Energy Policy in Denmark



December 2012

Preface Denmark´s path to a greener energy future



Denmark has a long tradition of active energy policy, initiated by the first oil crisis in 1973. Over the years, numerous actions have been taken on the basis of a broad consensus in the Danish Parliament – both in order to reduce the energy consumption and in order to increase the share of renewable energy.

The results have been significant and convincing: Danish experience shows that through persistent and active energy policy focused on enhanced energy efficiency and ambitious use of renewables, it is possible to sustain high economic growth and at the same time reduce fossil-fuel dependency and protect the climate and the environment. Since 1980, the Danish economy has grown by around 80% while energy consumption has remained more or less constant and CO2 emissions have been reduced. In terms of production, Denmark is one of the most efficient users of energy compared with the other EU Member States and OECD countries. For the Kyoto

period 2008-12, Denmark has committed itself to an ambitious greenhouse gas reduction target of 21% - this target will be met. For the year 2020, the Danish Government has set a target of reducing greenhouse gas emissions by 40% compared to 1990.

Now, the cornerstones for the Danish energy future have also been laid. The Danish Government has set the long-term goal to abandon fossil fuels by 2050. An important milestone was reached in March 2012 with an Energy Agreement for the period 2012–2020 – again based on a broad consensus in the Danish Parliament. This Agreement contains a wide range of ambitious initiatives, bringing Denmark a good step closer to the target of 100% renewable energy.

We are already on the right track: renewables now cover more than 40% of the Danish electricity consumption. Through expanded offshore wind production and use of biomass, it is expected that renewables will cover almost 70% of Danish electricity production in 2020.

We have a responsibility for our own and coming generations to secure a better climate, a greener growth path and a more secure energy system. As described above, Denmark has taken significant steps in this direction and we hope many other countries will follow.

In the following pages, a selection of past and present Danish energy policies is presented, together with the results achieved in terms of energy savings, use of renewables etc. It is my hope that this booklet will serve as an inspiration for others who want to reduce dependency of fossil fuels and combat climate change.

Martin Lidegaard Danish Minister for Climate, Energy and Building



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1 It began with the oil crises of the 1970s

Denmark's energy policy took shape after the oil crises of the 1970s. When oil prices accelerated in 1973 Denmark was among the OECD countries most dependent on oil in its energy supply. More than 90% of all energy supply was imported oil. As a consequence, Denmark launched an active energy policy to ensure the security of supply and enable Denmark to reduce its dependency on imported oil.

Focus on energy savings and diversified energy supply

Denmark chose early on to prioritise energy savings and a diversified energy supply, including use of renewable energy. A broad array of notable energy-policy initiatives were launched, including a focus on combined heat and electricity production, municipal heat planning and on establishing a more or less nation-wide natural

gas grid. Furthermore, Denmark extensively improved the efficiency of the building mass, and launched support for renewable energy, research and development of new environmentally friendly energy technologies as well as ambitious use of green taxes.

In combination with oil and gas production from the North Sea, the policy meant that Denmark went from being a huge importer of oil in 1973 to being more than self-sufficient in energy from 1997 onwards.

Ambitious targets for reduction of climate-gas emissions

Along with a gradual reorganisation of the energy supply for increased use of renewable energy, the energy policy has created the foundation for Denmark to be able to set ambitious targets for reduction of climate-gas emissions and for use of renewable energy.



Renewable energy target and new political agreement

The Danish Government has the target that Denmark should use 100% renewable energy in the energy and transport sectors by 2050.

An ambitious Energy Agreement

In March 2012 a new political agreement on energy was reached in Denmark. This Energy Agreement is an important step towards fulfilling the 2050 target. 95% of the members of Parliament (i.e. all parties but one) stand behind the Agreement.

The Agreement contains a wide range of ambitious initiatives, bringing Denmark a good step closer to the target of 100% renewable energy in 2050. The Agreement covers the period 2012 – 2020. By 2020, the Agreement will give the following main results:

- More than 35% renewable energy in final energy consumption
- Approximately 50% of electricity consumption to be supplied by wind power
- 7.6% reduction in gross energy consumption in relation to 2010
- 34% reduction in greenhouse gas emissions in relation to 1990.

