



Energy Efficiency trends and policies

in Denmark

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EXECUTIVE SUMMARY

Since 2000 the energy efficiency has improved in Denmark. This is clear when looking at the development in the primary energy intensity, which has declined by 15.9 % from 2000-2013 as well as looking at the energy efficiency of final consumers (final energy intensity, PPP), which has improved by 13.7 % from 2000 to 2013. All sectors have contributed to this improvement.

The energy efficiency in the industry has improved with 20.2% between 2000-2013.

Calculations show that observed energy consumption in Denmark fell by 1.2 % between 2012 and 2013, while the adjusted energy consumption fell by 1%. At the same time, the level of economic activity as measured by gross domestic product (GDP) fell by approx. 0.5 %. This means that energy efficiency (final energy intensity, climate adjusted) improved by 0.5 % in 2013.

The Danish Energy Agency is responsible for the implementation of the energy efficiency measures in all sectors except transport sector. The following descriptions of energy efficiency policies and measures in Denmark is based on the MURE database for energy efficiency measures available on the internet (<u>www.odyssee-mure.eu</u>). The database provides comprehensive and detailed information on the energy efficiency measures by sector in almost all EU Member States.

1. ECONOMIC AND ENERGY EFFICIENCY CONTEXT

1.1. ECONOMIC CONTEXT

Figure 1 presents main macro-economic indicators from 2000 to 2013. As the graph shows the



Figure 1 : Macro-economic development in Denmark. Years 2000 to 2013. Index 2000=100

Denmark's gross domestic product has been increasing in the period from 2000 to 2007 by 12% when measured in 2010 prices. In 2008 the financial crisis also affected Denmark's economy in general by showing a drop of 5% and harder on the industry sector with a drop of 12% from 2008 to 2009. For the years 2009 to 2013 the GDP growth rate has been 0.4%/year. The GVA of the industry sector has had a growth rate of 3.9%/year and private consumption has had a growth rate of 0.4%/year in the same period.

%/year	2000-2013	2000-2007	2009-2013	2008-2009
Gross Domestic Product	0.5%	1.6%	0.4%	-5.1%
Gross Value Added, Industry	0.4%	0.7%	3.9%	-12.1%
Private consumption	1.1%	2.3%	0.4%	-3.4%

Table 1 : Growth rates for GDP,	GVA and	private consu	mption.	Years 2000	- 2013
	GVA una	private consu			LOID

1.2. TOTAL ENERGY CONSUMPTION AND INTENSITIES

In Denmark total final energy consumption has decreased with 7.5% during the period 2000 to 2013.

However, due to the financial crisis in 2008, the pictures before and after this year are different. Up until 2007 the total final energy consumption increased. After 2007 the total final energy consumption decreased. In the period 2000 to 2007 there has been an increase of approx. 4.8% in total energy consumption. This is an average increase of 0.7%/year over the period. In the period 2007 to 2013 there has been a decrease of approx. 11.7%. The average decrease is 2%/year in the period.





Source: Odyssee

The figure shows the total final consumption in Denmark. It is clear that the trend changes in 2007 from an increasing trend up to 2007 to a decreasing trend from 2007. In 2010 there is an increase total final consumption (the blue line). The year 2010 had 18% more degree days than a year with normal degree days in Denmark. The lower temperatures meant an increase in the energy consumption.

The final energy intensity shows a steady decrease from 2000 to 2013. The energy intensity has decreased by 13.7% with an average of 1.1%/year

The primary energy intensity also shows a decrease from 2000 to 2013. The energy intensity has decreased by 16% with an average of 1.3%/year





The final and primary energy intensities are the energy consumption (climate corrected) over GDP converted into €2005 using ppp.

The ratio of the intensities has increased during the period. This indicates that, on average, less and less primary energy is needed per unit of final energy consumption.

In 2013 oil products were still dominant in final energy consumption in Denmark. During the period 2000 to 2013 primarily the share of oil products has decreased from approx. 48% to 41%. The share of renewables has doubled from approx. 5% to 10%. The share of heat (district heating) has increased slightly. Electricity and natural gas is at the same level. Coal has been on a low level, and has halved in the same period.





