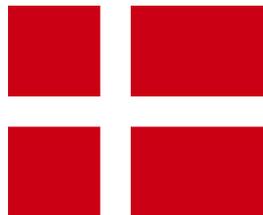


Development and promotion of a transparent European Pellets Market
Creation of a European real-time Pellets Atlas

Pellet market country report DENMARK



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1. Introduction

The Danish wood pellet market is one of the worlds largest and especially in relation to the number of inhabitants the consumption of wood pellets is significant.

Strong drivers provide for wood pellets use in all sizes of combustion plants from small boilers in single family houses and small block heating centrals over medium sized district heating plants up to large power plants producing power and heat for large district heating systems.

In 2008 the total wood pellet consumption in Denmark was around 1.1 million metric tonnes.

Pellet production in Denmark is to a large extent based on dry wood residues from the numerous wood processing industries. In the beginning of the century the national production capacity and actual production of around 200,000 t/y was able to cover half of the demand.

Currently the production is decreasing due to changes in the feedstock availability and as the demand has increased rapidly, Denmark has become the worlds largest pellet importing country.

The changes in production and consumer structure imply that wood pellets in Denmark over a period of 15 years have developed from being a locally produced and consumed fuel to being a globally traded commodity.

2. History of market development

In Denmark more than half of the residential heat demand is supplied via district heating. The utilisations of wood pellets started in the district heating sector in the late 1980'es when coal fired heating plants were converted to use wood pellets. The annual pellet consumption quickly reached around 100,000 tonnes and since the beginning of the 1990'es this has been the consumption in the district heating sector.

From the mid 1990'es the wood pellet consumption in individual boilers for space heating in private dwellings, public institutions and other large buildings increased rapidly. The drivers would be fuel tax exemption (in combination with high taxes on fossil fuels for heating purposes) and from 1995 an investment subsidy scheme for wood fired combustion systems with a nominal capacity below 250 kW. During 10 years the wood pellet consumption had more than tripled which made the Danish market the second largest in Europe only exceeded by Sweden.

Based on a variety of drivers parts of the Danish utility sector started to show interest in co-firing wood pellets into coal fired dust burners in the beginning of the new century. This resulted in a significant amount of wood pellets being utilised mainly in the advanced Avedøre 2 power plant south of Copenhagen.

Figure 1 shows the Danish wood pellet combustion divided into sectors.

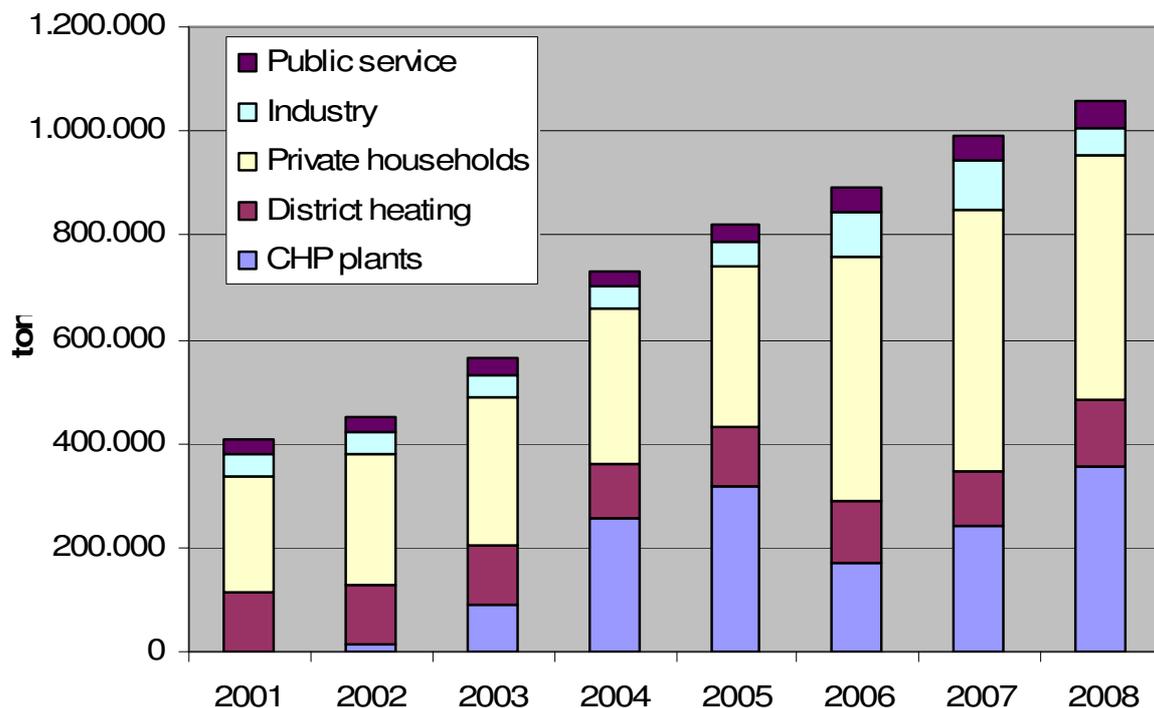


Figure 1: Danish wood pellet consumption 2001-2008. Source: FORCE Technology

Wood pellet production in Denmark started in the 1980'es based on the first experiences from US and Sweden and the feed pellet production in order to accommodate the demand from the district heating plants.

