

Firewood consumption in Denmark 2009

A study of the number of, and the firewood consumed in,
wood stoves, fireplaces, masonry stoves and logwood boilers in Danish homes and holiday homes

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October 2010

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Background

In 2006, a study of firewood consumption in Denmark in 2005 was carried out using a newly developed method for the first time. The purpose of the new method was to improve the somewhat uncertain method used so far. The new method revealed that the extent of firewood consumption had up to then been considerably underestimated.

As a follow up to the 2006 study, the Danish Energy Agency has decided to carry out similar studies of Danish firewood consumption every second year. This study describes the results of the collection of new data on firewood consumption in Denmark in 2009.

The scope of the study

This study was performed from May to August 2010. The work, financed by the Danish Energy Agency, was carried out by Anders Evald, project manager, from FORCE Technology, in cooperation with Lars Nikolaisen from the Aarhus division of the Danish Technological Institute. Furthermore, an external bureau was used to perform telephone interviews with private consumers of firewood.

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An interview study was carried out in which an appropriate number of private consumers of firewood for heating were asked about their consumer habits in telephone interviews. The study itself was performed by a subcontractor, while those actually responsible for the project decided the overall framework for the study.

At the request of the Danish Environmental Protection Agency (Danish EPA), and financed by the Danish EPA, this year's study includes a number of additional questions to analyse the stock of woodstoves and logwood boilers (konsekvensrettes hele vejen igennem) in Denmark with regard to their age as well as labelling with the Nordic 'Swan' ecolabel.

Dissemination of the results of the study includes this report for the Danish Energy Agency, which as usual has been published on the Agency's website. In addition, direct information has been provided for interested players such as the Danish EPA, chimney sweeps, forestry etc. Furthermore an article has been prepared about the study and its results. This report comprises the complete documentation of the study.

Summary

The statement of firewood consumption in Denmark for the year 2009 is based on a method that was developed in 2006. A total of 2,027 people have replied to questions in telephone interviews.

The total consumption of firewood in Denmark in 2009 was 25.059 PJ (vigtig rettelse . ikke , på engelsk!). Uncertainty is about +/- 2.5 PJ.

Interview study 2010

An interview study of private firewood consumption for heating has been carried out.

Method

Randomly selected individuals in Denmark were contacted over the telephone by a market research bureau and asked about their consumption of firewood for wood-burning stoves, wood-burning boilers etc. The consumers' information about their firewood consumption was converted into energy units and then scaled up to cover all of Denmark, based on statistical figures on the Danish housing stock.

Supplier

Telephone numbers were selected and telephone interviews carried out by

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Scope

The sample was taken from the SCI database by Jysk Analyse A/S. The basic material is from NN Markedsdata and it contains a database of all private households with a landline telephone in Denmark, as well as a database of private households which can only be contacted by mobile phone. Business addresses are not included. Sample selection followed a carefully planned pattern to ensure equal distribution of Danish households, irrespective of whether the household has a landline phone, mobile phone, or both. This is different from the 2005 and 2007 studies, when only landline telephones were included.

Out of a total of 3,000 telephone numbers, it was possible to make contact with 2,511 after up to eight attempts. Of the 2,511 households, 2,027 agreed to take part.

None of the respondents gave answers that were so inconsistent in substance that they could not be included in the study's analyses. The study therefore comprises a total of 2,027 respondents. This is about twice as many as the two previous studies.

Questions

The questions for the interviews were prepared by the project management and verified for practicability by Jysk Analyse. The interviews proper were carried out by Jysk Analyse's consultants after thorough prior briefing about the objective and method of the study.

For details about performance of the interviews, see annex 1.

The interviews

The question framework for the interviews has been reproduced in annex 2, while annex 3 is a copy of the specific instructions/explanations given to the interview firm by FORCE Technology

The answers of the respondents were noted down in Jysk Analyse's own CATI system. Data were then extracted from here to an Excel file, after which data were processed by FORCE Technology.

Respondents were not asked about their consumption in a specific year, so it must be assumed that their answers concern their consumption in the nearest preceding heating season, 2009/2010. The results were used as consumption figures for the year 2009 in the energy statistics, but this inaccuracy in time is deemed to have minimal significance.

Results

The figures in this section are stated with the number of significant figures resulting from the calculations. Therefore, the accuracy of the results has not been taken into consideration.

Respondents

Of the 2,027 respondents, 571 have one or more wood-burning stoves, masonry stoves, fireplaces or wood-burning boilers in their home or holiday home, see table 1.

	2009		2007		2005	
	No. resp.	Per cent	No. resp.	Per cent	No. resp.	Per cent
One or two firewood-consuming appliances in the home or holiday home	571	28.2%	308	32.0%	224	21.5%
Do not have firewood-consuming appliances	1456	71.8%	656	68.0%	818	78.5%
Total respondents	2027	100.0%	964	100.0%	1042	100.0%

Table 1 Percentage of respondents with firewood-consuming appliances

Respondents with more than one appliance

Some respondents, 50 in total, have more than one firewood-consuming appliance, see table 2.

Respondents with more than one appliance confuse the otherwise simple analysis of the figures. Since the statement is ultimately made by multiplying unit consumption by the numbers of appliances, we have decided to deal with information from these respondents by focusing on the number of appliances; not the number of households.

	Number of respondents	Number of appliances
Have two or three wood-burning stoves in the home	3	7
Have a wood-burning stove or a fireplace in the home	3	6
Have a wood-burning stove or a wood-burning boiler in the home	3	6
Have a wood-burning stove both in their home and in their holiday home	25	50
Have other combinations	16	38
Total	50	107

Table 2 Statement of respondents with more than one appliance

Respondents were asked separately about consumption at their homes and in their holiday homes so that consumption information for these consumers could be included without problems regarding breaking down consumption by the appliance. For other combinations, unit consumption was only included if the appliances were the same (e.g. two wood-burning stoves in the home). Consumption information for these respondents was divided equally between appliances, so that unit consumption was calculated per wood-burning stove. If the appliances were different, for example a wood-burning stove and a wood-burning boiler, data concerning the size of their consumption were omitted from the calculations.

Appliances

The 628 appliances that were in the homes of a total of 571 respondents, break down into the following different types in table 3.