The composition of final energy consumption by end users is illustrated in Figure 5. In Denmark the two dominant sectors are residential and transport which also holds an increasing share during the period 2000 to 2013. In 2000 the transport and residential sectors' shares were 31% and 30%, respectively; in 2013 the shares were 34% and 31%, respectively. In 2000 the tertiary sector's share was 13% whereas in 2013 the share was 14%.

Industry and agriculture had decreasing shares of final energy consumption from 19% and 6,4% respectively in 2000 to 16% and 5,4% in 2013 respectively.





Source: Odyssee

When decomposing the development from 2000 to 2012 it shows that from the decrease of 0.79 Mtoe, primarily energy savings has driven the decrease but also activity and structure have contributed to a downwards trend. On the other hand demography, lifestyles and climate have contributed to the opposite direction with 0.43 Mtoe, 0.45 Mtoe and 0.64 Mtoe, respectively.





2000-2012

Source: Odyssee

Each sectors' energy consumptions are more detailed described in relevant sections.

1.3. ENERGY EFFICIENCY POLICY BACKGROUND

Reducing energy consumption through increased energy efficiency and energy savings has traditionally been a priority for Denmark and is still an important part of Danish energy policy. The Danish Government has a long-term objective of being free of fossil fuels by 2050, and an important element in this objective is improving energy efficiency. In March 2012, the Danish Government's objective was followed up by an energy agreement for the period up to 2020 in which energy efficiency and savings are a crucial element in the transition towards a society based on 100 % renewable energy sources. Initiatives in the energy agreement entail a fall in energy end use by almost 7 % in 2020 compared with 2006. This means that gross energy consumption in 2020 will be reduced by 12 % compared with 2006. In the energy agreement, emphasis is put on, among other things, energy renovation of existing buildings and energy saving by energy companies as two of the primary national instruments to drive energy efficiency forward in Denmark.

A crucial element in the transition to 100% renewable energy will be that Denmark uses less energy by switching to more energy efficient technologies. Otherwise, economic growth will push up energy consumption and make it disproportionally expensive to expand the share of renewables in the energy supply. Moreover, investment in more energy efficient technology will often quickly pay itself back.

1.3.1. ENERGY EFFICIENCY TARGETS

Denmark has not set any overall energy efficiency or energy saving target.

Denmark's indicative target under Article 3 in the EED is an absolute primary energy consumption (gross energy consumption excluding consumption for non-energy purposes) of 741.08 PJ (17.70 Mtoe) in 2020. This equates to a 13 % reduction in primary energy consumption compared with 2006.

The corresponding target for final energy consumption (excluding consumption for non-energy purposes) is 610.4 PJ (14.58 Mtoe) in 2020.

The indicative target is derived from the Danish Energy Agency's 2014 baseline projection for energy consumption. The baseline projection takes account of the effects of adopted measures, which in this context are the 2012 Energy Agreement, the Finance Acts up to and including the 2014 Finance Act, the Danish Growth Plan and the 2014 Growth Package, including the Agreement on the abolition of the security of supply charge etc. and on PSO (Public Service Obligation) reductions.

2. ENERGY EFFICIENCY IN BUILDINGS

This chapter describes energy efficiency in the residential and the tertiary sectors.

2.1. ENERGY EFFICIENCY TRENDS

The following two sections describe the efficiency trends in the residential and the tertiary sectors. The main developments are that energy consumption has decreased.

For the tertiary and the residential sector the potentially strong influence of climatic variations should be taken into account when looking at the annual changes in energy consumption. The year 2000 was a mild year whereas 2010 was a cold year in Denmark.

2.1.1. RESIDENTIAL SECTOR

The final energy consumption of households decreased by 6.2% in the period 2000 to 2013. This is a decrease of 0.5%/year in average. The final energy consumption increased by 5.7% in the period 2000 to 2007 corresponding to 0.8%/year in average and decreased by 11.2% in the period 2007 to 2013 which is an average of 2%/year.