The production was initially based on dry wood residues from the numerous wood processing industries. Only recently some manufacturers have invested in facilities

for drying feedstock. A utility based large pellet production plant was commissioned in 2003. The capacity of the plant was 180,000 t/y wood pellets based on logs and wood chips from a nearby wooden floor manufacturer and 120,000 t/y straw pellets. Currently, the wood pellet part is closed down and the equipment is for sale.

In the beginning of the century the national production capacity and actual production at around 200,000 t/y was able to cover half of the demand. Currently the production has decreased to around 135,000 t/y due to changes in the feedstock availability. As the demand has increased rapidly – in 2008 it was 1.06 million tonnes - Denmark has become the worlds largest pellet importing country.

3. Pellet production

Wood pellet production in Denmark started in the 1980's in order to accommodate the emerging market in the district heating plants. The production was entirely based on dry wood residues from the numerous wood processing industries producing furniture, windows and doors etc. Today the feedstock is mixed dry and wet, as a few manufacturers have invested in facilities for drying feedstock.

The Danish wood pellet manufacturing companies vary in structure and comprise small, farm based pelletising plants as well as large dedicated pellet plants operating close to all available hours. Currently 12 companies produce pellets in Denmark. The production capacity is shown in Figure 2.

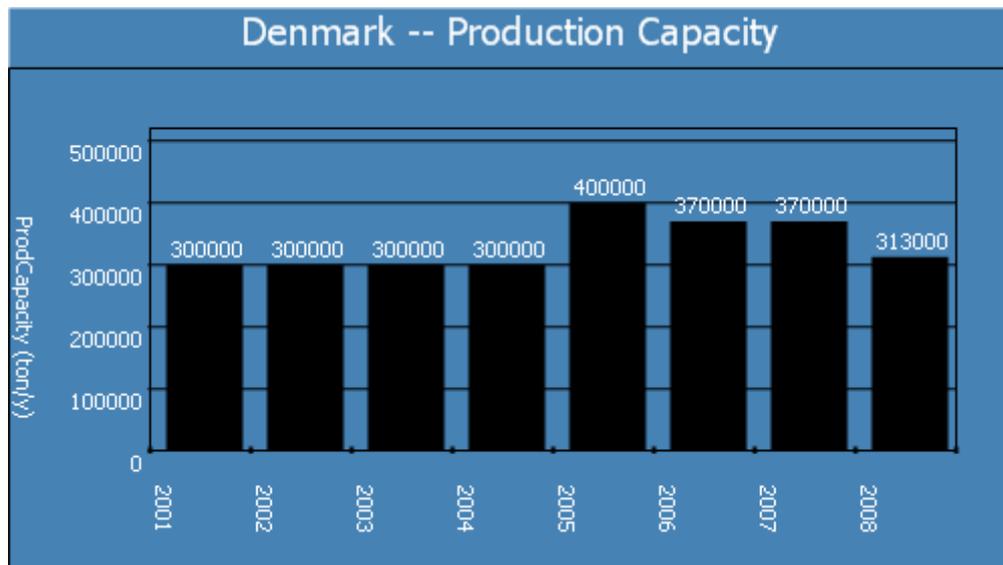


Figure 2: Wood pellet production capacity in Denmark. Source: FORCE Technology.

A large utility based pellet production plant started production in 2003. The capacity of the plant was 180,000 t/y wood pellets based on logs and wood chips from a nearby wooden floor manufacturer and 120,000 t/y straw pellets. Currently, the wood pellet part is closed down and the equipment is for sale.

In the beginning of the century the national production was around 200,000 t/y which was enough to cover half of the demand. Currently, the manufacturers struggle with the access to raw material. As pellets are mainly made of dry wood shavings and the wood processing industries are closing down or running at a low activity level, the pellet manufacturers have difficulties in procuring sufficient dry raw material.

Changes for other sources of raw material seem not to be viable. The wood chip market experiences a price increase that makes wood chips irrelevant for pellet manufacturers. Besides, the existing plants are designed to use dry and clean wood residues. Due to these changes in the feedstock availability the 2008 production had decreased to 134,000 tonnes. Figure 3 shows the recent development in the Danish pellet production.