	2009		2007		2005	
	No. appliances	Per cent	No. appliances	Per cent	No. appliances	Per cent
Wood-burning stoves in homes	448	71.3%	209	60.8%	166	69.2%
Fireplaces or masonry stoves in homes	59	9.4%	19	5.5%	17	7.1%
Wood-burning boilers in homes	24	3.8%	36	10.5%	20	8.3%
Wood-burning stoves in holiday homes	90	14.3%	80	23.3%	37	15.4%
Fireplaces or masonry stoves in holiday homes	6	1.0%				
Wood-burning boilers in holiday homes	1	0.2%				
Total	628	100.0%	344	100.0%	240	100.0%

Table 3 Firewood-consuming appliances by type

Understanding of the concept of a cubic metre

Firewood consumption is traditionally calculated in units of volume: cubic metres of stacked wood or cubic metres (m^3). However, perceptions and definitions of what constitutes a cubic metre of stacked wood differ among individuals, forestry professionals and firewood dealers.

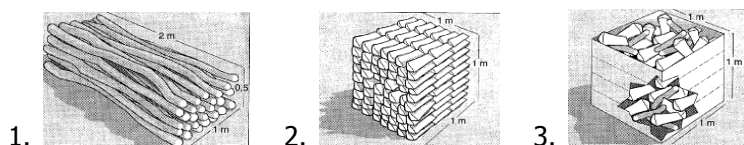
Individuals tend to use the concepts of "cubic metres" and "cubic metres of stacked wood" randomly. Respondents were therefore asked questions without using the more stringent distinction made by forestry professionals, who distinguish between "cubic metres" perceived as a solid volume of wood and "cubic metres of stacked wood" perceived as a stacked or loose volume of wood, including any air between the individual pieces of wood.

After this, an important part of the interview deals with following up the respondents' information about consumption of firewood with a question on what the respondent actually means by m^3 . There is a very big difference in density and therefore energy content depending on whether a respondent is talking about "cubic metres of wood stacked in forestry", "cubic metres of sawn, chopped and stacked wood", or "cubic metres of box-stacked (jeg er usikker på, om denne oversættelse af kasserummeter er korrekt; jeg kan ikke umiddelbart finde et bedre udtryk. Men det danske begreb kasserummeter indebærer at brændet ligger hulter til bulter, og altså netop IKKE er stacked) wood".

Therefore, as well as giving information on the consumption in cubic metres, respondents were asked which of the different types of cubic metres they had in mind when they answer the question:

Now, there are different ways to state volumes of firewood, so I want to make sure which type of cubic metre applies to your consumption. We use three categories; "cubic metres of wood stacked in forestry", "cubic metres of sawn, chopped and stacked wood", and finally "cubic metres of box-stacked wood".

The options are illustrated below for the interviewer:



The question regarding consumption at home and at people's holiday homes was asked separately in the 2009 study, while this distinction was not made in the previous studies. Table 4 shows the total for homes and holiday homes for 2009.

Understanding of cubic metre	2009		2007		2005	
	No. respondents	Per cent	No. respondents	Per cent	No. respondents	Per cent
Cubic metres of wood stacked in forestry	93	28.7%	64	28.7%	84	54.9%
Sawn, chopped and stacked	196	60.5%	126	56.5%	47	30.7%
Box-stacked firewood	35	10.8%	33	14.8%	22	14.4%
Total	324	100.0%	223	100.0%	153	100.0%

Table 4 Summary of respondents' understanding of the concept of a cubic metre

A total of 84% of the respondents who were able to give their consumption in terms of cubic metres could also account for their understanding of a "cubic metre".

In addition to stating their consumption as a number of cubic metres, with an associated explanation of what type of cubic metre, respondents were also asked to state firewood consumption as number of pallets of stacked firewood.

Unit consumption

On the basis of respondents' replies about their understanding of a cubic metre of firewood, the individual consumption figures were converted to a common unit: namely Giga Joules (GJ). The following calorific values have been used in the conversion.

Firewood measurements	Calorific value	Unit	Assumptions
Cubic metres of firewood stacked in forestry	5.94	GJ/cubic metre stacked wood	Mixed deciduous (68%) and coniferous (32%)
Sawn, split and stacked firewood	7.40	GJ/cubic metre stacked wood	Mixed deciduous (68%) and coniferous (32%)
Box-stacked firewood	4.39	GJ/cubic metre stacked wood	Mixed deciduous (68%) and coniferous (32%)
Pallet of stacked firewood	15.96	GJ/pallet unit	Pure deciduous (100%), 2.1 cubic metres of sawn, split and stacked wood per pallet unit.

Table 5 Assumptions for calorific value per cubic metre for different types of cubic metre

In the above, the calorific value of one cubic metre solid volume of wood has been calculated at 10.4 GJ/m³ for deciduous and at 7.6 GJ/m³ for coniferous, in accordance with previous calculations in the Danish Energy Agency's statistics. It has been assumed that firewood consumption breaks down into deciduous and coniferous wood, as in forestry's annual statement of firewood sales to Statistics Denmark (in 2004, this figure was 289,800 m³ deciduous and 136,900 m³ coniferous). This does not apply to pallets of stacked firewood, however, which are assumed to consist of 100% deciduous.

Unit consumption is subsequently calculated for the respondents who were able to provide an answer on the size of their consumption and the type of firewood measurement unit they applied in giving this answer. Respondents who replied that they do not use firewood in their wood-burning stove/wood-burning boiler are included with a consumption of 0.

Average unit consumption per appliance is determined by adjusting for respondents with more than one appliance. Consumers who cannot state their consumption or who cannot explain how they understand a cubic metre, have not been included in the determination of average unit consumption.

The average unit consumption for wood-burning stoves, fireplaces and masonry stoves in private homes is 31.04 GJ, based on valid replies from 298 respondents. This is slightly higher than in previous studies: 26.56 GJ (178 valid respondents) in 2007 and 26.59 GJ (113 valid respondents) in 2005. The higher unit consumption could be ascribed to statistical uncertainty (see annex 5) or to the fact that the heating season 2009/2010 was somewhat colder than in previous years, meaning consumers use more firewood.

Unit consumption of firewood analysed by the individual appliances in homes is shown in figure 1.