The electricity consumption of households has been on the same level in the years from 2000 to 2013. The consumption increased in the years 2000 to 2006 by 3.5% and decreased in the years 2006 to 2013 by 2.5%.

The developments of unit consumptions of electrical appliances are shown in Figure 8. In general the unit consumptions have decreased during the period 2000 to 2013. The unit consumptions of freezers, dishwashers, washing machines, refrigerators and dryers have decreased by 47%, 24%, 31%, 28% and 4.8%, respectively. For TVs the consumption has increased during the period by 92%.





Source: Odyssee

The energy consumption for space heating per m^2 has shown a decrease during the period 2000 to

2013. The energy consumption has been at the same level from 2000 to 2008 whereas from 2008 to 2013 a decrease of 19% is observed.





Source: Odyssee

The same pattern as for space heating per m² is seen for energy consumption per dwelling.

2.1.2. TERTIARY SECTOR

As for the residential sector, the tertiary sector is also highly dependent on climatic conditions since most of the energy is used for space heating. Climatic corrections are based on degree days.

The energy intensity, not climate adjusted, has decreased with 4.6% from 0.0151koe/€2005 in 2000 to 0.0144 koe/€2005 in 2013. The energy intensity, climate adjusted, has decreased with 10.6% from 0.016 koe/€2005 in 2000 to 0.0143 koe/€2005 in 2013.

In 2013, the electricity intensity was 75.044 kWh/€2005, which is 7.2% lower than in 2000.





The energy intensity in the service sector by branch is shown in Figure 11. The energy intensity is highest in Hotels and restaurants (0.062 koe/ €2005 in 2013) and lowest in Public and private offices (0.006 koe/ €2005 in 2013).





Source: Odyssee

In the period 2000-2013, the energy intensity has increased in the branches Education, Public and private offices and Hotels and restaurants as seen in Figure 11. In the branches Trade and Health the energy intensity has decreased.

The electricity intensity in the service sector by branch is shown in Figure 12. The electricity intensity is highest in Hotels and restaurants (321 kWh/€2005 in 2013) and lowest in Public and private offices

(36 kWh and 28 kWh/ €2005 in 2013). Except for Health the electricity intensities have increased in all branches in the period shown.



Figure 12 : Electricity intensity in the tertiary sector by branch. Climatic corrected. Years 2000 - 2013

Source: Odyssee

From 2000 to 2013 the fuel mix in the tertiary sector has not changed significantly. Heat (district heating) and electricity are the primary energy sources in this sector. The share of oil in the tertiary sector is halved, heat has increased by 4.4 percentage point and gas consumption has increased by 1.7 percentage point. The share of electricity has decreased marginally with 1.3 percentage point and the share of wood has decreased by 28%.





Source: Odyssee

2.2. ENERGY EFFICIENCY POLICIES

Nearly 40 % of the Danish energy consumption is used in buildings. To meet the long-term challenges, with higher prices and securing our energy of supply, it is important to reduce the energy consumption in buildings.

Building codes

The energy requirements for new buildings have been strengthened quite considerably the last 25 years. According to the EU's Buildings Directive, the energy provisions must be reviewed with regular intervals which shall not be longer than five years. Besides the mandatory requirements have two low-energy classes been defined, and they are planned to be next step as mandatory requirements. This has been a strong instruments to promote innovation and low-energy buildings.

The building codes have also strong requirements in relation to components in existing buildings.

Implementation of the energy labelling of buildings

For energy savings in existing buildings, the government has implemented the energy labelling of buildings into Danish law. The purpose of the labelling is to make the energy specifications of buildings visible for e.g. the owners, the buyers, and to deliver a plan showing the potential for reducing the energy of the house. The label, plan and documentation are composed by an Energy consultant and are paid by the seller/ the owner of the house.