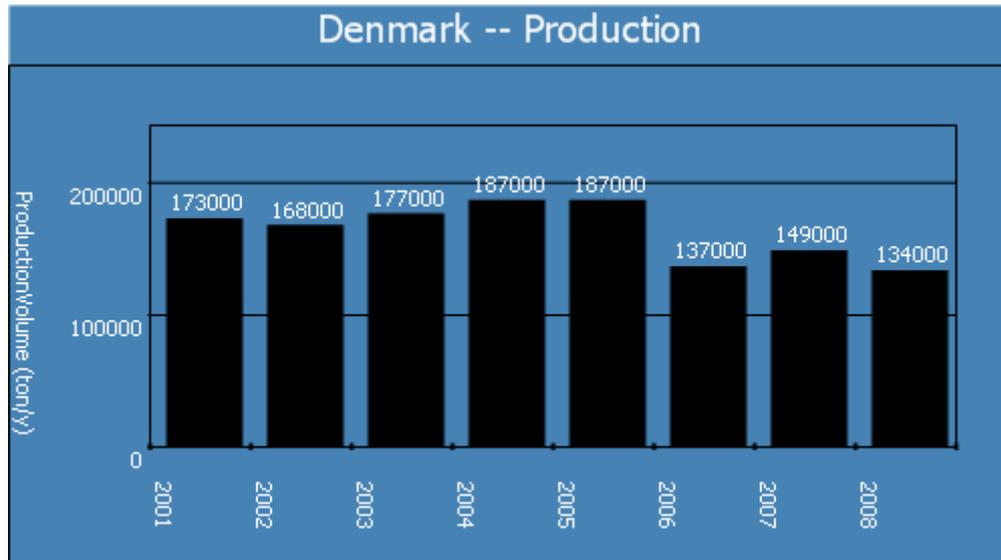


Figure 3: Wood pellet production in Denmark. Source: FORCE Technology.

Quality standards is not a very big issue in the Danish wood pellet market. In the small and medium scale markets pellets are to a wide extent purchased according to proprietary standards such as "HP-quality", "Celsico" etc. and according to previous experiences. Such branding is popular, while proper standards such as CEN, DINplus, Önorm, or the Nordic ecolabel are also used. This does, however, not mean that the pellets used in Denmark are of a low quality. If the consumer experiences problems with high ash content, problematic ash etc. it will be difficult for the dealer to continue operation for a longer period of time.

The allowed composition of fuel pellets is defined in an executive order from the EPA (please refer to section 7).

4. Pellet trade and logistics

The total supply of wood pellets can be calculated as the sum of Danish production, imports, and exports, adjusted for changes in stocks, at Danish distributors. In 2008 the total supply of wood pellets was 1,060,000 tonnes. This is 2½ times more than in 2001. Table 1 illustrates that the Danish production of wood pellets decreased from 43 per cent of the total supply in 2001 to 13 per cent in 2008. In absolute figures, the production has decreased by approx. 53,000 tonnes since 2004, which the producers explain is due to lack of access to feedstock - as mentioned above - because parts of Danish furniture production have been moved abroad.

Table 1: Danish Wood pellet supply. Source: FORCE Technology.

	2008		2006		2004		2001	
	[ton]	%	[ton]	%	[ton]	%	[ton]	%
Danish production	134.280	13%	137.080	15%	187.458	26%	173.073	43%
Import	925.401	87%	841.132	94%	470.588	64%	200.871	50%
Export	41.149	4%	-17.948	-2%	-795	0%	0	0%
Stock increase	-40.987	-4%	-64.468	-7%	73.883	10%	27.347	7%
Total supply	1.059.843	100%	895.796	100%	731.134	100%	401.291	100%

As it appears, imports have increased considerably from around 200,000 tonnes in 2001 to more than four times as much in 2008.

The number of Danish wood pellet importers has increased from 17 in 2001, 29 in 2004 to 37 in 2006 and 28 in 2008. The trend shows a market consolidation of the large importers. Eight importers who each purchase more than 20,000 tonnes per year accounted for 88 per cent of total imports in 2008. There were six large importers in 2004 and four in 2001, which accounted for 83 per cent and 79 per cent of total imports, respectively.

The number of small importers, importing below 10,000 tonnes has increased, but at the same time they have decreased their market share. Importers importing below 10,000 tonnes accounted for 2 per cent of total imports in 2008, as opposed to 16 per cent in 2001. Many small importers rapidly enter and leave the market - perhaps they import a few truckloads, and then realize it is too expensive, and leave the industry again. Broken down by country it appears that 50 per cent of imports come from the Baltic States in 2008.