Figure 1 shows how the gross energy consumption and the use of renewable energy will develop as a result of the Agreement. The arrows in the figure illustrate how the share of renewable energy is raised both by savings and by increased use of renewable energy.

Since a large part of the renewable energy will be electricity from wind turbines, electricity is going to play a major role in the future Danish energy system.

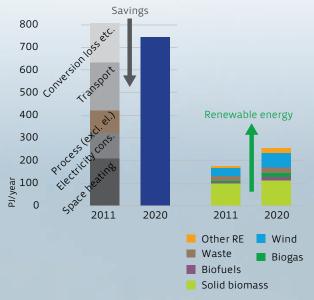


Figure 1: Danish energy consumption and use of renewable energy in 2011 and expected in 2020 as a result of the new Energy Agreement.

Several actions in the Agreement

The Agreement lists a large number of actions to be taken during the period 2012 – 2020. These actions will result in more than 35% renewable energy in final energy consumption in 2020. As the Agreement does not go beyond 2020, it does not lay out in detail the path from 2020 to 2050, which will lead to 100% renewable energy in 2050.

The Agreement includes 62 actions covering the following areas: energy efficiency, renewable energy for electricity production, district heating, combined heat and power production, use of renewable energy in households and industries, smart grids, biogas production, use of electricity and renewable energy for transport, research, development and demonstration and finally financing of the Agreement.

New analyses securing efficient solutions

Many of the actions will be implemented by acts, of which most have already been passed by the Parliament. However, not all actions require implementation of acts. 16 of the actions comprise new analyses to be carried out. These analyses are necessary in order to find the most efficient ways for Denmark to fulfil the target of 100% renewable energy. The analyses will focus on specific questions, for example, one analysis will focus on how to use the gas network during the transition from use of natural gas to use of biogas and other renewable energy gases.

The actions of the Agreement are presented in the following sections, together with a historical presentation of each sector or focus area.

3 Taxes on energy

Energy taxes on electricity and oil were introduced in Denmark in 1977. Since then, the taxes have been increased several times and taxes have also been put on coal and natural gas. In 1992, the taxes were supplemented by CO_2 taxes. The main reason for the taxes are promotion of energy savings and CO_2 reductions. Besides, the taxes finance part of the state budget.

Fuels for electricity production are exempted from the taxes, as taxes on these fuels would have a negative influence on Denmark's large import and export of electricity. Instead, an energy tax is put on electricity produced.

Furthermore, to some extent industry is also exempted from the taxes, see section 10.

High tax level compared to other countries

Figure 2 shows some examples of Danish taxes on energy for households, compared to the taxes in Japan, the United States and Germany. In general, Danish tax levels are high compared to the other countries. However, regarding fuels for transport, the Danish tax level is the same as the German tax level. This is because a higher tax in Denmark than in Germany would cause Danish consumers to buy their fuel for transport in Germany and by so doing avoid the Danish tax.

The exact influence of the energy taxes on Danish energy consumption cannot be measured, but there is no doubt that the taxes have had a big influence on energy consumption.



A new tax on renewable fuels

Until now there has been no tax on renewable fuels. With the new Energy Agreement, consumption of fossil fuels will decrease, and state revenues from taxes on coal, oil and gas will decrease correspondingly. Therefore, a new "security of supply tax" has been introduced on all fuels – bio and fossil – for space heating. This new tax will also finance some of the subsidies for renewable energy which are part of the Agreement.

Revenues

The revenue from energy taxes is approx. DKK 40 billion or approx. 2 per cent of GDP. Around 45 per cent of the revenue is from transport, almost 50 per cent from space heating and electricity and 8 per cent from process energy.

