ENERGY EFFICIENT HOUSEHOLD APPLIANCES IN SWEDEN

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ABSTRACT

The average yearly energy use for household appliances in a standard Swedish house was 4780 kWh in 1987. Using best available technology (BAT) for 2002 the yearly the energy use can be reduced by 54%. BAT is not always a good choice due to the enormous investment costs for some products, but there are many energy efficient appliances that are offered at a reasonable price level. Unfortunately builders of new houses simply buy the cheapest products available to increase their margin of profit, whereas the buyer is interested in the product with the lowest energy use. In high performance houses the energy use of appliances has to be kept at a very low level to avoid overheating. By using only BAT, the annual energy use for household appliances in Sweden would decrease from 19,6 TWh to 9,8 TWh, which means that two nuclear reactors could be closed down and the electrical grid could be dimensioned for a lower peak load. The results of testing procedures on refrigerators with DIN EN 153 are becoming less accurate, the more insulated a refrigerator is. Therefore new testing methods should be developed.

INTRODUCTION

Between 1970 and 1999 the energy use for household appliances in Swedish dwellings doubled from 9,2 to 19,6 TWh (Energimyndigheten 2000) and in 1995 the energy use for residential refrigerators in the United States was 7% of the country's total use of electricity (Meier, 1995). These facts clearly show the necessity of taking a closer look on the energy use of household appliances.

For a standard Swedish detached house built in 1990 the yearly energy use is approximately 15 000 kWh. As shown in figure 1, one third (5000 kWh) of the energy is used for heating, another 4 - 5000 kWh is used for household appliances, 3 - 4000 kWh for domestic hot water and 2 - 2500 kWh for fans and pumps (Lövehed, 1995). Since the amount of energy used for household appliances is almost as big as the amount used for heating the dwelling, there is a similar potential for economic and environmental gains by reducing their energy use. A reduction in energy use for household appliances can be even more important as the source of energy is mostly electricity. The delivery of electricity is combined with losses in the power plant and in the grid. Therefore even a small reduction can have a rather big effect on the use of primary energy.

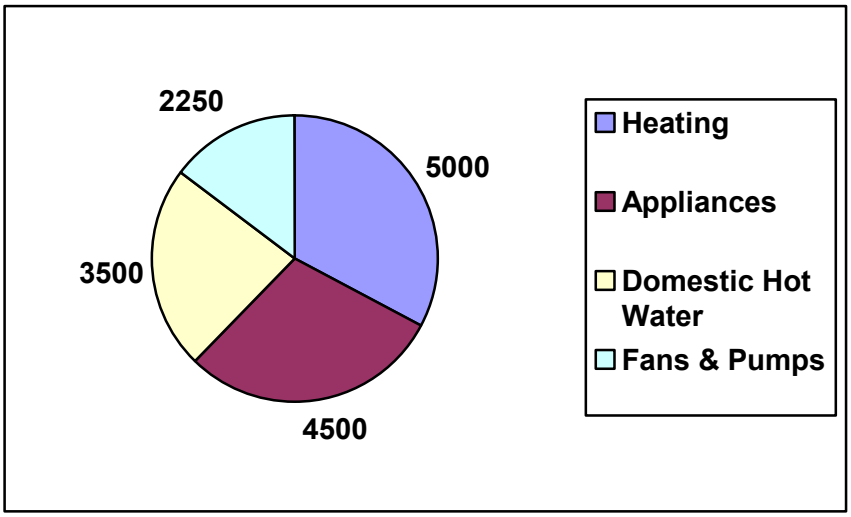

Figure 1: Energy use (kWh) in Swedish detached house 1990

The energy use of 4 - 5000 kWh for household appliances in a standard Swedish home can be reduced by 42% to approximately 2770 kWh per year (Lövehed, 1995) by using best available technology (BAT). A comparison is shown in Table 1. The reduction can be even bigger by using BAT for 2002, as Table 2 shows.

	Standard appliances 1987 (kWh / a)	**BAT 1995 (kWh / a)**
cooking	1030	568
washing and drying	750	271 + 350
dishwasher	370	250
refrigerator and freezer	1450	457
lighting and other	1180	300 + 574
Σ	**4780**	**2770**

Table 1: standard appliances 1987 and best available technology 1995

	Standard appliances 1987 (kWh / a)	**BAT 2002 (kWh / a)**
cooking	1030	568
washing and drying	750	133 + 175
dishwasher	370	198
refrigerator and freezer	1450	230
lighting and other	1180	300 + 574
Σ	**4780**	**2178**

Table 2: standard appliances 1987 and BAT 2002

With BAT for 2002 the yearly energy use would be 2178 kWh. Comparing to the average of 1987 the energy use can be reduced by 54%. The efforts made by developing new energy

efficient products is clearly shown by comparing the total energy use for BAT 1995 and BAT 2002. A reduction by 21% for the energy use of BAT is achieved within seven years.