As the wood pellet production in Denmark is decreasing due to changes in the feedstock availability and as the demand has increased rapidly, Denmark has become a large importing country. The changes in production and consumer structure imply that wood pellets in Denmark over a period of 15 years have developed from being a locally produced and consumed fuel to being a globally traded commodity.

Distribution of wood pellets in Denmark takes place in almost any shipment size and type. The utilities using wood pellets receive fuel by ships. At the Avedøre plant the harbour facilitates ships with cargo sizes of 2,000 - 4,000 tonnes.

Medium sized consumers such as district heating plants are supplied with either tipping lorries or blower lorries.

Individual plant owners buy pellets in a variety of modes:

- Small bags with a maximum weight of 40 kg
- Big bags of up to 1200 kg
- Blower lorry
- Tipped off
- Personal collection

5. Pellet consumption

Efficient drivers provide for wood pellets being used in all sizes of combustion plants from small boilers in single family houses and small block heating centrals over medium sized district heating plants up to large power plants producing power and heat for large district heating systems.

Please refer to Figure 1 or an overview of the consumption development.

Around half of the Danish wood pellet consumption is used in small and medium sized pellet boilers for heating purposes (2008). Pellets stoves are only slowly entering the market. District heating plants and power plants together account for the second half of the present consumption. This share is, however, expected to change as large growth is foreseen in the utility sector.

In the residential heating market, the very high taxes on oil and gas for heating are the significant drivers. When the basic oil and gas prices are high too, pellet heating becomes very favourable.

New data published by the Danish Energy Agency reveals that the Danish market development has been strongly influenced by changes in political framework conditions. During the late 1990s the Danish market for residential pellets boilers was one of the most dynamic markets in Europe. A sudden change of policies was introduced by a new conservative/liberal government which cancelled all subsidies for renewable energies. This led to an immediate decline in the market growth after the year 2000.

Due to limited domestic feedstock for pellet production the amount of imported wood pellets is growing significantly; in 2008 almost 90 % of the Danish wood pellet consumption is imported.

The framework conditions for electricity production based on renewables in Denmark is given by a feed-in tariff system, the implementation of the EU scheme for greenhouse gas emission allowance trading which has regulated CO₂ emissions from January 2005 and a liberalized electricity market. Further the Biomass Agreement from 1993 sets a framework for use of biomass in large scale power plants; it works like a biomass quota system. To some extend, also feed-in tariff support applies.

Since spring 2007 the pellet prices in Denmark have remained constant at a level which is low enough to encourage consumers to change for pellets and high enough to be attractive for suppliers.

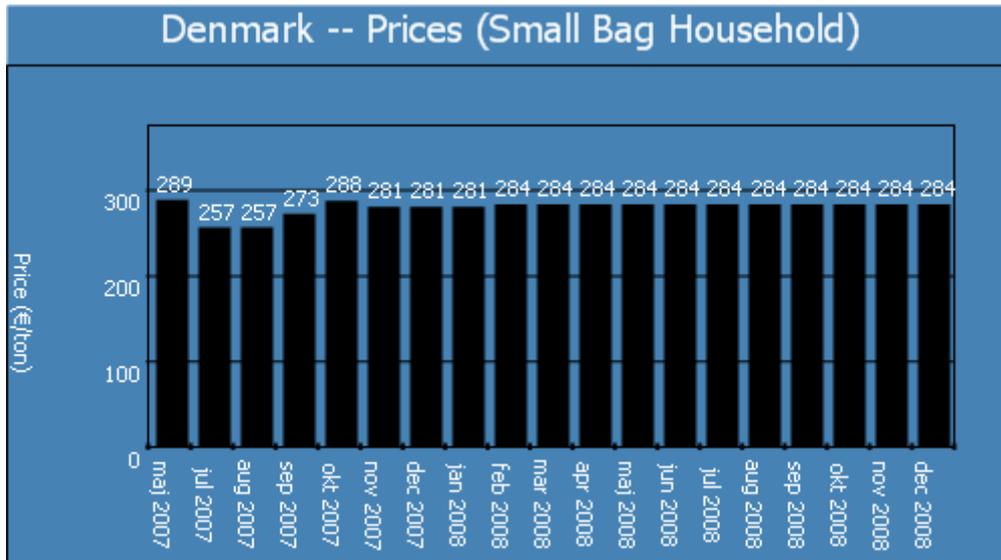


Figure 4: Danish pellet prices. Average price per tonne of pellets in 25 kg bags on pallets. Excludes delivery and transport, includes VAT (25%)