Energy-efficient appliances and equipment

A campaign to improve the energy efficiency of appliances and products is an important part of the Danish effort to improve energy efficiency, in which energy labelling and ecodesign requirements are the two most important schemes. In addition, there are the Energy Star programme and European industry agreements. All of these share a European dimension in which Denmark is following the EU's targets and energy requirements for products and appliances.

At the end of 2013, there were requirements for a total of 46 product types, and at least 85 product types are expected by be covered by the rules in 2020. Previously, the schemes mainly covered household appliances, but in future they will also cover building components and products aimed at enterprises.

In 2013, the Danish Energy Agency conducted an analysis of the Danish energy saving impact as a result of ecodesign requirements and energy labelling for products. The analysis calculated the impact of the ecodesign requirements to be 5 640 GWh per year in 2020, corresponding to 5 % of energy consumption in 2011 excluding transport. The requirements are therefore making a significant contribution to reducing Danish energy consumption.

Strategy for energy renovation

One of the elements in the Danish Energy Agreement is to compose a strategy for energy renovation of existing Danish buildings. The Danish Government adopted in May 2014 a strategy for energy renovation of buildings. The strategy contains 21 initiatives which will promote the renovation of the Danish building stocks and insures that energy efficiency measures are implemented on the

buildings.

It is expected, that the effect of the strategy on energy consumption will be a reduction of net energy consumption for heating and hot water with 35 pct. in 2050 compared with today. The strategy includes following initiatives:

- Revision and upgrade of building regulations and energy requirements that applies to renovation and retrofitting of existing buildings
- New requirements to the energy efficiency of windows. These requirements will be tightened in 2015 and 2020. Furthermore new requirements will be defined for windows, which are installed in buildings after 2020.
- Information to building owners, construction companies, financial institutions etc. on energy how to improve energy efficiency
- Revision of the energy certificates scheme to improve the efficiency of the scheme
- Promotion of the ESCO-concept
- Promotion of energy efficiency in public buildings
- Measures to improve professional training to craftsmen and engineers in the building sector
- Development and demonstration of new technologies.

The strategy is part of the National Energy Efficiency Action Plan, which was submitted to the Commission in 2014 in accordance with the directive on energy efficiency (Directive/2012/27/EU)

Consumer information programmes and training

According to the EU Energy Efficiency Directive Member States are obliged to focus on and strengthen consumer information, and information and training about energy efficiency. The Danish Energy Agency has drawn up an action plan and strategy for the information campaign on energy efficiency at end-user level. The aim of this information campaign is to promote energy-efficient solutions and purchasing and energy-efficient behaviour among end users. The information campaign focuses on end users, with home owners, the public sector and commercial enterprises as specific focus areas.

Improving the energy efficiency of buildings and modifying behaviour in connection with buildings is a priority in the Danish public and consumer information campaign. This involves preparing material on energy-efficient solutions, information on building regulations, and better access to information and knowledge about energy renovation. The Danish Energy Agency's website www.sparenergi.dk is the backbone of the Agency's communications with end users concerning energy-efficient solutions both in private households and in public and private enterprises.

Funds for advancement of alternatives to oil and natural gas boilers (households).

With the Danish Energy Agreement in 2012 it was decided, that no oil and natural gas boilers can be installed in new buildings in Denmark starting from 2013. Furthermore, it was decided that from 2016 new oil boilers cannot be installed in existing buildings, which are placed in areas with district heating or natural gas supply. To support the reorganisation from oil and natural gas to renewable energy a fund on 5.6 million euro has been earmarked to the advancement of energy efficient alternatives to oil and natural gas boilers in existing buildings. The funds will be used in the years 2013-2015. The target group for the activities within the fund is house owners, users, consultants,

workmen and finance and insurance companies.

3. ENERGY EFFIENCY IN TRANSPORT

3.1. ENERGY EFFICIENCY TRENDS

A macroeconomic view of the dependency of energy efficiency in transport can be given by the indicator energy intensity in transport – measured as energy consumption in the transport sector per total GDP unit.

