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Technical and legal application possibilities of the compulsory labelling of the standby consumption of electrical household and office appliances

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1 Problem, objective and methodology

The standby consumption of electrical households and office appliances continues to be significant world-wide since the number of products with standby components is constantly increasing. For Germany, a recent assessment of the Fraunhofer ISI (Cremer et al. 2003) for 2001 arrived at an electricity demand of almost 15 TWh for household and office appliances in standby mode, i.e. in standby and off-mode. This represents almost 40 % of the total consumption of these appliances and around 3 % of the total electricity demand of the final energy sectors in Germany. The standby share in electricity demand is over 80 or even 90 % for numerous appliances. The Federal Environmental Agency calculated that every year standby losses in German households and offices are responsible for wasted electricity amounting to 3.5 billion Euro (UBA 2004). For the OECD countries, field studies show that between 3 and 13 % of the electricity consumption of households can be ascribed to standby losses (IEA 2001). Without energy policy measures on both national and international levels, there is a great risk that a further increase in standby consumption will occur. Many studies dealing with this subject have already been conducted and have shown that low standby consumption is technically feasible and usually achievable at a reasonable cost.

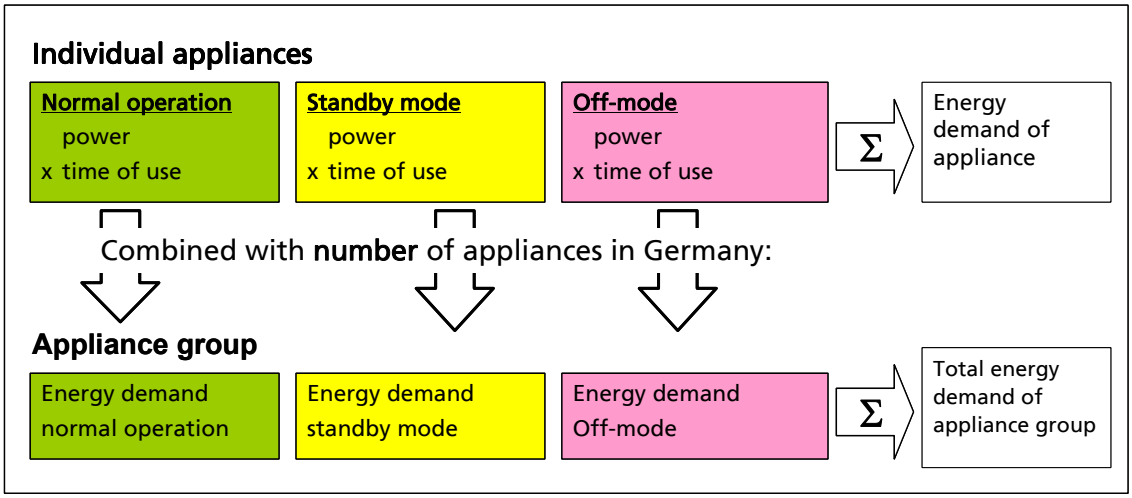
One possible energy policy measure to reduce the standby consumption of electrical household and office appliances is the introduction of mandatory consumption labelling. In principle, a high degree of effectiveness is attributed to such regulatory/ command-and-control measures with regard to influencing the energy efficiency of devices. Compulsory energy labels to identify and, where necessary, to classify electricity consumption produce greater market transparency and offer buyers an additional decision criterion. In this way they promote indirectly the development, production and supply of energy-efficient products. When combined with comparatively low implementation costs, the cost-benefit ratio is also relatively good compared with other measures. Up until now, compulsory energy labels have been used globally mainly to indicate the consumption in normal operating mode, primarily for large electrical domestic appliances and other devices used predominantly in households such as water heaters, lighting or air conditioning devices.

Against this background, the **objective** of this study was to examine under which technical, legal and organisational prerequisites mandatory labelling can achieve a significant reduction of the standby consumption of electrical household appliances. This entails in detail:

- examining the technical design and application possibilities for mandatory labelling, taking into account a minimum limit of standby consumption.
- Examining the legal design and application possibilities taking particular account of European law aspects and the relationship to already existing voluntary and obligatory labels.
- Examining implementation possibilities with regard to how the objectives linked with the introduction of a mandatory label may be best met and how to most effectively reach the target groups concerned – manufacturers, retailers and buyers; this also includes the use of supportive instruments.