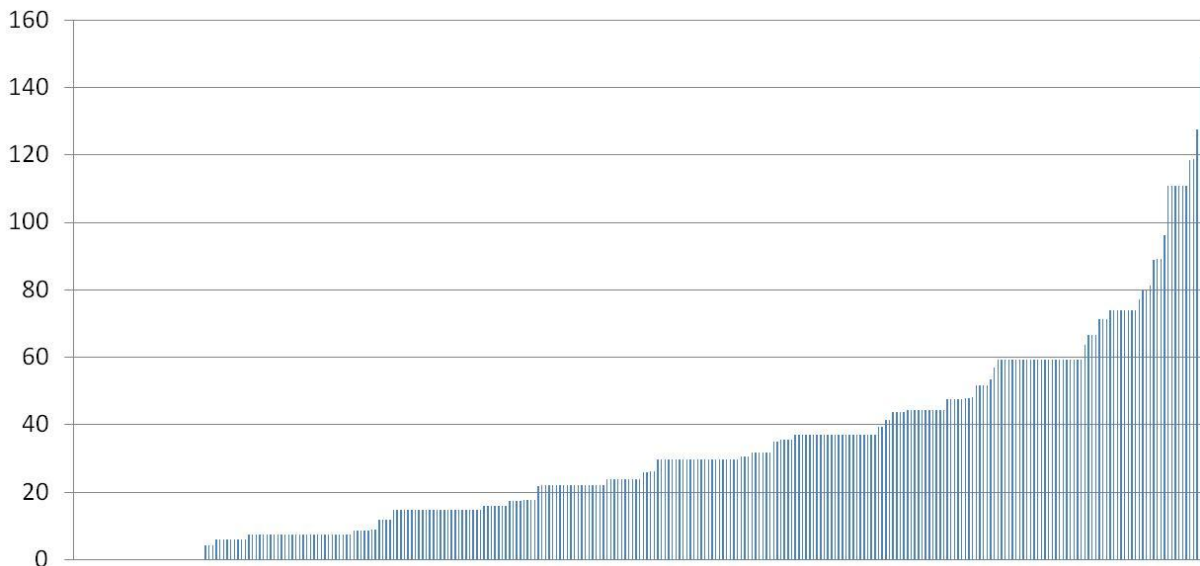


Figure 1 Distribution curve of firewood consumption in 312 appliances in the homes of 298 consumers; consumption has been calculated in GJ; appliances include wood-burning stoves (90%) as well as fireplaces and masonry stoves (10%), but not wood-burning boilers.

Average unit consumption for wood-burning boilers was 116.60 GJ from 18 respondents with a valid reply, which corresponds nicely with 110.17 GJ from 25 respondents with valid replies in the 2007 study. The results for both studies were somewhat less than the 2005 study, in which the figure was 148.76 GJ, but only based on 13 valid replies. The wood-burning boilers category has been calculated as the total for homes and holiday homes as there are only a few wood-burning boilers in holiday homes (1 respondent in the 2009 study).

The average unit consumption for wood-burning stoves in holiday homes is 14.24 GJ, based on valid replies from 68 respondents. The figure for the 2007 study was 10.63 GJ on the basis of valid replies from 69 respondents, and in the 2005 study the figure was 15.22 GJ, based on valid replies from 23 respondents.

Number of appliances and consumption

The number of firewood-consuming units in Denmark is calculated on the basis of figures from Statistics Denmark on the number of homes etc. in Denmark. The figures are from StatBank Denmark and concern the year 2009, see table 6.

Homes and holiday homes	No.
Number of inhabited homes in Denmark, Statistics Denmark, StatBank Denmark, 2009	2 548 240
Number of vacant homes in Denmark, Statistics Denmark, StatBank Denmark, 2009	187 246
Number of holiday homes in Denmark, Statistics Denmark, StatBank Denmark, 2009	198 069

Table 6 Statement of housing used to calculate total stock. Holiday homes used as permanent homes are included in the figure for inhabited homes. Holiday homes used as permanent homes are therefore not included in the figure for holiday homes.

The total number of the various types of firewood-consuming units is then calculated from their percentage share in the interview study (for example, for wood-burning stoves/fireplaces/masonry stoves in inhabited homes defined as $((448+59)/2027 = 25.01\%$, see tables 1 and 3). In this way, the figure in the column "percentage" is calculated so that the calculation of total number of appliances is adjusted for respondents who have two appliances. Finally, the figure is multiplied by unit consumption to reveal Denmark's domestic consumption of firewood, table 7.

	Basis	Percent	Number of units	Unit cons. GJ	Consumption (TJ)
Wood-burning stoves in inhabited homes (including fireplaces/masonry stoves)	2 548 240	25.01%	637 374	31.04	19 784
Wood-burning stoves in vacant homes in Denmark	187 246	25.01%	46 835	-	-
Wood-burning stoves in Danish holiday homes	2 548 240	4.44%	113 143	14.24	1 611
Wood-burning boilers in private homes	2 548 240	1.23%	31 429	116.60	3 665
Total					25 059

Table 7 Total number of appliances and consumption of firewood in Denmark 2009

Thus, there is a total of 637,374 wood-burning stoves in inhabited homes in Denmark. Furthermore, there are 46,835 wood-burning stoves in homes, which according to Statistics Denmark's method are defined as "vacant". These are not included in the following. In addition to this, there are 113,143 wood-burning stoves in holiday homes, so that the total number for all of Denmark amounts to **750,518** wood-burning stoves.

The number of wood-burning stoves in holiday homes is calculated on the basis of answers from respondents in inhabited homes, since only inhabited homes, and not holiday homes, were contacted in the interview study.

In 2009, total firewood consumption in Denmark was therefore 25,059 TJ, broken down as in figure 2.