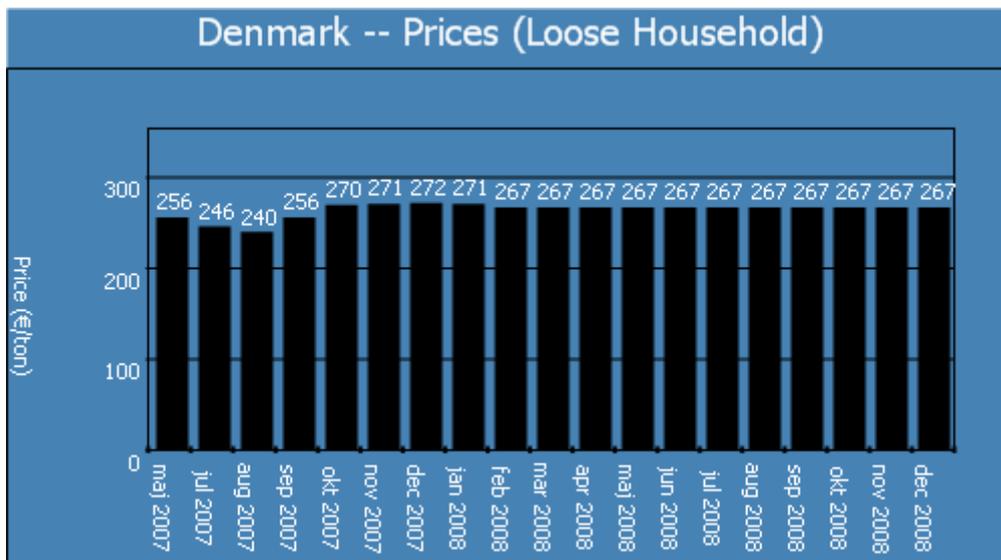


Figure 5: Danish pellet prices. Average price per tonne of pellets delivered in bulk volume of 5 tonnes. Includes delivery and transport of maximum 50 km, includes VAT (25%)

6. Mixed biomass pellets

The straw potential in Denmark is presented in Table 2. Residues origin mainly from wheat and barley. The total amount of agricultural residues is 8.3 million tonnes corresponding to an energy resource of approximately 33 TWh.

Table 2: Agricultural residues potential, Denmark, 2000.

Agricultural residues potential	1000 t
Wheat	3796
Durum wheat	0
Rye	486
Barley	3821
Oats and mixed cereals	251
Maize	0
Other cereals	0
Total	8354

This availability of residues would indicate a mature market for agricultural fuels. Large amounts of straw is used for energy purposes, however, the Danish Mixed Biomass Pellet (MBP) market is not very developed. It consists of two types of supply chains:

The first type is made of 10 manufacturers that sell small amounts of MBP in order to satisfy the needs of small to medium scale customers who demand a cheap fuel and wish to experiment with their plant installation. Most of the manufacturers mainly market feed pellets or rape seed oil and sell a few tonnes of mainly rape seed cake pellets for fuel purposes. Two manufacturers market sunflower seed shell pellets.

The second type is made out by one large manufacturer, the utility company Vattenfall that produces annually 80-100,000 tonnes of straw pellets at the pellet factory in Køge for its own use at the plant Amagerværket in Copenhagen. In 2008 80,000 tonnes have been used an old block at the plant, while in 2009 a newly refurbished block will be put in operation and is expected to use 100,000 tonnes straw pellets annually along with a significant amount of wood pellets. Straw for the straw pellets is bought locally/regionally from farmers on Sealand.

During the past 20 years Denmark has seen several projects on development, production and combustion MBP, however, the conclusion has often been that possible advantages within price and heating value do not outweigh the risks of malfunctions of the combustion plant. There are numerous examples of plant owners that have bought and used cheap pellets in their residential wood pellet plant and shortly after have had to remove hard cindered slag from vital boiler parts. Due to these experiences as well as corrosion and fouling experiences in larger plants,

Danish consultants and Centre for Biomass Technology have been rather reluctant to recommend the use of MBP.

Further, the costs in the supply chain including straw procurement, pellet production and logistics associated with straw pellets are in most cases higher than the costs for wood pellets (which even exhibit superior properties).

7. Legal framework & Policy

Drivers

Large scale: The framework conditions for electricity production based on renewables in Denmark is given by a feed-in tariff system, the implementation of the EU scheme for greenhouse gas emission allowance trading which has regulated CO₂ emissions from January 2005 and a liberalized electricity market. Further the Biomass Agreement from 1993 with the 2008 update sets a framework for use of biomass in large scale power plants.

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.

In 1999, the Danish Parliament entered into an agreement on a comprehensive electricity reform. A mandatory target of doubling the share of renewable electricity to 20 % by 2003 was adopted. Thus, the utilization of renewable energy (in the electricity sector) in Denmark would be raised from a level of around 8 % to 12-14 % by 2005 and 35 % by the year 2030.

