Wood-burning and atmospheric emissions. Preliminary national figures for homes 2006.

More and more wood being burnt in clean-burning stoves

By Kristin Aasestad

In 2006, Norwegians burnt an average of 300kg of wood in their homes. Almost 40 percent of this wood was burnt in clean-burning stoves and this proportion is increasing rapidly. In 2006, new stoves gave Norway 0.9 TWh of extra energy from the wood burnt and reduced airborne particles by 14,000 tonnes.

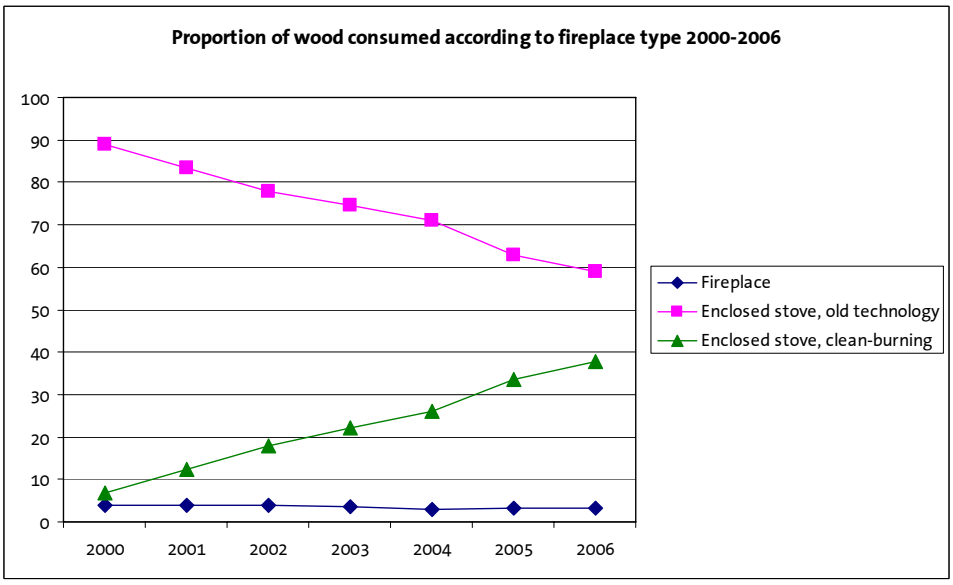
New stoves produce fewer airborne particles and are more energy-efficient than old stoves. The new stoves have resulted in households gaining 0.9 TWh of extra energy from the wood burnt in 2006 and a reduction in the release of airborne particles of 14,000 tonnes compared with if the wood had been burnt in old stoves. These are the results of a questionnaire survey undertaken by Statistics Norway (SSB) with contributions from the Norwegian Water Resources and Energy Directorate (NVE), the Norwegian Pollution Control Authority (SFT) and the Ministry of Agriculture and Food (LMD).

Units of measurement for energy
The use and production of energy is often measured in watt-hours. A 40-watt light bulb burning for one hour consumes 40 watt-hours of electrical power.
The energy consumed by a household is usually measured in kilowatt-hours (kWh, i.e. a thousand watt-hours). The power consumed in Norway is measured in gigawatt-hours (GWh = billion watt-hours) or terawatt-hours (TWh, 1000 billion watt-hours TWh = Terawatt hour, T = tera = 10^{12}).

More wood burned in new stoves

The questionnaire survey shows that Norwegian homes (excluding holiday homes) consumed just under 1.4 million tonnes of wood in 2006. In addition, there were roughly 470,000 households in Norway with clean-burning stoves, representing around 36 percent of all fireplaces. 38 percent of wood consumed in 2006 was burnt in clean-burning stoves (stoves manufactured after 1998). This represents an increase of 20 percent since 2002.

Wood consumption in holiday homes is considered for the first time in this survey. The figures show that consumption in this area is also considerable.



For 2006, the figures from the study undertaken during the first quarter of 2007 were used.
For 2005, the average from the study during the 3rd and 4th quarters of 2005 and the 1st, 2nd and 3rd quarters of 2006 were used. For 2001 and 2003, the average figures for the previous year and the subsequent year were used.

Source: Survey of living conditions 2000, 2002 and 2004.

60 percent of airborne particle releases come from wood-burning

Wood consumption in Norwegian residential homes and holiday homes totalled just under 1.6 million tonnes in 2006. Figures from the emissions accounts produced by Statistics Norway and the Norwegian Pollution Control authority show that a total of 57,300 tonnes of airborne particles (PM_{10}) was released in 2005. 60 percent, or 33,900 tonnes, came from wood-burning, including holiday homes. The primary reason for the high emissions caused by wood-burning is that almost 60 percent of the wood was burnt in old, polluting stoves (manufactured before 1998). Laboratory tests indicate that older stoves on average emit five to six times more airborne particles than new clean-burning stoves. If we assume that the wood burnt in the new stoves had been burnt in the old stoves, emissions of airborne particles from residential homes and holiday homes would have been 16,000 tonnes higher. In contrast, the theoretical potential for a reduction in airborne particles is around 25,000 tonnes if all the wood had been burned in new stoves.