The results of an earlier study of the energy consumption of ICT technologies in Germany form the **methodological starting-point** for this work (Cremer et al. 2003). These results were updated primarily with regard to standby consumption. Estimating the current and future energy demand of electrical household and office appliances was done based on a bottom-up model incorporating the following demand-determining components: the stock of appliances, the power consumption in the various operating modes and the respective operating times of the appliances (Figure 1-1).

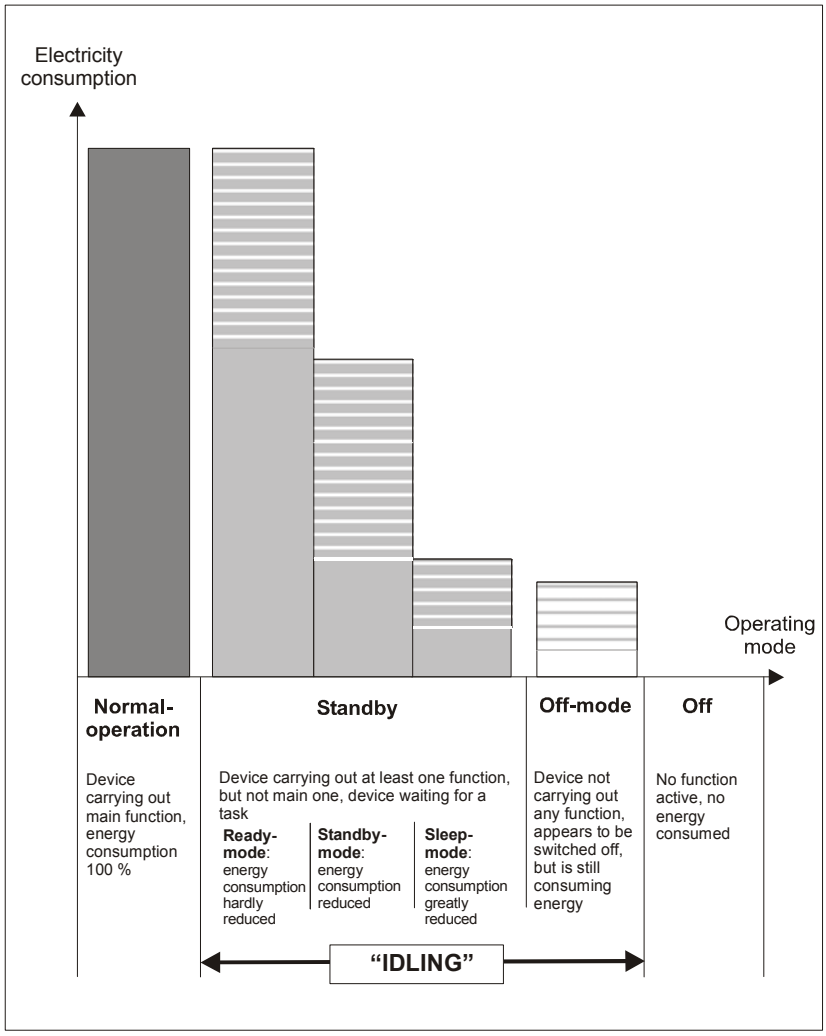
Figure 1-1: Model to determine the power demand of household and office appliances and the associated infrastructure



Source: Cremer et al. 2003

Modelling the power demand of electrical household and office appliances was done for the benchmark years 2001 (as comparison year for Cremer et al.'s study 2003), 2004 (as current reference year) as well as 2010 and 2015 (as projections). In doing so, the following modes of operation were distinguished: normal operation, standby mode[1], off-mode, off. This study focuses on "standby consumption", which, as defined here, covers both standby and off-mode (see Figure 1-2) [2].

Figure 1-2: Definitions of the operating modes of electrical household and office appliances used in this study



1 Within the standby mode, distinctions are made between the three modes "ready", "standby" and "sleep", depending on the reduction in energy consumption due to the restriction in functions.

2 As yet there is no uniform definition of the operating modes; the term "standby", in particular, is used inconsistently. A further difficulty in assigning names is that not every German term has a corresponding unambiguous English translation and vice versa.