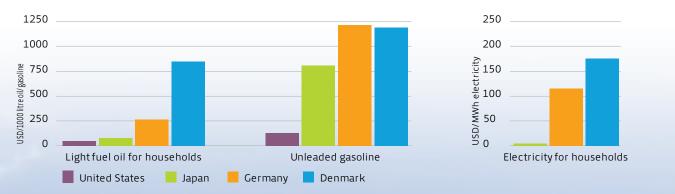


Figure 2: Current taxes (first quarter of 2012) in USD on fuel for heating, fuel for transport and electricity in the United States, Japan, Germany and Denmark. Figures for tax on electricity for the United States are not available. Source: "Energy Prices and Taxes. Quarterly Statistics. First quarter 2012", International Energy Agency 2012.



Heat savings in buildings

Since 1961 there have been energy requirements for new Danish buildings. Before the first oil crisis in 1973, nearly all Danish energy consumption was based on oil, and together with the cold Danish climate, this meant that when the oil price increased dramatically in late 1973, heating of buildings became very expensive. Therefore, many consumers decided to invest in energy improvements for their houses. The requirements for new buildings were also tightened in 1977. In 1978, state subsidies for energy improvements to existing buildings were introduced. These subsidies lasted to 1984.

The energy performance of new buildings is regulated in the Danish building code. The energy performance covers energy for heating, cooling, ventilation, domestic hot water and lighting. The energy requirements have been tightened several times since 1961. Today, the heat demand of new buildings is only about 25% of what it was before 1977.



Decreasing heat demand per square meter

Together with the taxes on fuels for space heating, these measures have resulted in decreasing net heat demand for space heating, measured per square meter of heated floor area. Figure 3 shows the development in net heat demand for space heating per square meter of heated area.

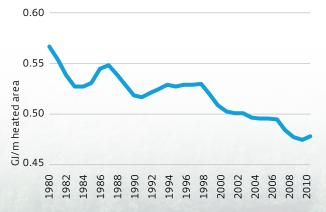


Figure 3: Development in net heat demand per m² of heated area for households. The figures are averages for all Danish households and averages over 3 years.

Future decrease in energy for heating

The most recent building code also has future requirements for new buildings to be built from 2015 and from 2020. In 2020 the energy performance of new buildings will be extremely good. At that time, new buildings will be "nearly zero" buildings, with the small use of energy covered primarily by renewable sources.

The new Energy Agreement contains a number of initiatives aimed at reducing the energy consumption of existing buildings further, including subsidies for investments in energy conservation, an energy savings package for rented housing and elaboration of a new strategy for energy renovation of existing buildings.

Use of renewable energy in buildings

In 1981, state subsidies for renewable energy, for example for heat pumps and for solar heat for space heating, were introduced. As a result of these subsidies (together with the incentive from the energy taxes on fossil fuels), the share of renewable energy for space heating grew by 8 percentage points, from 5% in 1980 to 13% in 2001¹. The subsidy schemes were altered a number of times during the years, but remained in effect until 2001, when the schemes were finally abolished.

High oil prices making renewables attractive

Around 2000, increasing oil and natural gas prices gradually made use of wood for heating attractive for private consumers, and the share of renewable energy consequently grew considerably. This growth took place without any governmental efforts, apart from the energy tax system, which favours renewable energy. Today, 23% of the energy used for heating is renewable energy, mainly wood, with a minor share coming from heat pumps. To this comes the share of renewable energy in district heating. With approximately 40% of Danish district heating being based on renewables, the total share of renewables for heating adds up to 41%.

Ban on oil and natural gas

In order to reduce the use of oil and natural gas for space heating, the Energy Agreement states that from 2013 use of oil and natural gas will not be allowed in new buildings. For existing buildings within district heating areas and natural gas areas it will not be allowed to install new oil furnaces from 2016. Moreover, analyses will be drawn up to examine how heat pumps and solar heat can be promoted. Since use of biomass for individual space heating may not be the most efficient way of using the biomass, promotion of biomass for individual heating is not part of the Energy Agreement.

1) Use of RE for district heating is not included in these figures, see section 8.