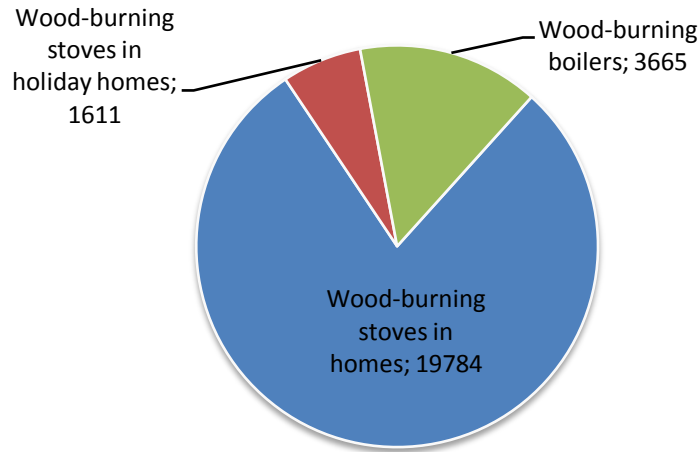


Figure 2 Firewood consumption in 2009 in TJ

Origin of firewood

Calculations in the study of where Danish firewood consumers get their firewood gave the following result, see table 8.

Origin	2009		2007		2005	
	No. resp.	Per cent	No. resp.	Per cent	No. resp.	Per cent
1) Wood from private gardens, windbreaks and similar	283	49.6%	99	35.5%	104	47.7%
2) Pure waste wood from sawmills, the timber industry, joineries etc.	15	2.6%	18	6.5%	20	9.2%
3) Bought directly from the forest, e.g. via a license to gather deadwood or from forest firewood sites.	128	22.5%	80	28.7%	57	26.1%
4) Pallets of stacked firewood, delivered or picked up (these are very popular in Denmark and can be delivered directly to your house)	31	5.4%	22	7.9%	12	5.5%
5) Other suppliers of firewood, e.g. do-it-yourself retailers, filling stations, farmers or firewood sites outside the forest	98	17.2%	54	19.4%	18	8.3%
6) Mostly burn other materials than firewood (used wooden items, pallets, packaging, demolition timber, furniture etc.)	15	2.6%	6	2.2%	7	3.2%

Table 8 Origin of firewood, stated on the basis of consumers' assessment of the primary way they obtain firewood

In the latest study, respondents were asked separately about the origin of firewood for their home and the origin for their holiday home. In the 2005 and 2007 studies this question did not distinguish between the two. A total of 480 of the 515 respondents with firewood-consuming appliances in their homes, and 90 of the 94 respondents with firewood-consuming appliances in their holiday homes answered this question. In table 8, the figures for homes and holiday homes have been added together.

According to this latest study of the source of consumers' firewood, the factor of 3.00 (see the section on methodology) should be 4.45 (in that 22.5% of the firewood consumed is stated to have been bought as firewood directly from the forest). This factor-based method, based on logging statistics from forestry, is no longer used, partly because the 2005 study revealed that the factor-based method

is far more uncertain than the new method, which has been applied since 2005. For a more detailed description of the old method, and a discussion of the uncertainty it entails, see the memorandum on methodology in the references.

Imports

In order to determine the percentage of Danish consumption of firewood which is imported, a sample of significant importers and other market stakeholders in the firewood market were contacted. On the basis of figures from these telephone calls, an estimate was made of the percentage of imports in Danish consumption. A more detailed reasoning behind this estimated imports figure is in annex 4.

The percentage of firewood imported in 2009 is estimated at 8%, corresponding to 2,005 TJ.

This figure is a qualified estimate based on the assumption that about 100% of pallets of stacked firewood, which accounts for about 6% of the firewood market, are imported, and that an estimated percentage of firewood processed from whole logs is also imported (estimated on the basis of interviews with importers).

Age, labelling and accumulation tanks

In connection with the 2009 study, the Danish Environmental Protection Agency has had a number of additional questions included to illustrate the composition of the stock with regard to age, Swan labelling or lack thereof, and whether boilers are equipped with accumulation tanks.

See the questionnaire in annex 2.

Ages of wood-burning stoves and fireplaces/masonry stoves are stated in table 9.

Age	Before 1985		From 1985 to summer 2008		After summer 2008	
	No. resp.	Per cent	No. resp.	Per cent	No. resp.	Per cent
Wood-burning stoves etc. in homes	121	26.6%	274	60.2%	60	13.2%
Wood-burning stoves etc. in holiday homes	24	28.2%	50	58.8%	11	12.9%
Total wood-burning stoves etc.	145	26.9%	324	60.0%	71	13.1%

Table 9 Age of wood-burning stoves, fireplaces and masonry stoves in Denmark in 2009. The analysis is based on replies from respondents. Approximately 90% are wood-burning stoves, the rest are fireplaces/masonry stoves.

Ages of wood-burning boilers are stated in table 10. Note that there is considerable uncertainty because of the limited number of boilers.

Age	Before 1980		After 1980	
	No. resp.	Per cent	No. resp.	Per cent
Wood-burning boilers	6	25.0%	18	75.0%

Table 10 Age of wood-burning boilers in Denmark in 2009. The figures apply for appliances in homes and holiday homes together (only one respondent has a boiler in a holiday home).

Numbers of Danish wood-burning stoves with a Swan label are summarised in table 11.

Swan-labelled wood-burning stoves	Labelled		Not labelled	
	No. resp.	Per cent	No. resp.	Per cent
Wood-burning stoves etc. in homes	105	37.0%	179	63.0%
Wood-burning stoves etc. in holiday homes	20	34.5%	38	65.5%
Total wood-burning stoves etc.	125	36.5%	217	63.5%

Table 11 Percentage of Danish wood-burning stoves labelled with the Swan label

Finally, respondents were asked whether their wood-burning boilers were equipped with accumulation tanks. The result here was that 14 out of 23 respondents, 60.9%, have accumulation tanks for their wood-burning boilers, while 9 out of 23 respondents, 39.1%, do not. Appliances in homes and holiday homes have been added together in this statement. Note that there is considerable uncertainty due to the small number of replies.

Methodology

The old method

Up to and including 2004, consumption of firewood in Denmark in the official energy statistics issued by the Danish Energy Agency was determined using a method developed around 1990.

This method was based on the only figure for firewood in Denmark stated in other statistics, namely forestry logging data broken down by forestry product, including firewood.

Assuming that only part of Danish firewood consumption is recorded in logging statistics, forestry figures were used as an indicator of consumption and the statistics were multiplied by a factor which compensated for the amount of firewood consumption obtained from other sources (private hedges and gardens, holiday home gardens, trees along railways, parks, along roads, and residues from the wood industry etc.).

From the mid 1990s and up to 2004, forestry logging figures have been multiplied by 3.00, as one-third of firewood was assumed to originate from forests.