Apart from the development of the stock concerned, the future power demand of electrical household and office appliances is influenced primarily by the existence of (technical and behavioural) saving potentials with regard to the energy consumption in the different operating modes and their actual realization. To forecast the power demand in the years 2010 and 2015, the following scenarios or potentials were calculated:

- a "business-as-usual" scenario as the reference scenario, in which no additional electricity-saving measures are assumed beyond those already existing today, i. e. the existing technical saving possibilities are not exploited here (see Chapter 2).
- The calculation of the technical saving potential for standby consumption which assumes that all technical saving potentials are realized (see Chapter 3).
- The estimation of the effective saving potential resulting from the introduction of compulsory labelling of the standby consumption of electrical household and office appliances (see Chapter 5).

The starting point for these calculations was a detailed list of all the main electrical household and office appliances, differentiated according to the main functions of entertainment, communication, data processing and household appliances (see Table 1-1). A distinction was made between private households and offices as areas of use. End-use appliances and the associated infrastructure were examined separately; the latter was further split according to building-internal infrastructure and the infrastructure of the telecommunication suppliers. However, the office and telecommunications infrastructure is not relevant for this study, which focuses on standby consumption, since the ICT appliances and systems used here (such as servers or mobile communication systems) operate almost exclusively in normal mode. They were only included in the list because this study also aims to follow up and update the results of Cremer et al. (2003) on the electricity consumption of all ICT appliances[3]. However, those appliances not relevant for standby consumption were only updated and otherwise looked at in much less detail.

3 Compared with the appliance lists used in Cremer et al. (2003), several additions were made in the domain of household end-use appliances: new appliances were included such as rear-projection televisions, hard disc recorders, AV receivers and subwoofers. A greater differentiation of set-top-boxes was made which are expected to increase massively in the future and there was greater consideration of multifunctional appliances. New additions also include electrical household appliances which are sometimes also used in offices and are increasingly relevant for standby consumption.

Table 1-1: List of electrical household and office appliances and their associated infrastructure included in the study

Function	End-use appliances		Building-internal infrastructure
Main group	Households	Offices	
Entertainment (audio-visual)	**Audio**		**Televisions**
	Compact system		Antenna preamplifier
	Hifi amplifier		LNB
	Cassette recorder		
	CD player		
	Minidisc player		
	Other media players		
	Clock radio		
	Radio recorder		
	Televisions		
	Cathode ray TV		
	LCD TV		
	Plasma TV		
	Front-projection TV		
	Rear projection TV		
	SAT boxes 1		
	DVB boxes 1		
	Cable boxes 1		
	Video		
	Video recorder (analogue)		
	DVD player		
	DVD recorder		
	Hard disc recorder		
	AV receiver		
	Subwoofer		
	Cameras	**Cameras**	
	Video camera/camcorder	Video camera/camcorder	
	Digital camera	Digital camera	
	Other devices		
	Video game consoles		
	Audio-video mini devices (battery powered) 2		
Communications	**Telephones (fixed network)**	**Telephone (fixed network)**	**Communications infrastructure**
	Cordless telephone (DECT)	Cordless telephone (DECT)	DSL splitter
	Smart phones	Smart phones	DSL modem
	Answering machines	Answering machines	CATV modem
	Fax machines 3	Fax machines 3	Satellite modem
	Telephones (mobile)	**Telephone (mobile)**	DSL Router/WLAN
	GSM	GSM	Telephone modem
	UMTS	UMTS	ISDN-Box
			Entryphone
Data processing	**Computers**	**Computers**	
	Personal Computer (PC)	Personal Computer (PC)	
	Notebook	Notebook	
	PDA	PDA	
	Monitors	**Monitors**	
	Cathode ray screen	Cathode ray screen	
	Flat screen	Flat screen	
	Printer [4]	**Printer** [4]	
	Ink jet	Ink jet	
	Laser	Laser	
	Matrix	Matrix	
	Other devices	**Other devices**	
	Scanner	Scanner	
	Copier (desktop)	Copiers	
		Projectors	
Household appliances	**Household appliances**		
	Microwave ovens		
	Cookers		
	Extraction hoods		
	Coffee machines		
	Coffee espresso machines		
	Dishwashers		
	Refrigerators		
	Fridge-freezers		
	Freezers		
	Washing machines		
	Tumble driers		
	Washer-driers		
	Battery chargers/charging stations		