6 Municipal heat planning

Prior to 1979, there was no law regulating heat supply in Denmark. Most consumers had oil furnaces or other forms of individual heating. The oil crises in 1973/74 and at the end of the 1970s set focus on Danish energy consumption, and

resulted in a policy aiming at improving security of supply, reducing the dependence on oil, and building a multi-source energy supply structure. When natural gas was found in the Danish part of the North Sea, this new energy source became an important factor in reducing oil dependency.

Heat planning to reduce oil dependency

In order to fulfil the policy goals and at the same time to utilise the natural gas, the first heat planning law was passed in Denmark in 1979. The law contained regulations on the form and contents of heat planning in Denmark and was the beginning of new public planning.

The planning was divided into phases. In the first phase, local authorities were to prepare reports on their heat requirements, the heating methods used and the amounts of energy consumed. They were also asked to assess heating possibilities. County councils then used this data to prepare regional heat supply summaries.

Both regional and local heat plans

In the second phase, local authorities were to prepare a draft of future heat supply while the county councils prepared "regional summaries". On this basis, the county councils then prepared a definitive regional heat plan, which became the third phase in overall heat planning. The plans were required to show:

- in which areas the various forms of heat supply should be prioritised
- where future heat supply installations and pipelines should be located.

Within the boundaries of the regional plan, and after negotiation with the local energy utilities, the local authorities would then prepare a municipal heat plan. Heating projects for establishment, expansion or other changes of the local district heating system and the local natural gas system were subject to local authority approval and should correspond to the regional and municipal heating plan.

Choice of heat supply based on costs

The choice of heat supply was to be based on economic costs, and as aid to the local authorities in completing the relevant economic calculations, the first Danish technology catalogue was developed. This catalogue contained information not only on heat supply plants, but also on various other items that were considered important, such as how to calculate the distribution of heat demand over a year, how to assess the investments in gas networks and district heating networks etc. Fuel price forecasts were also prepared.

District heating and natural gas

Increased use of district heating and of natural gas played an important role in many heat plans, and the heat planning process led to an extensive development of both natural gas and district heating networks. From 1972 to 1990, the share of natural gas for heating grew from 0% to more than 10%, and the share of district heating grew from 20% to approx. 40%. Since 1990, the use of natural gas and district heating has grown further, and today the shares are 17% and 48% respectively, for natural gas and district heating.

Revival of planning

During the 1980s, great efforts were put into the planning process, and by the end of the 1980s, heat plans had been made for the entire country. In 1990 the public planning system was replaced with the so-called project system, which no longer required development of regional and municipal heat plans prior to approval of projects for establishment, expansion or other changes of the local district heating system. Today, the Heat Supply Act is still in force (although changed a number of times), but planning activities are at a much lower level, since heat plans are not required today.

Today, many Danish municipalities want to become "green", CO_2 neutral or in other ways environmentally friendly. This has led to a demand to revitalise the old heat planning concept, and therefore a new energy planning voluntary concept, which will include all types of energy consumption, is being elaborated. The concept is focusing on long-term strategic initiatives and choices at local level. Cooperation between authorities, energy utilities and other stakeholders is vital. A budget for such voluntary energy planning activities has been set aside the new Energy Agreement.

Energy efficient electricity and district heat production

With more than 55% of the net energy demand for heating being supplied from district heating systems, Denmark has one of the highest shares of district heating in the world. This fact has given Denmark a unique opportunity to increase the efficiency of electricity and heat production by using combined heat and power (CHP) plants for the production. In 1980, only 18% of the electricity produced at thermal plants was produced in combination with heat. In 2011, this share had increased to 63%.

Expansion of combined heat and power

This development is the result of a strong political effort. Use of surplus heat from large electricity plants for district heating has been promoted by state subsidies (Act from 1977). During the 1980s and 1990s, many district heating plants have been converted to combined heat and power production, mainly gas fuelled. This development has been enabled by government-led heat planning establishing the framework for local authorities. The financial incentive to invest in the CHP conversion was facilitated by an electricity generation subsidy for small-scale CHP plants.

The new Energy Agreement states that an analysis of the future role of district heating is to be carried out.