This factor was determined on the basis of three studies carried out in the early 1990s: "Omnibus 1992", "Omnibus 1994" and "Det åbne land". In the three studies, individuals were asked, among other things, about their firewood consumption, including questions about where they get their firewood. The result of these studies was, roughly speaking, that one in three consumers buy their firewood in the forest, giving rise to the factor 3.00.

Further documentation for the method used previously is in the memorandum of methodology, which summarises the Danish Energy Agency's methods for providing data on biomass in the energy supply. The memorandum of methodology for firewood, and corresponding memos for straw, wood chips, wood pellets and wood waste is available (in Danish) on the Danish Energy Agency website.

It was always clear that the method was subject to extreme uncertainty. Furthermore, a study carried out by the Danish Technological Institute in 2005, revealed new figures, which were based chiefly on data from chimney sweeps and which indicated a larger consumption of firewood than previously assumed. Therefore, in 2006, a comparison of the different studies was performed, and a new method was developed which involved asking a larger number of firewood consumers directly about their firewood consumption.

After completion of this interview study in 2006, it was concluded that, even though the new method is also associated with uncertainty, it is far better than the previous method, and also better than the study based on data from chimney sweeps by the Danish Technological Institute.

Collaboration with chimney sweeps

Skorstensfejlerlauget (a Danish association of chimney sweeps) was involved in work on several studies of use of firewood conducted by the Danish Environmental Protection Agency in 2005 and the Danish Energy Agency in 2005, 2007, and 2009. In 2005 in particular, Lars Nikolaisen from the Danish Technological Institute worked closely with Khi-Data in Fredericia, which for a time administered the Skorstensfejlerlauget's records. Individual master chimney sweeps' records of fireplaces etc. were stored in various ways by Khi-Data, some online, others not online.

The registers of fireplaces etc. are the basis for day-to-day planning by chimney sweeps. There is no single register from which it is possible to extract data across districts. For example some master sweeps record the number of work operations in a cleaning job rather than the number of fireplaces. Neither is there uniform nomenclature for the various types of fireplace etc.; a stoker can be for coal, wood pellets or corn, and it is not possible see what type of appliance is being recorded, e.g. whether it is a through-draft boiler, a down-draft boiler or some other type. The conclusion in 2005 was that it was not possible to compile statistically reliable figures for the number of appliances, the firing technology, or the fuel used, on the basis of the chimney sweeps' records.

By having chimney sweeps keep records on a uniform form through a nationwide survey, reliable data could be obtained on the location of fireplaces etc., output in kW, type of fuel etc. A proposal for such a common registration system was drawn up in 2005, see annex 6. According to this, it would be possible to carry out a consumption study for any type of fuel or firing technology. If data on firing technology and fuel used were recorded by property number, it would be possible to conduct statistically reliable telephone interviews or collect information some other way.

Such data material could be used by:

1. The Danish Building and Housing Register for accurate information about type of heating in the individual property.
2. The Danish Energy Agency for statements of energy consumption and type of fuel.
3. The National Environmental Research Institute for calculations of spread (immission).
4. Chimney sweeps for accurate records of fireplaces etc.
5. Statistics Denmark. Number of boilers, wood-burning stoves etc.

In June 2010 this was discussed with the Skorstensfejlerlauget and on the basis of the framework in annex 6, the board estimated that it would cost about DKK 90 (EUR 1.2) per property to change and extend the current registration system. With 0.7 mill. wood-burning stoves in Denmark, this system for all properties would cost about DKK 60 mill. (EUR 8 mill.).

Extraction and size of sample

The 2007 study revealed a surprisingly high increase in firewood consumption in Denmark, giving rise to an analysis of the methodology and the uncertainty linked to the size of the sample (no. of respondents) in particular, and the method of sample extraction (representation of a Danish household through a telephone number). For a more detailed discussion of these issues, see the report on the 2007 study.

With this background, for the 2009 study two changes were introduced, which together should result in a more accurate study:

- The sample was extended from the previous about 1,000 respondents and 300 firewood consumers to about twice as many; about 2,000 respondents and about 600 firewood consumers.
- Selection of respondents as random private persons with a landline telephone has been changed so that telephone numbers are more representatively distributed between mobile numbers and landline numbers.

Uncertainties

Annex 5 contains a report on the uncertainties in the study. There is still considerable uncertainty in the study, although less than previously and much better than that in other countries, where the Danish method appears robust compared with the very rough estimates which many countries continue to use.

Recommendation

We therefore suggest that the method applied here is also applied in future when determining firewood consumption in Denmark. Since the study is associated with expenses for the consultants and analysis institution, it would seem reasonable to conduct the study every other year and carry out a projection in intervening years, for example based on trends in firewood production data according to forestry statistics.

References

1. Firewood study for 2005
2. Firewood study for 2007
3. Memorandum of methodology on firewood
4. User survey for wood-burning stoves and solid fuel boilers. Carried out for the Danish Environmental Protection Agency by the Danish Technological Institute, August 2005. Rev 11.05.2006

Annex 1: Description of method from Jysk Analyse



Background

In 2006, a study of firewood consumption in Denmark in 2005 was carried out for the first time using a newly developed method. The purpose of the new method was to improve the somewhat uncertain method used so far, and at the same time examine whether a study performed by Lars Nikolaisen, the Danish Technological Institute, about consumer habits and emissions from wood-burning stoves in Denmark, could provide new data, including on the number of wood-burning stoves and the extent of firewood consumption in Denmark.

Therefore, a new method for calculating firewood consumption was developed and applied, revealing that the extent of firewood consumption had up to then been considerably underestimated.

As a follow up to the 2006 study, the Danish Energy Agency has decided to carry out similar studies of Danish firewood consumption in Denmark every second year. This study describes the results of the collection of new data on firewood consumption in Denmark in 2009/10 (the data was collected in June 2010 and respondents were asked about firewood consumption within the past 12 months).

Completion of the study

The study was performed as telephone interviews (CATI Computer Assisted Telephone Interviews) on the basis of the questionnaire attached as an annex. All telephone interviews were performed from our CATI call centre at Algade 31, 9000 Aalborg, Denmark from where our trained interviewers were instructed about the study and from where they made the calls.