In the period 2000-2013, the energy intensity in transport has declined 6.2%, which means that the amount of energy used for transport needed to produce one unit of GDP has declined 6.2% since 2000. After a decrease in 2001 and 2002 the intensity increased in 2003 to 2005 and the intensity declined again from 2007.



Figure 14 Energy intensity of transport. Development from 2000 to 2013

Source: Odyssee

ODEX is an indicator for energy efficiency. For transport the ODEX improved by 13.8% (1.1%/year) between 2000 and 2013.





When looking at the final energy consumption for transport in 2000 to 2013 the development has been increasing from 2000 to 2007 and decreasing from 2007 to 2013. Road transport is the primary consumption category in the transport sector with a decrease of about 1%-point from 2000 to 2013. The share of diesel consumption in road transport has increased with about 18 %-point in the same period of time as shown in Figure 16.





Source: Odyssee

3.2. ENERGY EFFICIENCY POLICIES

The energy consumption of the transport sector in Denmark rose in the period between 1990 and 2007, when the energy consumption was 224 PJ. From 2007 to 2012, energy

consumption in the transport sector fell, amounting to 204.8 PJ in 2012.

The financial crisis from 2008 led to reduced fuel consumption in both the private sector and in industry. The change in vehicle taxation in 2007 had a major influence on what new cars are bought, especially by private individuals. Today's new vehicles are 20 to 40 % more fuel efficient than seven years ago, and Denmark has already achieved the EU target for 2015 of average CO2 emissions for new cars of 130 g CO2/km.

Denmark is short of the target of a 40 % reduction in CO2 in the non-quota sector by 2020, having a shortfall of around 6 %. A climate plan has been drawn up, and measures to close the CO2 reduction gap will be taken in the housing, agricultural and transport sectors. Measures in the transport sector are, with few exceptions, expensive compared with measures in the housing and agricultural sectors, which are therefore expected to have to bear a large share of the reduction.

Among other things, the electrification of the railway network converting the trains from diesel to electric, financed by the Train Fund, will be completed in the mid-2020s and is expected to lead to an annual reduction in CO2 emissions of 220 000 tonnes.

The measures on transport are expected to provide a basic development with continued slackening of the transport sector's energy consumption up to 2020.

4. IN INDUSTRY

4.1. ENERGY EFFICIENCY TRENDS

The industry sector includes manufacturing, mining and quarrying and construction. For the manufacturing sector, the energy efficiency has improved by 20.9% from 2000 to 2013. The decrease has been steady over the period. The average decrease has been 1.8%/year.





Source: Odyssee

In the manufacturing industry sector the shares of oil and coal consumption have decreased by 6.8 %-points and 2.4 %-points, respectively. The share of heat is at the same level. The share of electricity and natural gas has increased by 2.8 %-points and 4.1 %-points, respectively.



Figure 18 Energy consumption in manufacturing sector by fuel. Years 2000, 2005, 2010 and 2013

Source: Odyssee

The branches described in **Erreur ! Source du renvoi introuvable.** are the branches with the largest gross value added in Denmark. Final energy consumption in the manufacturing sector has decreased for most branches except for the chemical industry in the period 2000 to 2013. In the food industry the consumption has decreased by 18.7%, in the machinery industry it has decreased by 12.1%, in other industries with 34.4%. The chemical industry has increased by 2.6%.





4.2. ENERGY EFFICIENCY POLICIES

Energy saving by energy companies

Since 2006, the grid and distribution companies in the areas of electricity, natural gas, district heating and oil have been key actors in the energy saving effort and have been subject to annual energy savings. The aim of the agreement is to create a solid basis for more cost-effective and market-oriented energy saving, with a particular focus on achieving cost-effective savings.

The target has been increased several times, and the annual saving target is from 2015 equal to approx. 3 pct. of final energy consumption expect energy used for transport. Around 60 pct. of the saving are done in private enterprises. A new independent evaluation shows that the saving in industry are very cost-effective.