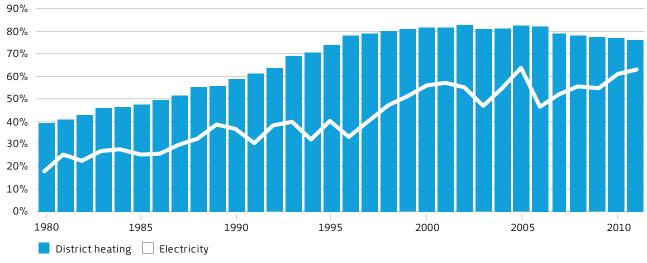


Figure 4: Development of CHP share of thermal electricity production and district heating production in Denmark

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Energy loss halved

Because of the increased efficiency, the conversion loss and heat distribution loss has fallen from 107% of the produced heat and electricity in 1972 to only 50% in 2011. If this loss had remained at 107%, the loss in 2011 would have been approx. 110 PJ higher than today. 110 PJ equals approx. 14% of total gross energy consumption in Denmark, so the extensive use of CHP has reduced the Danish gross energy consumption by 14%.

Use of renewable energy in electricity and district heat production

Of the total amount of renewable energy used in Denmark, the largest share is used for production of electricity and district heating. In 2011, 113 PJ out of 174 PJ of renewable energy was used for electricity and district heating. Wind for electricity constituted 35 PJ and bioenergy for electricity and district heat production constituted 77 PJ.

Promotion of wind energy

Wind turbines have been supported by changing governments in numerous ways, including state subsidies, feed-in tariffs, orders to the electricity utilities to build a specific number of wind turbines (before the liberalized electricity market was formed), tenders for offshore wind farms (comprising an element of subsidy paid by the electricity consumers) and orders to the municipalities to allocate suitable areas for new onshore wind turbines. Today, approx. 28% of electricity in Denmark is produced by wind turbines, and as a consequence of the Energy Agreement this share will increase to 50% in 2020. The Energy Agreement includes approx. 1,500 MW of new wind capacity to be established through tenders for offshore farms, new planning tools for onshore wind turbines and a new subsidy scheme for offshore wind turbines in coastal areas. Besides, a number of old wind turbines will be replaced by new and larger ones.

Increased use of biomass

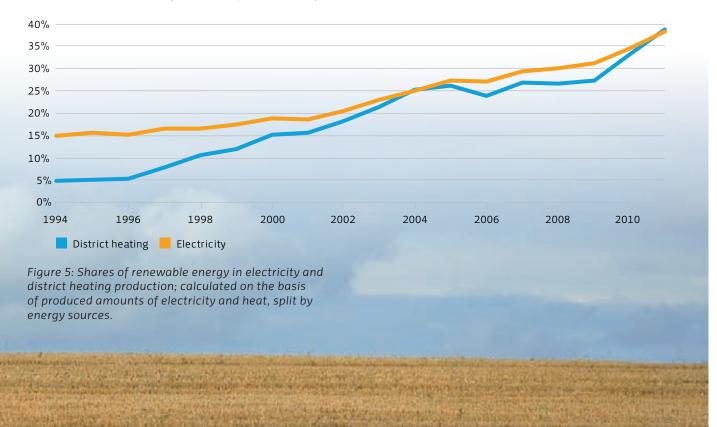
Use of biomass for electricity production and for CHP has been supported by subsidies to small scale plants and orders to the large power plants to convert to biomass (before the liberalized electricity market was formed). After liberalization of the electricity market large power plants using biomass are now supported by subsidies in the form of feed-in tariffs. To this comes the indirect effect of energy taxes on fossil fuels for heat production.



Use of biomass at district heating plants for heat production has only been supported by the government indirectly by exemption from energy tax, as combined heat and power production has had a higher priority than heat-only production. This means that gas-fired CHP has been preferred to biomass heat production in areas where natural gas has been available. Despite this fact, more than 25% of the fuel used for electricity and district heating production in 2011 was bioenergy.