Interviews with private households were carried out between 17.00 and 21.00 on weekdays and between 12.00 and 17.00 at the weekend. Eight calls were made to each selected phone number before the attempt was dropped.

This study was performed between 27 May and 10 June 2010. The gross sample was 3,000 telephone numbers, and of these it was possible to make contact with 2,511 after up to eight attempts. Of the 2,511 households, 2,027 agreed to take part. This gives a participation rate of 80.7%; an extremely satisfactory result for a study of this type.

Sample selection

The basis for sample selection was the SCI database. Every month Jysk Analyse A/S receives from NN-markedsdata a complete update of all private households with a landline phone number in Denmark as well as a database of private households which can only be contacted by mobile phone.

The SCI database contains about 2,270,000 households which can be contacted by either landline or mobile phones. The SCI database also contains street codes, post codes and municipality codes for almost all telephone numbers, meaning that regional samples can be selected within a limited area defined by post code or municipal code. In order to ensure uniform high quality, we always check that the respondent lives within the area for which we are carrying out a survey.

The RANDI™ program was used for sample selection from the SCI database.

Annex 2: Description of method from Jysk Analyse A/S



<< QUESTION 1 >>

Hello, my name is _____. I'm calling from Jysk Analyse. We are conducting a study for the Danish Energy Agency about use of wood-burning stoves, fireplaces and wood-fired boilers in Denmark.

In this regard your household has been selected and therefore I wonder if I could ask you a few questions.

Is that OK?

The interview only takes XX minutes and your replies will be kept confidential.

(INT: the respondent must be 15 years or older, so ask if you are in doubt.)

Will take part
Will not take part

<< QUESTION 2 >>

First I need to know whether at all you have a wood-burning stove, wood-burning boiler, fireplace or masonry stove in your home or holiday home?

No, neither at home nor in my holiday home -> end
Yes, at home
Yes, in my holiday home
Yes, both at home and in my holiday home

** Ask every respondent with a wood-burning stove or wood-fired boiler in their home **

<< QUESTION 3 >>

Have you got a wood-burning stove, fireplace, masonry stove or wood-burning boiler in your home?

(Fireplace insert = wood-burning stove)

Wood-burning stove
Fireplace or masonry stove
Wood-burning BOILER:

Has more than one (even if the same type)
Cannot answer:

*** IF MORE, THEN A3 ****

<< **Question A3** >>

Note type and number

Wood-burning stove
Fireplace or masonry stove
Wood-burning BOILER:

*** Ask every respondent with more than one type ***

<< **Question AA3** >>

Which unit do you use the most?

Wood-burning stove
Fireplace or masonry stove
Wood-burning BOILER

*** Ask every respondent with a wood-burning stove or wood-fired boiler in their holiday home ***

<< **QUESTION 4** >>

Have you got a wood-burning stove, fireplace, masonry stove or wood-burning boiler in your holiday home?

(Fireplace insert = wood-burning stove)

Wood-burning stove
Fireplace or masonry stove
Wood-burning BOILER

Has more than one (even if the same type)
Cannot answer

*** IF MORE, THEN A4 ****

<< **Question A4** >>

Note type and number

Wood-burning stove
Fireplace or masonry stove
Wood-burning BOILER

*** Ask every respondent with more than one type ***

<< **Question AA4** >>

Which unit do you use the most?

Wood-burning stove

Fireplace or masonry stove
Wood-burning BOILER

*** Ask every respondent with a wood-burning stove or wood-fired boiler in their home ***

<< QUESTION 1 in THE HOME >>

How much firewood does the "STOVE in your HOME" consume per year in cubic metres (or cubic metres of stacked wood)?

(if the respondent states an interval, note down the mean value)

Firewood consumption in m3
If you buy firewood on pallets (number of pallets)
Not used (approx. 0 m3)
Don't know

*** Ask every respondent who stated consumption in m3 ***

<< QUESTION 1 EXACT_ CONSUMPTION in THE HOME >>

You have now given your HOME's consumption of firewood in cubic metres (m3 - cubic metres of stacked wood).

Now, there are different ways to state volumes of firewood, so I want to make sure which type of m3 applies to your consumption.

We use three categories; "cubic metres of wood stacked in forestry", "cubic metres of sawn, chopped and stacked wood", and finally "cubic metres of box-stacked wood".

(The three options are illustrated for the interviewer: 1, 2 and 3)

Cubic metres of stacked wood from forestry (cubic metres of whole logs, usually two-metres long)
Cubic metres of sawn, split and stacked firewood in lengths of approximately 30 cm
Cubic metres of box-stacked wood (loosely stacked firewood of approximately 30 cm in length delivered in a box)
Don't know

<< QUESTION 2 EXACT_ CONSUMPTION in THE HOME >>

Where does the firewood for the "STOVE in your HOME" come from?

(ONLY one answer. If the firewood comes from more than one source, the most significant source should be ticked off.)

Wood from private gardens, windbreaks and similar
Pure waste wood from sawmills, the timber industry, joineries etc.
Bought directly from the forest e.g., via a license to gather deadwood or from forest firewood sites
Pallets of stacked firewood, delivered or picked up (these are very popular in Denmark and can be delivered directly to your house)
Other suppliers of firewood, for example, do-it-yourself retailers, filling stations, farmers or firewood sites outside the forest
Mostly burn other materials than firewood (used wooden items, pallets, packaging, demolition timber, furniture etc.)

Don't know

*** Ask Question 2 to every respondent with a wood-burning stove, fireplace or masonry stove ***

<< QUESTION 2 in THE HOME >>

Is the "STOVE" in your HOME older than from 1985?

Before 1985
After 1985
Don't know

*** Ask every respondent with a wood-burning stove, fireplace or masonry stove manufactured after 1985 ***

<< QUESTION 3 in THE HOME >>

Was the "STOVE in your HOME" purchased after summer 2008 (June 2008)?

Yes, purchased after summer 2008
No, purchased before summer 2008

*** Only ask QUESTION 4 if the household has a wood-burning stove ***

<< QUESTION 4 in THE HOME >>

Does the wood-burning stove have a Swan label?

Yes
No
Don't know

*** Ask QUESTIONS 5 and 6 to every respondent with a wood-burning boiler ***

<< QUESTION 5 in THE HOME >>

Was the wood-burning boiler in your home manufactured before or after 1980?