Incentives for RE electricity production consist of a carrot and stick combination including a quota-like scheme from the Biomass Agreement in 1993, and a compensation scheme for renewable electricity. The Biomass Agreement motivates utility companies to use a certain amount of biomass fuels, totalling 1.4 million tonnes annually. Between 0.2 and 0.4 million tonnes can be wood fuels including wood pellets, the rest must be straw. In 2008 the threshold was increased with another 700,000 tonnes of wood fuel. This quota-like system is the foundation for most of present use of biomass in power plants in Denmark.

Originally this scheme was simply a mandatory use of biomass fuels imposed by the parliament on the power producers. After liberalization of the sector around 2000, the same quotas apply, but now motivated through a feed-in price, guaranteed at 0.40 DKK/kWh (= 0.054 €/kWh) (as the total of electricity market value and government support), and on top of this a plant specific support on consumed biomass between 25 and 100 DKK/tonne (= 3.4 - 13.5 €/tonne).

The general compensation system in Denmark for electricity produced from RES is based on feed-in tariffs. The system is complicated and includes tariff, that vary according to the technology chosen, to the fuel in question, and to the year, when the plant was built. The Electricity Act of May 1st 1996 set up feed-in tariffs for geothermal, small hydro, biomass, tidal, solar PV and wind onshore in the range of 0.0506 €/kWh to 0.0673 €/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. However, it shall be stressed that the production of RES based electricity does not issue certificates, which are tradable on an individual market, as it is the case in other countries.

Further, there is also exemption from CO₂ taxes for electricity produced from RES. The CO₂-tax is currently 0.0115 €/kWh.

Medium scale: There are no investment grants, tax deduction schemes or similar effective for industrial, district heating or large building wood pellet heating installations.

For heating purposes, VAT and energy taxes are similar to the situation described in the following section.

For electricity production, the current situation is covered by the section above.

Small scale: Generally wood pellets for heating in small scale installations are attractive due to the high energy tax on fossil fuels for heating.

There are no investment grants, tax deduction schemes or similar effective for domestic wood pellet heating installations. A grant system was in place until 2000, where support between 10 % and 30 % of investment costs in small wood pellet boilers were given. The scheme closed down as the general economic performance of these type installations proved to be attractive, even without the grant.

Heating oil and natural gas are the traditional fuels for domestic heating; both of these fuels are heavily taxed with an energy tax and carbon dioxide tax.

The following graphics illustrates the current price relations for private households in Denmark, calculated in DKK/GJ inclusive of VAT.