The Energy Agreement will lead to increased use of biomass for electricity and heat production by:

- allowing producers and consumers to share the financial advantage of using biomass (until now, the electricity producers have not been allowed to benefit from the tax advantage of biomass for heat)
- allowing some of the smaller district heating plants to produce heat from biomass instead of CHP from natural gas
- increased subsidies for biogas production.



9 Electricity market and Nordic power pool

In Denmark, electricity can be traded both bilaterally between generators/traders and distribution companies/end-consumers/traders and via the Nordic Power Exchange (NordPool). Use of this market system for electricity has eased integration of wind and reduced costs of buying power from abroad. The market serves as a costefficient backup and it serves to balance the wind generation.

What is NordPool?

NordPool is a series of international electricitytrading markets, incorporating the Scandinavian and Baltic countries. Hourly power contracts for physical delivery during the next 24-hour period are traded in the spot market (NordPool Spot); owned jointly by the Nordic transmission system operators (TSO's). On the spot market the market price is settled for every hour and for every regional area. The TSO's also run an intraday market for physical trade called Elbas. At the Elbas market, electricity can be traded up to one hour before physical delivery. Two other markets also exist; the regulating power market and the reserve capacity market.

Monopoly in Denmark

Until the late 1990s, Danish electricity production and supply was not regulated by market forces. In the 1980s wind turbines and other small producers of electricity had obtained a right to sell all of their produced electricity to the large power companies at fixed prices, but apart from that the Danish electricity sector was in reality a monopoly.

In the first half of the 1990s there was pressure from manufacturing industry and others to be able to freely choose electricity supplier. This was the key driver for the reorganisation of the electricity sector in Denmark.

EU directive on international electricity trade

At the same time, the European Union drove a development based on the principle of free movement of goods. The first EU directive on the internal market in electricity demanded that each Member State should organise international trade in electricity, requirements for unbundling and transparency to system operator independence, access to the grid, and minimum size of liberalised consumers. This first directive had to be implemented into national legislation by 19 February 1999. The directive has been followed by two more directives (to be implemented in 2004 and 2011) aiming at improving the market systems.

The Danish electricity reform

In Denmark, the first step towards the internal market in electricity took place with an amendment to existing regulation passed by Parliament in 1996, and it entered into force by 1 January 1998. The legal adjustment enabled largescale consumers with an annual consumption of more than 100 GWh to choose their own supplier and have the electricity transported through the grid. Only seven companies complied with this requirement. Also distribution companies with annual sales of more than 100 GWh were allowed to purchase their electricity at their own choice. These distribution companies covered 90% of demand. The change in legislation only had limited effect and should be considered as an interim measure before the reform a year later.

The big reform took place by issuing an entirely new Electricity Supply Act in June 1999. This required full unbundling of activities by separating monopoly activities of distribution and transmission from sales and generation. Monopoly activities continued to operate under regulated tariffs, whereas tariff-regulation of generation and trade was terminated. The new Electricity Supply Act included a full roadmap for opening of the Danish end-user electricity market:

Consumption above 100 GWh - immediately (implemented already a year earlier)

Consumption above 10 GWh - by 1 April 2000

Consumption above 1 GWh - by 1 April 2001

Full market opening by 1 January 2003.

Today the electricity market is fully implemented and well functioning. The state-owned TSO "Energinet.dk" has the responsibility for the operation of the market, together with its sister organisations in Norway, Sweden, Finland and the Baltic States.

The new Energy Agreement includes a number of activities aiming at improving the possibilities of the electricity market to deal with the fluctuating electricity production from wind turbines and other renewable energy electricity producers.

Energy savings and use of renewable energy in industry

Until 1993, Danish industry was exempted from energy and CO_2 taxes, due to export interests. In order to encourage the companies to save energy, a CO_2 tax on energy consumption in industry was introduced in 1993, and in 1996 a new "Green Tax Package" was introduced. This package comprised 3 elements:

- An increased tax on CO₂ emissions from fossil fuels used for industrial processes
- Enterprises could get a reimbursement of this tax provided that they made an agreement with the authorities on specific energy savings projects
- Enterprises could apply for subsidies for the savings projects. The sum set aside for subsidies amounted to DKK 1,800 mill. for the period 1996-99.