1 Differentiated based on simple, average and high level of features
2 Here, the power supply units, not the appliances themselves are regarded.
3 Incl. fax/answering machine combinations
4 Incl. combined printer, scanner and copiers (poss. Also with additional fax function)

2 Stock and energy demand of electrical household and office appliances in Germany up to 2015

One aspect of this study was to update the results of Cremer et al.'s study (2003) on the current and future energy demand of information and communication technology devices (ICT) in households and offices in Germany. The entire domain of household appliances represented a new addition to the quantification. The main results are presented in summarized form below. All the updated data and forecasts entered into the calculation model on the stock, power input and duration of use as well as the resulting power demand in the three operating modes distinguished here can be taken from the detailed tables included in Appendix 1. The focus of this study was on determining the electricity demand of appliances while idling, i.e. in standby and off-mode.

2.1 ICT end-use devices in private households

Appliance stock

Data on household equipment with ICT end devices formed the basis for determining the stock of these devices in German households in 2004 as well as for estimating the development up to 2015. The appliance stock was extrapolated using the number of private households which will probably increase slightly to around 39.5 million by 2015 (Pötzsch/Sommer 2003). To determine the appliance stock or household equipment in the reference year 2004, data from official or semi-official statistics (Statisches Bundesamt, Eurostat, RegTP, OECD, ITU, Bundesanstalt für Arbeit), statistics from company and sector associations (ZVEI, GfU, BVT, BITKOM, EITO) as well as results from market and opinion research (ACTA, media analyses, consumer analyses, Typologie der Wünsche Intermedia) were used. In order to obtain a consistent data set for predicting the future stock, these data sources were systematically standardized. For the prediction of the future household equipment, saturation values were able to be determined for most of the devices which are not completely new to the market, and the future equipment determined using a non-linear regression analysis based on the past development.

Based on this procedure the following tendencies emerge with regard to the development of the stock of ICT end appliances in private households in Germany up to 2015 (see also Annex A1.1):

- *audio devices* represent an almost saturated market so that only a slight increase in the stock of such appliances is to be expected.

- The number of televisions will rise from about 55 million in 2004 to 60.2 million in 2015; most of this increase is due to the growth in second or third TV sets. During the period under observation, it is assumed that CRT TVs are gradually replaced by LCD and – to a limited extent also plasma TVs – which, however, will probably only play a subordinate role in 2015, as will front- and rear-projection televisions.
- There will be a strong growth in the future in the number of set-top-boxes (STB) which are increasingly necessary for television reception. In particular, the switch of television technology from analogue to digital services leads to a stock increase in set-top-boxes since a STB is required for each television set, i.e. for second and third TVs as well. The anticipated expansion of digital terrestrial television (DTT) also results in a stock increase of STBs. Taking into account the set-top-boxes already needed today for pay TV reception, the total number of STBs installed in Germany (including SAT boxes) will increase by around 170 % from 23.18 million today to well above 60 million according to this estimation.
- Appliances for recording audio-visual data (video recorders, DVD recorders) have become prevalent in households in the past few years. It can be expected that the stock of DVD players will increase tenfold in the next ten years and that a rapid displacement of conventional video recorders will take place.
- The stock of *video cameras or camcorders* will double in size again between 2004 and 2015, and massive stock growth can be expected for digital photo cameras from around 10.4 million in 2004 to 32.3 million in 2015, which thus reach today's level of conventional compact cameras. However, only a slight increase is anticipated for game consoles because market saturation is already becoming apparent here.
- Germany was already almost fully equipped with fixed network telephones several years ago. However, within the stock, a clear structural shift has begun away from simple telephones to so-called "smart phones", which are relevant for electricity consumption and feature many additional functions, as well as to cordless phones, consisting of a base station and one or more handsets. This trend will continue in the future.
- The number of *mobile phone users* in Germany has grown enormously, especially since 1999. For 2004, the number of actual mobile users is estimated at 71.1 million. The total figure cited is often even higher, but it can be assumed that there are many unused telephones and mobile phone lines which are not relevant for electricity consumption. A slight increase in mobile phone users is expected up to 2015 to around 78 million. In spite of the currently uncertain development of UMTS it is assumed that this will gradually spread in the years up to 2010 and that the (pure) GSM end-use devices will be completely replaced by UMTS-compatible ones between 2010 and 2015 (Friedewald et al. 2004).
- There were a total of 32.6 million *computers* in German households in 2004, of which 4.6 million were notebooks. A 40 % increase is expected up to 2015 with the strongest growth in the number of notebooks. The often observed trend towards mobile IT and telecommunications support can also be seen in the growing number

