain or increase emission of these gases.

<sup>2</sup> Greenhouse gases are gaseous components of the atmosphere that contribute to the greenhouse effect. While some greenhouse gases occur naturally in the atmosphere, others result from human activities. Naturally occurring greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide and ozone. Some human activities such as burning of fossil fuels, deforestation, livestock and paddy rice farming and covered vented landfill emission, raise the levels of greenhouse gases.

**Table 2 – Energy consumption in Denmark in selected years**

Source of energy (PJ)	1980	1990	2000	2004
Oil	548	356	375	347
Natural gas	0	83	193	197
Coal and coke	241	326	177	165
Renewable energy	27	55	94	128
<b>Total consumption</b>	<b>816</b>	<b>820</b>	<b>839</b>	<b>837</b>
<i>Share of renewable energy consumption to total energy consumption (%)</i>	<i>3.3</i>	<i>6.7</i>	<i>11.2</i>	<i>15.3</i>

Source: Danish Energy Authority. (2004) *Energy Statistics*.

## 2. Sources of renewable energy

2.1 There are different sources of renewable energy. These sources include biomass and wastes<sup>3</sup>, wind power<sup>4</sup>, heat pumps<sup>5</sup>, solar energy<sup>6</sup>, hydro power<sup>7</sup> and geothermal energy<sup>8</sup>. Table 3 shows the production of renewable energy in Denmark in 2004.

<sup>3</sup> Biomass and wastes are organic, non-fossil materials of biological origin using for heat production and electricity generation. Biomass and wastes comprise wood and wood wastes, biogas, municipal solid wastes and biofuels.

<sup>4</sup> Wind power is the kinetic energy of wind converted into electricity in wind turbines.

<sup>5</sup> Heat pumps transfer heat from natural heat sources in the surroundings to a building or an industrial application. These heat sources include air, ground, water and man-made heat sources such as industrial or domestic wastes.

<sup>6</sup> Solar energy is the solar radiation exploited for solar heat (hot water) and electricity production.

<sup>7</sup> Hydro power is the potential and kinetic energy of water converted into electricity in hydroelectric plants.

<sup>8</sup> Geothermal energy comprises energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam.

**Table 3 – Renewable energy production in Denmark in 2004**

Source of energy	Quantity (PJ)	Percent share (%)
Crude oil	828	63.6
Natural gas	356	27.3
Renewable energy	118	9.1
<i>Wastes<sup>(1)</sup></i>	37	2.9
<i>Wind power</i>	24	1.9
<i>Straw</i>	18	1.4
<i>Firewood</i>	12	0.9
<i>Wood chips</i>	7	0.5
<i>Wood wastes</i>	6	0.5
<i>Heat pumps</i>	4	0.3
<i>Biogas<sup>(2)</sup></i>	4	0.3
<i>Wood pellets</i>	3	0.2
<i>Biodiesel<sup>(3)</sup></i>	2	0.2
<i>Hydro power</i>	0.1	*
<i>Fish oil</i>	0.6	*
<i>Solar energy</i>	0.4	*
<i>Geothermal power</i>	0.1	*
<b>Total energy production</b>	<b>1 302</b>	<b>100.0</b>

Remarks: (1) Wastes refer to municipal solid wastes incinerated at specific installations with energy recovery. Municipal solid wastes comprise renewable and non-renewable wastes produced by households, industries, hospitals and the tertiary sector.

(2) Biogas is a kind of gas composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass. It comprises landfill gas, sewage sludge gas and other biogases such as biogas produced from the anaerobic fermentation of animal slurries and wastes in abattoirs, breweries and agro-food industries.

(3) Biodiesel is a kind of diesel produced from biomass or used fried oil.

\* Figure less than 0.1%.

Source: Danish Energy Authority. (2004) *Energy Statistics*.

### 3. Supply of electricity by renewable energy

3.1 Renewable energy is greenhouse-neutral, meaning that it does not increase the concentration of greenhouse gases in the atmosphere. It is widely used for electricity generation and heat production.

3.2 In 2004, electricity supply generated by renewable energy accounted for 28.6% of the total electricity supply in Denmark, with wind power accounting for 18.5%. Table 4 shows the proportion of electricity supply generated by renewable energy.