LIST OF BEST AVAILABLE TECHNOLOGY 2002

The Swedish Consumer Agency has published a searchable list on the internet (www.konsumentverket.se) with household appliances available on the Swedish market and the German Niedrig-Energie-Institut has published a similar list for the German market. Some of the most energy efficient products are presented in the Tables below. Prices for appliances available in Sweden are given in Swedish crowns (SEK) (9,3 SEK = 1 Euro) and the prices include 25% value added tax.

Refrigerator-Freezer combination	height (cm)	refrigerator volume (l)	freezer volume (l)	energy use (kWh/a)	price (SEK)
Gorenje KE 266LA	181	176	69	284	5600
Bosch KGE2920NL	175	190	90	329	6590
Bosch KGV2421	155	174	57	292	4890
Quelle Privileg 313	200	189	95	230	
Vestfrost BSKF 875	201	191	93	255	

Refrigerator	height (cm)	volume (l)	energy use (kWh/a)	price (SEK)
AEG Santo Super 3272 - 6KA	180	307	135	7500
Liebherr KSPv 4260 Premium	184,1	398	127	

Freezer	height (cm)	volume (l)	energy use (kWh/a)	price (SEK)
Gorenje FE 246 CA	150	208	237	5200
Quelle Privileg 216	160	195	208	

Dishwashers	width (cm)	energy use (kWh/a)	water use (m3/a)	price (SEK)
Gaggenau 240110	60	198	2,200	13500
AEG Favorit 55750i-m	60	220	3,300	9790
Whirlpool ADP 2966 6e sinnet	60	227	3,520	7000
Siemens SE 25293	60	231	2,640	

Use of dishwasher: 12 dishes, 220 times per year (4,23 times a week)

Washing machines	capacity (kg)	energy use (kWh/a)	water use (m3/a)	price (SEK)
Siemens WXB1060SN	5,0	133	8,424	4909
Husqvarna Mästertvätt 17600	5,0	139	6,084	8390

VIP				
AEG Öko-Lavamat 88830	5,0	139	6,084	
Quelle Privileg Pro Comfort 9650 T	5,0	140	5,304	

Use of washing machine: 156 times per year (three times a week), 60 ºC, 5 kg cotton

Drier	type	capacity (kg)	energy use (kWh/a)	drying time (min)	price (SEK)
AEG Öko-Lavatherm WP	condensing / heat exchanger	5,0	175	100	14490
Gorenje WT 641 P	condensing	5,0	335	70	3600
Miele T 478 G	gas / exhaust air	5,0	25+406 gas	51	
Crosslee White Knight DE 437	gas / exhaust air	4,5	35+325 gas	110	
Nimo ETS 600	cold air / exhaust air/ closet	4,0	28	480	
Ecodry 502 b	condensing / heat exchanger	5,0	180	97	

Use of drier : 100 times per year

DISCUSSION

Payback

Unfortunately the market situation does not always make BAT a good choice due to the enormous investment costs. The payback-time for such appliances can be extremely long and no customers, except perhaps enthusiasts, would buy a tumble-drier that is three times as expensive as a standard one that costs about 5000 Swedish crowns (SEK) (9,3 SEK = 1 Euro). A standard tumble-drier, presented on the Swedish Consumer Agency's homepage, uses 3,53 kWh for one drying procedure. The most efficient tumble-drier uses 1,75 kWh. If a tumble-drier is used three times a week and if the price for electricity is calculated for as 1 SEK per kWh including taxes, the yearly savings will be (3,53-1,75)*3*52 = 278 SEK and the resulting payback-time is 10 000 / 278 = 36 years. Unfortunately this makes the most efficient tumble-drier a very bad investment since its payback time is much longer than its expected lifetime. It has to be emphasised that despite this negative example, there are many energy efficient appliances that are offered at a reasonable price level. For example Siemens' washing machine, WXB1060SN, or Gorenje's refrigerator-freezer combination, KE 266LA, are products that are rather cheap. So even for a household with an average or low income there are possibilities to save energy by choosing products at a low price level. The price of durables does of course not only depend on their energy performance, but rather on the quality or the prestige of the brand. The price of the dishwasher Gaggenau 240110 is certainly at a high level due to the prestige of the brand and not because it happens to be the most energy efficient dishwasher.