Before 1980
Newer, manufactured after 1980
Don't know

<< QUESTION 6 in THE HOME >>

Does your wood-burning boiler have accumulation tanks?

- Yes
- No
- Don't know

*** Ask every respondent with a wood-burning stove or wood-fired boiler in their holiday home ***

<< QUESTION 1 in THE HOLIDAY HOME >>

How much firewood does the "STOVE in your HOLIDAY HOME" consume per year in cubic metres or cubic metres of stacked wood?

(if the respondent states an interval, note down the mean value)

- Firewood consumption in m³
- If you buy firewood on pallets (number of pallets)
- Not used (approx. 0 m³)
- Don't know

*** Ask every respondent who stated consumption in m³ ***

<< QUESTION 1 EXACT CONSUMPTION in THE HOLIDAY HOME >>

You have now given your HOLIDAY HOME's consumption of firewood in cubic metres (m³ - cubic metres of stacked wood).

Now, there are different ways to state volumes of firewood, so I want to make sure which type of m³ applies to your consumption.

We use three categories; "cubic metres of wood stacked in forestry", "cubic metres of sawn, chopped and stacked wood", and finally "cubic metres of box-stacked wood".

(The three options are illustrated for the interviewer: 1, 2 and 3)

- Cubic metres of stacked wood from forestry (cubic metres of whole logs, usually two-metres long)
- Cubic metres of sawn, split and stacked firewood in lengths of approximately 30 cm
- Cubic metres of box-stacked wood (loosely stacked firewood of approximately 30 cm in length delivered in a box)
- Don't know

<< QUESTION 2 EXACT CONSUMPTION in THE HOLIDAY HOME >>

Where does the firewood for the "STOVE in your HOLIDAY HOME" come from?

(ONLY one answer. If the firewood comes from more than one source, the most significant source should be ticked off.)

- Wood from private gardens, windbreaks and similar
- Pure waste wood from sawmills, the timber industry, joineries etc.
- Bought directly from the forest e.g., via a license to gather deadwood or from forest firewood sites
- Pallets of stacked firewood, delivered or picked up (these are very popular in Denmark and can be delivered directly to your house)
- Other suppliers of firewood, for example, do-it-yourself retailers, filling stations, farmers or firewood sites outside the forest.
- Mostly burn other materials than firewood (used wooden items, pallets, packaging, demolition timber, furniture etc.)
- Don't know

<< QUESTION 2 in THE HOLIDAY HOME >>

Was the "STOVE in your HOLIDAY HOME" manufactured before or after 1985?

- Before 1985
- After 1985
- Don't know

*** Ask every respondent with a wood-burning stove, fireplace or masonry stove manufactured after 1985 ***

<< QUESTION 3 in THE HOLIDAY HOME >>

Was the "STOVE in your HOLIDAY HOME" purchased after summer 2008 (June 2008)?

- Yes, purchased after summer 2008
- No, purchased before summer 2008

<< QUESTION 4 in THE HOLIDAY HOME >>

Does the wood-burning stove in your holiday home have a Swan label?

- Yes
- No
- Don't know

*** Ask QUESTIONS 5 and 6 to every respondent with a wood-burning boiler ***

<< QUESTION 5 in THE HOLIDAY HOME >>

Was the wood-burning boiler in your holiday home manufactured before or after 1980?

- Before 1980
- After 1980
- Don't know

<< QUESTION 6 in THE HOLIDAY HOME >>

Does your wood-burning boiler have accumulation tanks?

- Yes
- No
- Don't know

<< QUESTION 23 BACKGROUND >>

May I ask your age?

Note age:
Will not answer:

<< QUESTION 24 BACKGROUND >>

What is your postcode?

Note postcode:
Will not answer:

<< QUESTION 99 >>

I have no further questions

Thank you for your help.

Have a nice evening

Note sex

-
- Man
 - Woman

Annex 3: Supplementary information for interviewers

A short description of a wood-burning boiler and how it differs from a wood-burning stove

The wood-burning stove is placed in the living room and has no connection to the rest of the heating system in the house (only very few will have a built-in water tank which is connected to the heating system). The heat is emitted to the room via the hot surface of the stove.

A fireplace is often built into a wall and works according to the same principle as the stove. The heat is primarily radiated to furniture and people in the room.

A masonry stove can constitute the main source of heating in a house and functions as a wood-burning stove in that the heat is absorbed by the masonry and then slowly released to the room during the day.

A wood-burning boiler is the main source of heating, it is placed in a boiler room and heats up the water in the radiators positioned in the individual rooms of the house. It also heats the hot water used in the bath/shower and the kitchen.

Rules of thumb concerning consumption; a guide to interviewers

The expected firewood consumption:

Wood-burning stove/fireplace in a holiday home: 2-3 cubic metres of stacked wood/year

Wood-burning stove/fireplace in a house or apartment: 3-6 cubic metres of stacked wood/year

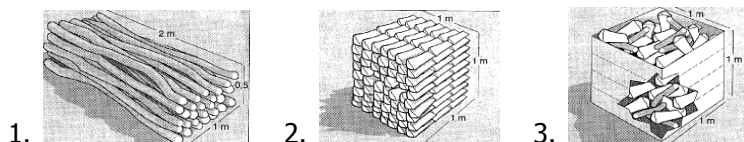
Masonry stove in a house: 5-15 cubic metres of stacked wood/year

Wood-burning boiler: 20-30 cubic metres of stacked wood/year

You should not register supplementary energy consumption such as district heating, coke, gas, oil, electricity, straw etc.

Understanding of a cubic metre

The three options for cubic metres are illustrated below for the interviewer:



Other definitions

Fireplaces with inserts: these should be categorised as wood-burning stoves and included with them.

Wood-burning stove with inset furnace: we do NOT need a separate question on whether or not there is an inset furnace in the stove.

Annex

Videnblad no. 68 (knowledge sheet, only available in Danish) from Centre for Biomass Technology.

Photo of a pallet of stacked firewood.

Annex 4: Imports of firewood to Denmark

To have a basis for comparison with the 2007 study, the same companies were contacted as then. However some importers have ceased trading and in these cases new firms were found. Four importers of pallets of stacked firewood and two importers of three-metre long logs for processing to firewood in Denmark responded. In general, they informed us of stable or slightly increasing imports compared with 2007.