Energy audit and management system

On 29 January 2014, the Danish Government presented a bill to the Danish Parliament containing the general rules for the implementation of the EU Energy Efficiency Directive's requirement for mandatory energy audits, Article 8(4). The Act was adopted by the Danish Parliament on 1 April 2014. It contains an obligation for enterprises to carry out a mandatory energy audit every fourth year. The enterprise can also satisfy the obligation by using and maintaining a certified energy or environmental management system that includes an energy audit as part of the management system. The Act also provides a legal basis for the Minister for Climate, Energy and Building to lay down detailed rules on, among other things, the content of energy audits and qualification requirements for the experts who are to carry out the energy audit.

Renewable energy for production processes

In the political agreement of 22 March 2012 the Danish Parliament decided that renewable energy must account for 35 per cent of the final energy consumption in 2020. Due to domestic tax policy toward the industry, fossil fuels are less expensive than renewables and incentives to convert to renewable are absent.

To compensate the industry a subsidy scheme have been set up to promote energy-efficient use of renewable energy in industrial production processes.

The new investment scheme will bridge the price gap between renewable and fossil fuels. The state subsidy scheme will support industries to convert to renewable energy sources or district heating:

- Replace fossil fuels with renewable energy
- such as wind, solar, biogas or biomass
- to power manufacturing processes.
- Replace fossil fuels by district heating e.g, horticulture will be able to change from coal-fired boilers to district heating.
- Invest in energy-efficiency measures.

Centre for energy savings in industry

As part of a new political agreement from June 2014 on growth 40 million DKK (5,4 mio. EURO) was allocated to run a new centre for energy savings in enterprises. The money was given for the period 2014-2017. The Centre is in the process of being fully established. However the aim of the centre is to identify and exploit the energy efficiency potential already existing within primarily small and

medium sized companies. The large companies are covered by the mandatory energy audit. The centre should complement already existing measures as for example RE in processes and The Energy Companies saving effort.

5. ENERGY EFFICIENCY IN AGRICULTURE

5.1. ENERGY EFFICIENCY TRENDS

The agricultural sector includes agriculture, horticulture, forestry and fishing. The energy intensity has been fluctuating over the years 2000 to 2013. In the period from 2000 to 2006 the energy intensity was at the same level of about 0.36 koe/€2005, in 2007 the intensity dropped and from 2007 to 2009 the intensity increased to 0.43 koe/€2005. From 2010 to 2013 the intensity was around 0.34 koe/€2005 but a bit more inconsistent than from 2000 to 2007.



Figure 20 Energy intensity in agricultural sector. From 2000 to 2013

Looking at the energy consumption by fuel in the period from 2000 to 2013 the distribution has not changed much. Oil share has decreased by 5.4 percentage points over the period. The electricity share has increased from 17.1% to 20.5% of the energy consumption.



Figure 21 Energy consumption in agricultural sector. Years 2000, 2005, 2010 and 2013

Source: Odyssee

5.2. ENERGY EFFICIENCY POLICIES

Renewable energy for production processes

The RE for production processes is part of the energy agreement of 2012, in which a fund of DKK 3.75 billion was allocated to the scheme. RE for production processes is aimed at converting energy consumption in the production processes of enterprises from fossil fuels to renewable energy and district heating. Grants are provided for energy efficiency measures in connection with converting production processes from fossil fuels to renewable energy. The scheme is aimed at all types of enterprise, including SMEs. There has been a strong demand for the scheme from SMEs in agriculture.

Voluntary agreement scheme with greenhouse gardeners

Resulting from the agreement with the Danish Energy Agency on energy-efficient initiatives, nurseries have over the last years had the possibility to obtain subsidies for implementing energyefficient technology, e.g. special energy-saving screens and insulation elements, which has prompted greenhouse gardeners to implement new technologies.

Due to this agreement, the industry as a whole has been able to handle the development of new production methods and climate control strategies and technologies, at industry level, and thereby been able to implement new instruments at each individual nursery.

Nurseries that have an agreement on implementation of energy efficient measure with the Danish Energy Agency have all experienced massively decreased energy consumption resulting from the requirements of the agreement.