Decision making
The problem, especially on the Swedish housing market, is that the builders of new homes mostly offer turn key projects with all white goods already included. It is the builders interest to simply buy the cheapest products available to increase his margin of profit. The buyer on the other hand should be interested in the product with the lowest energy use since this will have effects on his energy bill for the next decade or even longer. When investing in a new home it should therefore be the buyer and not the builder who decides on which appliances are to be installed. In other European countries, as for example Germany, it is common that the buyer of a house is responsible for the appliances since the houses are generally sold without any household appliances at all.

High performance houses
The question is when an investment in energy efficient household appliances can be justified. From a consumer's perspective, if an old appliance in an existing house is to be replaced with a new appliance, it can generally be justified when the price level of efficient appliances is the same as for standard appliances. A special case appears when an old house with poor insulation is heated with electric resistant heating. If a less energy efficient appliance is chosen it will simply help to heat the house and reduce the amount of energy needed for the electric resistant heating a little. For new high performance houses it is different. Built with high insulating walls and windows and using very effective heat exchangers in the exhaust air it is absolutely necessary to invest in BAT in order to avoid overheating. This is not so important for dishwashers or washing machines since most of the surplus heat from such appliances leaves the house with the wastewater. It is very important though, for appliances like tumble-driers, refrigerators, freezers and lighting equipment where almost 100% of the energy use is a heat gain to the indoor environment. In order to reduce the total energy use of a household and in order to keep a comfortable temperature, the energy use of appliances in high performance houses has to be kept at a very low level.

Environmental effects
Assuming that the energy use could be cut radically by 50% by using only the best available technology, the annual energy use for household appliances in Sweden would decrease from 19,6 TWh to 9,8 TWh. If everyone who had to invest in a new household appliance would choose the most energy efficient product available, this decrease of energy use could probably be reality within the next 15 years, assuming that this is the average lifetime of household appliances. Since about 47% of the Swedish electricity derives from hydro power and 46% from nuclear power the effects on CO_2 emissions would be rather low. But it means that two nuclear reactors could be closed down. Even with a less ambitious reduction of energy use, big changes on the supply side could be achieved. For a government it could therefore be of interest to subsidise the most energy efficient products in order to enhance a change in power supply.

Peak load
Using energy efficient household appliances also has a positive effect on the electrical grid because it can be dimensioned for a lower peak load. The peaks appear mostly during winter, in the morning hours and in the late afternoons when people are at home using their electrical appliances. The less installed power a household has, the less it influences the power load on the electrical grid. Today there are no limits for how many Watts a household is allowed to have installed, but a regulation might help to avoid extreme peak situations where fossil fuels have to be used as additional sources of energy. A vision into the future might show solutions where providers of electricity are given the possibility to decide when water is heated or

laundry is dried by remote control in order to even out the power load. This way the electricity provider will be able to optimise his production system. Perhaps this could result in a new kind of contract where the remote control option for the electricity provider gives lower energy costs for the consumer.

Testing methods for refrigerators

Current testing methods for refrigerators (DIN EN 153) can predict an average field energy use, but the methods are not developed to predict the energy use for individual users. This means that the energy use marked on a label can vary a lot depending on the user's behaviour. The main energy losses are highly dependent on the ambient air temperature. The losses occur as thermal losses through the walls, losses at the compressor or by opening the door. With a higher ambient air temperature the thermal losses will increase and the efficiency of the compressor will decrease so that more energy is needed to keep a cool temperature inside the refrigerator. By using new, very well insulated refrigerators, with for example vacuum insulation, the effects of the thermal losses are minimised. Now the energy use mainly depends on the number of door openings or how much food is put into the refrigerator, which is not a technical but a behavioural factor. The more well insulated a refrigerator is, the less accurate is the result of the testing procedure. In the testing method DIN EN 153 the effect of door-openings is compensated by a higher ambient air temperature (25 ºC), but this compensation will have less effect, the better insulated the refrigerators are. It might therefore be of interest to develop new testing methods where the behavioural aspect is taken more into account so that the consumers of such durables are not mislead by values of energy use stated on today's labels.

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