More heat

Research has shown that new stoves are more efficient than older stoves. This means that we can benefit from more heat per kilo of wood burnt. According to SINTEF Energy Research, old stoves which are used with a good air supply can have an efficiency of around 70-75 percent. When these stoves are used with a reduced air supply, as is believed to be the case in most homes, their efficiency is reduced to around 35-40 percent. New stoves with a good air supply can have an efficiency of up to 80 percent. Even if new stoves are used with a reduced air supply, they will maintain an efficiency of 70-75 percent. In comparison, open fires have an efficiency of up to 15 percent.

In the following calculations, we have assumed an efficiency of 40 percent for an enclosed stove with old technology, 75 percent for an enclosed stove with new technology and 15 percent for an open fire. It is estimated that the wood consumed in both residential and holiday homes during this period gave 3.8 TWh, which is half the theoretical energy output of 7.3 TWh. With these efficiency estimates, the replacement/installation of clean-burning stoves has led to 0.9 TWh more being produced in 2006 than if the same wood had been burnt in stoves using old technology.

Wood consumption in homes, energy content and airborne particle emissions[1] (PM_{10}) from wood-burning according to fireplace type. 2006. 1,000 tonnes and TWh

	Wood consumption in homes	Theoretical energy content	Energy generated	Airborne particle emissions (PM_{10})	Scenario: stoves with old technology only	
					Energy generated	Airborne particle emissions (PM_{10})
	1,000 tonnes	*TWh*	*TWh*	*Tonnes*	*TWh*	*Tonnes*
Total	1,376	6.43	3.37	29,800	2.52	44,242
Open fire	43	0.20	0.03	604	0.03	604
Enclosed stove, old technology	813	3.80	1.52	26,547	2.49	43,638
Enclosed stove, clean-burning	521	2.43	1.83	2,649		

[1] Sintef has recommended that a factor of 40 g/kg be used for old enclosed stoves, except for Oslo for which it recommends 33 g/kg due to reduced nocturnal burning.

Most wood-burning in Northern Norway

Preliminary figures for 2006 indicate that wood consumption per inhabitant was highest in the three northernmost counties in 2006. Compared with previous surveys, respondents in these counties stated a higher wood consumption than previously. Previous surveys have indicated that wood consumption per inhabitant is highest in Hedmark and Oppland. The figures for Hedmark and Oppland in this year's survey are however uncertain, as many of the respondents in these counties stated that they burnt wood in their properties but did not state their wood consumption. The wood consumption has therefore been calculated from the average values for the whole country among those who responded. Consumption per inhabitant was lowest in Oslo and Akershus, at less than 140 kg/inhabitant. The national average is around 294 kg/inhabitant.

The wood-burning study and SSB's emissions calculations
The results are based on responses to questions relating to wood-burning in SSB's Travel and Holiday Survey. Almost 8,000 people were interviewed by telephone in six quarterly surveys from August 2005 to January 2007 inclusive. Wood consumption was calculated on the basis of the results of the survey. Emissions were calculated by multiplying the wood consumption by the emission factors for Norwegian fireplaces. We have previously published figures for the 12-month periods from July 2004 to June 2005, October 2004 to September 2005 and January to December 2005 in addition to the county figures for 2005. The current publication gives preliminary figures for 2006.
This survey will take place every quarter. From autumn 2007, figures for the consumption of wood from the study will be used to calculate the energy accounts/energy balance and atmospheric emissions. Consumption figures from this study will therefore supersede figures for the acquisition of wood from the Consumption Survey. Once the statistics become available, it will be possible to calculate figures for wood-burning at a municipality level one year earlier than today, as a result of more up to date national figures. From 2007, the study will also cover wood consumption in holiday homes.

Wood consumption in homes according to county group. 2006.
1,000 tonnes and kg/inhabitant

	1,000 tonnes wood	Kg/inhabitant
Total	1,376	294
Akershus and Oslo	137	129
Hedmark and Oppland	145	390
Rest of Østlandet[1]	286	317
Agder and Rogaland	171	254
Vestlandet[2]	268	332
Trøndelag	171	419
Northern Norway	199	430

[1] Rest of Østlandet includes the counties of Østfold, Buskerud, Vestfold and Telemark.

[2] Vestlandet includes the counties of Hordaland, Sogn og Fjordane and Møre og Romsdal.

Uncertainty
There are many uncertainties associated with the figures presented here, including that regarding the survey answers and the emission factors. It is important to be aware that the period for which we are presenting figures in this survey is that from 1 January to 31 December 2006 inclusive.
Figures in the Energy accounts which was published on 20 October 2006 give the final figures for 2004. These figures are however based on the Consumption Survey regarding the acquisition of wood and not the consumption of wood, as is done in this survey.