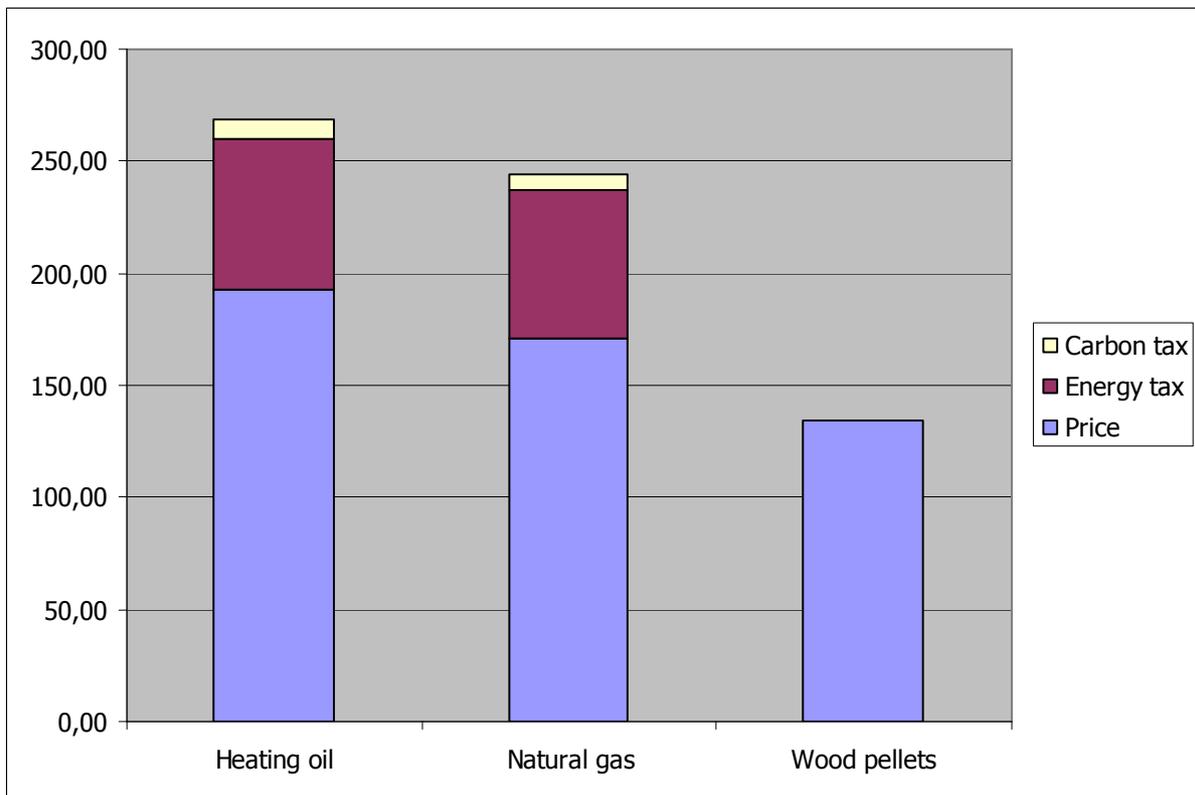


Figure 6: Price relations for residential heating fuels (DKK/GJ).

The VAT rate is 25 % for natural gas, heating oil and for pellets, so this is not an incentive.

Danish definition of biomass for energy purposes

In Denmark biomass is defined according to the Danish Act no. 638 of July 3 1997 on biomass waste. (Danish: Bekendtgørelse om biomasseaffald). It defines which types of solid biomass that can be used as a fuel and combusted in ordinary combustion plants. It includes waste from agriculture, forestry and companies working with biomass such as sawmills and furniture manufacturers. Any type of biomass or mix of biomass that is not mentioned in the annex to the act is defined as waste and must be handled and approved according to the EU Waste incineration directive in terms of temperature and retention time in an incineration plant. Furthermore, a waste tax is due.

The figure below gives details on how biomass is defined in Act no. 638.

Table 3: Appendix to the Danish Act. No 638 on biomass waste. Only these types of biomass can be used as fuel and converted in ordinary combustion systems.

1	Raw wood , including bark, forest wood chips and untreated milled chips	9	Untreated grain and seeds
2	Clean wood , including shavings and saw dust, not containing adhesives, lacquer, paint, varnish, impregnants (besides any mill stamps etc.), foil, laminates, nails, screws, fittings, etc.	10	Untreated cotton and flax
3	Wood waste from the production and treatment of clean, laminated wood, with an adhesive content (phenol-resorcinolresin, polyvinyl acetate resin, urea-formaldehyde resin, polyurethane resin, and melamine-urea-formaldehyde resin) not exceeding 1% on dry weight basis.	11	Lolly sticks with a content of paraffin approved for use in foods not exceeding 1% on dry weight basis.
4	Straw (including baling cord from straw bales)	12	Green pellets (dried grass, clover etc.)
5	Kernels and seeds from fruits and berries.	13	Malt
6	Fruit residues (dry parts of fruits)	14	Thatched roofing
7	Nut and seed shells (including grain and seed screenings)	15	Tobacco waste in the form of whole or broken tobacco leaves, tobacco stalks, etc.
8	Untreated cork	16	Fuel pellets or fuel briquettes produced exclusively from wastes in this attachment.

Danish emission thresholds for combustion of wood pellets

The emission thresholds that apply to combustion of wood pellets in Denmark are the same as for other biomass defined in the above mentioned ministerial order. The thresholds are defined in a number of different ministerial orders and a guide from the EPA. The thresholds have been compiled in a comprehensive table covering all thresholds for all sizes of conversion plants. The table is available in appendix A.

8. Projections on future development

The Danish wood pellet market will grow significantly in the years to come.

The demand in the residential sector can be expected to increase due to high fossil fuel prices and high energy taxes. However, in the long run, the total market for heating is limited. Some of this development will take place in larger heating systems, and in the commercial and industrial sector that has only recently seen stronger interest for renewable energy fuels.

The present large scale consumption level of approx. 0.35 million tonnes is expected to increase steeply in the coming years. This is based on the increased biomass obligation (extra 700,000 tonnes) for the power companies to meet Denmark's current need to reduce significantly the CO₂-emission.

At the district heating-plants the present consumption of around 0.1 million tonnes/year can be expected to slowly decrease in favour of other wood fuels.

On the production side the raw material is currently the critical point. Some producers have made their production ready to convert wood-logs. There is a growing interest in new technologies with which primary wood resources could be pelletized.

9. Summary and conclusions

With an annual wood pellet consumption of around 1,100,000 tonnes and a population of 5.5 million, the per capita wood pellet consumption in 2008 almost reached 200 kg per person. Although this figure provides evidence for the mature character of the Danish pellet market, there is still a high potential for the market to grow.

The growth will take place in the residential sector and especially in the utility sector where wood pellet co-firing seems to be a quick and economic way of meeting RES targets.

Growth in the Danish wood pellet market is expected to mainly be supplied via imported fuel.