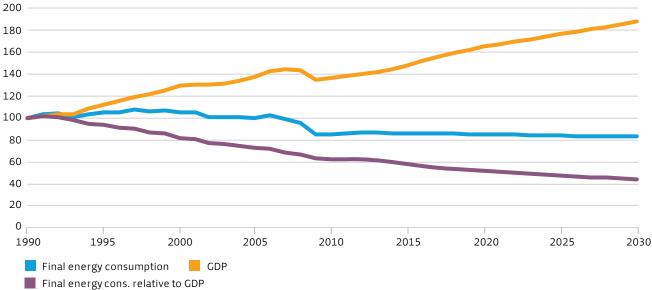
Since 1996, the agreement system has been developed continuously. The present concept is the result of a close dialogue between the Danish Energy Authority and various interested parties such as the Confederation of Danish Industries.

In 2005, the European CO_2 emission trading scheme (ETS) was introduced. A large part of the CO_2 emissions from Danish industry was covered by this scheme. Following the introduction of the ETS, the Danish CO_2 tax was changed. Industries covered by the ETS were exempted from CO_2 tax, while the tax for enterprises not covered by the scheme was set at the CO_2 quota price.

Declining energy intensity

As a result of these efforts, the energy intensity in industry has been declining for the last 20 years, and it is expected to decline further in the





future. Figure 6 shows the development in final energy consumption in industry, together with the development in consumption relative to GDP². The figure shows that the energy intensity in Danish industry is expected to more than halve from 1990 to 2030.

Figure 6: Development in GDP and in final energy consumption in industry (1990 = 100).

Until now, focus has been on energy savings in industry. With the new Energy Agreement the focus is widened to cover renewable energy as well. Thus, a new green business scheme of DKK 250 mill. in 2013 and DKK 500 mill. per year from 2014 to 2020 will promote the efficient use of renewable energy in industry.



11 Energy for transport

Gasoline and oil for transport is also taxed heavily in Denmark. The first taxes were put on these fuels in 1977, and the taxes have been raised a number of times since then. Today the taxes (comprising an energy tax, NO_x tax and a CO_2 tax) are approx. 92 DKK/GJ for diesel and approx. 134 DKK/GJ for gasoline. Besides, there is a high purchase tax on new cars and an annual owners tax depending on energy efficiency. Despite this high tax level, the use of fuels for transport has been growing steadily during the last 40 years, from 140 PJ in 1972 to 210 PJ today. The share of renewable energy is very small – only 3% in 2011. One of the reasons for this low share of renewable energy is that it is in general more expensive to use renewable energy within the transport sector than in other sectors. This is also the case for electric cars, which are today very expensive compared to traditional cars.



Use of biofuels and electricity

From 2012, all gasoline and diesel for transport sold in Denmark must contain an average of 5.75% biofuel. Due to EU legislation, it can be expected that this will be increased to 10% from 2020.

In order to promote use of electric cars, these cars are today exempted from the purchase tax and the annual owners tax. There are two ways of increasing the use of renewable energy for transport in the future, either by using biofuels (liquid and / or gaseous) or by using electricity produced by wind turbines and other renewable energy sources. Today, it is not clear to which extent each of the two ways will be used, and therefore the new Energy Agreement says that analyses regarding energy efficient vehicles, use of alternative energy sources etc. have to be carried out. Furthermore, money has been set aside for investments in infrastructure regarding energy for transport and for prolonging the registration fee exemption for electric cars.



11 Read more

The Energy Agreement

www.ens.dk/energyagreement

Wording of the agreement (in Danish): www.ens.dk/eneriaftaletekst

Danish energy statistics

Energy Statistics 2011 (in Danish): www.ens.dk/statistik2011

Energy in Denmark 2010 (in English): www.ens.dk/energyindenmark2010

Energy Statistics 2010 (in English): www.ens.dk/statistics2010

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