In the 2009 study, one conclusion is that that pallets of stacked firewood account for 5-7% of consumption. Converted to energy units, this is 1,400-1,600 TJ. The energy content of a pallet of stacked firewood is determined at 15.96 GJ. Therefore, there is an annual consumption of about 90,000-100,000 pallets of stacked firewood. We believe that all pallets of stacked firewood are imported, i.e. imports of pallets of stacked firewood can be estimated at 1,600 TJ per year.

A few firms import up to 20,000 pallets of stacked firewood. These are a mixture of stacked wood and wood packed in 30-litre bags. According to our information, a pallet of stacked firewood weighs approximately 1,000kg (with a water content of 18-25%), and pallets of bagged wood contain 72 bags of 12-13kg, which comes to about 900kg in total. There are many small importers who import 1,000-2,000 pallets a year. 1,000 pallets corresponds to 40 truckloads, i.e. about 1-2 loads per working week, and this seems to be the level of the many pallet suppliers on the internet.

Three-metre long logs are imported and sold on to retailers for processing to firewood. Compared with 2007 imports are stable, but over a five-year period there are reports of large fluctuations so that in an individual year imports can halve, for example as a result of a mild winter and higher prices in the pulp and paper industry. Overall, we received information about imports of approximately 28,000 m³ solid volume as three-metre long logs. One larger importer estimated that this amounts to 30%-50% of annual imports. The Danish Energy Agency's statistic on the calorific value of solid volume wood (deciduous) is 10.4 GJ/m³ solid volume. In other words, we have reliable figures for imports of 280 TJ wood for firewood which does not come as pallets of firewood. This information indicates that imports of logs for firewood are 2-3-times greater than imports of pallets of stacked firewood. We estimate that 500-600 TJ logs for firewood are imported. This figure is 2% of the total consumption of firewood. However there is some uncertainty linked to the method of interview as the number of importers of both pallets of stacked firewood and of logs is unknown.

Overall, we estimate that 8% of firewood consumption in 2009 was imported. This corresponds to 2,005 TJ. The figure is a qualified estimate, but there is great uncertainty.

In comparison, the estimate for 2007 was that 8% of firewood was imported, corresponding to 2,176 TJ/year, while the imports figure in the 2005 study was 10%, corresponding to 1,963 TJ/year.

Lars Nikolaisen, Danish Technological Institute, 15 September 2010

Annex 5: Uncertainty calculations

Calculation of the uncertainty of the total number of appliances and of consumption of firewood on the basis of a 95% confidence interval. Calculations were made by Mads Ruby, Jysk Analyse, assisted by Kim Winther, Danish Technological Institute.

Number of households with stoves/fireplaces/boilers	No. of appliances	Percentage (p)	(1-p)*p	Uncertainty interval	
				Min.	Max.
Wood-burning stoves and/or fireplaces in homes	498	24.6%	19%	22.7%	26.4%
Wood-burning stoves and/or fireplaces in holiday homes	95	4.7%	4%	3.8%	5.6%
Wood-burning boilers	25	1.2%	1%	0.8%	1.7%
Don't have wood-burning stoves/fireplaces/boilers	1456	71.8%	20%	69.9%	73.8%
Total	2027	-	-	-	-

$$Percent = p \pm 1.96 \sqrt{\frac{(1-p) * p}{n}}$$

Unit consumption in GJ	No. of appliances	Consumption GJ* (μ)	Std. Dev. (σ)	Uncertainty interval	
				Min.	Max.
Wood-burning stoves and/or fireplaces in homes	231	31.04	28.22853	27.40	34.68
Wood-burning stoves and/or fireplaces in holiday homes	42	14.24	16.29719	9.31	19.17
Wood-burning boilers	18	116.60	70.95073	81.31	151.89
Don't have wood-burning stoves/fireplaces/boilers	1456	-	-	-	-

* On the basis that cubic metres of wood stacked in forestry (5.94 GJ/m³), cubic metres of box-stacked wood (7.40 GJ/m³) and cubic metres of sawn, chopped and stacked wood (4.39 GJ/m³) contain mixed deciduous (68%) and coniferous (32%). Pallets of stacked firewood (15.96 GJ/m³) contain pure coniferous wood (100%).

$$Consumption = \mu \pm 1.96 \frac{\sigma}{\sqrt{n}}$$

Total uncertainty from the above (95% confidence interval) for the main results of the study is min. 22,554 TJ to max. 27,564 TJ.

Annex 6: Proposed future registration form

Type of appliance for homes, institutions, industry, holiday homes etc.					DEA Firewood stats/Type of app. 1.x		
Technological Inst.		Address			District		
Date: 07.09.2005		Property no.			Route		
Signature: LSN		Date			Sweep		
Fuel	X	Appliance	No.	Output kW	Comment	Yes	No
Petroleum		Old stove			No glass door, before 1990		
Petro coke		DS labelled stove			From ca. 1990		
Coke		New stove (tertiary air)			SINTEF labelled. From 2000		
Coal							
Brown coal		Fireplace open					
Oil		Fireplace with insert			Note DS label		
Natural gas		Masonry stove					
LPG		Circulation stove					
Fuel oil		Tiled stove					
Firewood		Cooker			Wood, coke, brown coal		
Waste wood		Other stove (describe)					
Wood briquets							
Wood pellets		Straw boiler, hand-fired			Whole small bales		
Other pellets		Straw boiler, tractor-fired			Whole large bales		
Woodchips		Straw boiler, automatic			Chopped		
Drychips		Boiler, through draft*			Eg: Salamader, Rio, etc.		
Corn		Boiler, down draft*			Eg: HS, MB, Solo 30		
Straw		Boiler,*			Eg: Baxi Solo Plus		
Bio-oil (rape)		Bioboiler Automatic**			Built-in burner		
Olive granulate		Bioboiler Automatic**			Fitting burner		
Biogas		Boiler Automatic			Fossil fuel		
		Boiler liquid fuel					
		Boiler gas-forming fuel					
Other (note)		Other boiler (note)					
		*Wood, coke, petro coke and brown coal **Pellets/corn/chips/granulate *Hand-fired					
Notes							