10. Appendix A

Danish Emission Thresholds

Danish emission thresholds for energy plants February 2009

Input capacity		Fuel/plant type	Emission thresholds mg/m ³ (n,t)					
MW	approx. kg/h		Particles	SO ₂	NO _x	CO	UHC	
Above 0,120 and less than 0,3 <small>* threshold values change at 0,15 MW * Input capacity calculated as natural gas</small>	8 - 20	LPG-gas			140	80		
	9 - 23	Natural gas			65/125*	75		
	10 - 25	Gas oil			110/250*	100		
		Fuel oil						
	30 - 75	Wood and biofuels	150			2500/1200*	100	
	17 - 43	Coal	125			2500/1200*	100/80*	
	30 - 75	Straw	150*			2500/1200*		
	9 - 23	Gas engines*			550	500	1.500	
	9 - 23	Gas turbines*			200	150		
		20 - 65	LPG-gas			140	80	
Above 0,3 and less than 1	23 - 70	Natural gas			65/125*	75		
	25 - 80	Gas oil			110/250*	100		
		Fuel oil						
	75 - 260	Wood and biofuels	300			500		
		Coal						
	75 - 260	Straw						
	23 - 70	Gas engines*			550	500	1.500	
	23 - 70	Gas turbines*			200	150		
		65 - 130	LPG-gas			140	80	
		70 - 140	Natural gas			65	75	
Above 1 and less than 2	80 - 160	Gas oil			110	100		
		Fuel oil			-			
	260 - 520	Wood and biofuels	40/(100) [†]			625		
	260 - 520	Coal	40			625		
		Straw						
	70 - 140	Gas engines*			550	500	1.500	
	70 - 140	Gas turbines*			200	150		
		130 - 325	LPG-gas			140	80	
		140 - 360	Natural gas			65	75	
		160 - 400	Gas oil			110	100	
Above 2 and less than 5	175 - 440	Fuel oil	100		300	100		
	520 - 1300	Wood and biofuels	40/(100) [†]			625		
	520 - 1300	Coal	40			625		
		Straw						
	140 - 360	Gas engines*			550	500	1.500	
	140 - 360	Gas turbines*			200	150		
		325 - 1600	LPG-gas			140	80	
		360 - 1800	Natural gas			65	75	
		400 - 2000	Gas oil	30		110	100	
		440 - 2200	Fuel oil	100		300	100	
Above 5 and less than 25	1300 - 6500	Wood and biofuels	40/(100) [†]		300	625		
	1300 - 6500	Coal	40		300	625		
	720 - 3600	Straw	25		200	100		
	360 - 1800	Gas engines*			550	500	1.500	
	360 - 1800	Gas turbines*			200	150		
		1600 - 3200	LPG-gas			140*	80	
		1800 - 3600	Natural gas			65 *	75	
		2000 - 4000	Gas oil	30		110*	100	
		2200 - 4400	Fuel oil	100		300*	100	
		6500 - 13000	Wood and biofuels	40/(100) [†]	*	300	625	
Above 25 and less than 50 <small>* For power generating companies quotes apply</small>	6500 - 13000	Coal	40	*	300*	625		
	3600 - 7200	Straw	25	*	200*	100		
	1800 - 3600	Gas engines*		*	550*	500	1.500	
	1800 - 3600	Gas turbines*		*	200*	150		
		> 3200	LPG-gas	5	5	100-150		
		> 3600	Natural gas	5	5	100-150		
		> 4000	Gas oil	30 - 50	200 - 1700	200 - 450		
		> 4400	Fuel oil	30 - 50	200 - 1700	200 - 450		
		> 13000 [‡]	Wood and biofuels	30 - 50	200	200-650		
		> 7200	Coal	30 - 50	200 - 2000	200-650		
	> 3600	Gas engines*		*	550*	500	1.500	
	> 3600	Gas turbines*		*	50 - 120	150		

Reference is 10% O₂ according to the EPA guideline no. 2/2001 and the Ministry of the Environment Order no. 1402 of 2007-12-11. No threshold value applies.
 Reference 5% O₂ according to the Ministry of the Environment Order no. 621 of 2005-06-20. These fuels can not be used in these plants according to EPA guideline no. 2/2001.
 Reference 2% O₂ according to the Ministry of the Environment Order no. 808 of 2003-09-25. It is governed by the Ministry of the Environment Order no. 2663 of 2006-12-14.
 Reference 8% O₂ according to the Ministry of the Environment Order no. 808 of 2003-09-25. Reference 15% O₂ according to EU Directive.
 † Figures in parenthesis apply for condensing plants and dry biomass. ‡ Does not apply to straw fired plants in rural zones. * The higher value applies for plants older than 2001.
 Reference: FORCE Technology - Telephone 7215 77 00 - info@force.dk