**Table 4 – Proportion of electricity supply generated by renewable energy in Denmark in 2004**

Source of renewable energy	Proportion of electricity supply generated by renewable energy to total electricity supply (%)
Wind power	18.5
Biomass	5.2
Wastes, renewable <sup>(1)</sup>	3.2
Wastes, non-renewable <sup>(2)</sup>	0.9
Biogas	0.7
Hydro power	0.1
Solar energy	Not applicable
<b>Available sources of renewable energy</b>	<b>28.6</b>

Remarks: (1) "Wastes, renewable" refer to the biodegradable portion of wastes.

(2) "Wastes, non-renewable" refer to the non-biodegradable part of both solid and liquid wastes, combusted directly for the production of electricity.

Source: Danish Energy Authority. (2004) *Energy Statistics*.

### 4. Policy for renewable energy

4.1 The first energy plan addressing environmental issues in Denmark was published in 1990. In 1996, the Danish government endorsed *Energy 21*, the energy strategy followed until today, reinforcing its aim to reducing the emission of carbon dioxide by 20% by 2005 and up to 50% by 2030 as compared to the level of 1988. Renewable energy is expected to contribute 30% of the total electricity production by 2010 and up to 75% by 2030. Both biomass and wind are the main sources of renewable energy adopted in Denmark.

4.2 With a view to achieving the goals specified in *Energy 21*, the Danish government has developed a wide range of supporting measures for the renewable energy industry. These measures include subsidization, tax exemption for renewable energy, taxation on fossil fuels, research and development support and financing by electricity tariff.

### Subsidization

#### *Investment subsidy*

4.3 The Danish government provides investment subsidy to approved renewable energy plants, including wind turbines, biogas plants, straw-fired and wood-chip-fired heating and combined-heat-and-power (CHP) plants and solar heating systems.

#### *Other forms of subsidies*

4.4 State electricity production subsidy is given to power plants using renewable energy so that they are in a better position to compete with conventional electricity production plants. Power plants using renewable energy are guaranteed sale of their electricity to the public grid at minimum prices.

4.5 With a view to increasing the annual sale of solar heating systems, solar panels are eligible for financial support in Denmark. Initiatives have also been taken to promote the use of larger solar heating units, including solar heating installations in public buildings with large water consumption.

### Tax exemption

4.6 Heat production plants such as biomass district heating plants and solar heating plants are exempted from energy and carbon dioxide taxes to safeguard their competitive edge.

### Taxation on fossil fuels

4.7 To protect the domestic market of natural gas and renewable energy, a fossil energy tax was introduced in 1986 to maintain the fairly high price level of oil. In 1995, green taxes, including taxes on carbon dioxide and sulphur dioxide, were introduced to not only the energy industry but also the commercial sector.

### Research and development support

4.8 The Danish government supports the research and development activities of renewable energy mainly through two research and development programmes, namely the Energy (applied) Research Programme and the Development Programme for Renewable Energy.

#### *Energy (applied) Research Programme*

4.9 Established in 1976, the Energy (applied) Research Programme provides grants for both specific renewable energy projects and research and development centres, in particular in the areas of wind power, biomass and fuel cells. To strengthen the basic research in renewable energy, the Danish government increases the funding for this Programme to finance both the development of renewable energy as well as the demonstration of energy efficiency for the period 2004-2008.

#### *Development Programme for Renewable Energy*

4.10 The Development Programme for Renewable Energy provides subsidies for renewable energy technology development. With the financial support from this Programme, the Danish Energy Authority implements a number of programmes for small-scale CHP plants using solid biofuels and biogas. These programmes strengthen the technological development in the area of biomass.

#### *Other development programmes*

4.11 Between 1997 and 2001, several minor development programmes were conducted to encourage the technological development of wave power, solar electricity, hydrogen power and seasonal storage of solar heat.

Financing by electricity tariff

4.12 In 1993, the Danish Parliament adopted a biomass agreement ordering power plants to increase the utilization of straw and wood chips in large-scale CHP plants. To further increase the utilization of renewable energy for CHP systems, power plants are obliged to promote the expansion of wind turbines and biomass-fired CHP plants. In addition, district heating plants are converted to CHP plants using natural gas or biomass. All these developments are financed by electricity tariff.

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Prepared by Vicky LEE  
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Tel: 2869 9602

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