of PDAs (Personal Digital Assistants). The total number of computer monitors is growing in parallel to the number of desktop PCs. Up to 2015, the cathode ray tube screens still common today will be completely replaced by the flatter LDC displays. German households with PCs now also feature printers as standard equipment so that the situation here is likely to evolve in the same way as for PCs. The sales of combined printer/scanner/copier devices (possibly with additional fax function) have risen strongly recently. It is assumed that the share of multifunctional devices will increase to 30 % of all households in 2010 and to 40 % of households in 2015[4].

Power input of the appliances

The respective power input selected for the years 2001 and 2004 in normal, standby and off modes is based on measurement values given in the literature or our own measurements. The estimates made for the years 2010 and 2015 take into account both expected increases due to higher design and performance requirements and decreases in power consumption due to autonomous technology progress or already ongoing measures to increase energy efficiency. Particular attention was paid to performance thresholds of existing product labels and the standards set in current manufacturer voluntary commitments to reduce the electricity consumption of electrical appliances which focus mainly on consumer electronics.

A drop in power consumption between 2001 and 2010/15 was only assumed for a few appliance groups in **normal mode**. Technical possibilities to reduce the power demand are usually compensated or often even overcompensated by increased (use) performance or additional functions especially for ICT appliances. For this reason, it was assumed that power input remains constant between 2001 and 2015 in normal mode for appliances which are already technically mature and for which there is no marked demand for increased performance or complex additional functions. This is the case for all audio devices, for analogue video recorders, cameras, fixed network telephone devices, PDAs, some peripheral PC devices (printers, scanners, active boxes) as well as copiers. A drop in power consumption in normal mode which overcompensates technical progress and the trend towards increased performance or additional functions is only expected for very few appliances under present conditions (mobile phones, simple DVD players, scanners).

However, the opposite trend, i.e. a future increase in power consumption, is expected for a whole series of appliances because of continued increases in performance or

4 Since these devices are accounted for in this study as "printers", the stock of scanners and fax machines has been correspondingly reduced.

convenience requirements which outweigh the technically feasible consumption reductions. This trend, which was already implied in the study by Cremer et al. (2003), became much more conspicuous between 2001 and 2004 for several appliances than was assumed in 2003. This is particularly true for televisions and monitors with LCD technology and has the result that the saving possibilities expected from this technology switch are likely to be considerably smaller than first assumed. The same thing is true for LCD monitors. There will be strong future growth in the number and thus the power demand of set-top-boxes which are increasingly needed for television reception. Their power input in normal mode is currently between 8.5 (DVB boxes) and 17 W (SAT and cable boxes). However, an increasing power consumption is assumed for the forecast up to 2015, at least for some of these appliances in normal mode on account of the continued development from purely reception and signal decoding devices to multimedia platforms with additional PC/hard drive functions. The same is true for PCs, notebooks and game consoles. It is assumed that the trend in the household sector towards ever more powerful devices with correspondingly increased power demand in normal mode will be prolonged in the near future.

Whereas the power consumption in normal mode is expected to increase for a series of appliances up to 2010/15, the opposite tendency was observed in **standby mode** between 2001 and 2004. Current measurements for the majority of appliances show a decrease in power consumption, although this turned out to be only moderate in many cases. The most obvious drop was seen in PCs, notebooks and LCD monitors. Generally, a slight decrease in power consumption is assumed in the updated balance sheets for most ICT end-use devices in households in standby mode between 2001 and 2004 as is a continuation of this trend up to 2010/15. A conspicuous decrease in standby mode consumption is expected for audio-visual appliances because of the manufacturers' voluntary commitment of 2003. The consumption figures for set-top-boxes, however, are still relatively high at around 5 W in 2010 and 4 W in 2015. This also applies for some relatively new appliances such as hard disc recorders and subwoofers, which are also marketed under the heading "home cinema". The expected decrease in standby power consumption of desktop computers is primarily due to the integration of more efficient power supply units (PSUs), the increasing use of mobile processors and a greater use of power management systems. As regards notebooks, it is assumed that the chip industry will make a concerted effort to increase energy efficiency in order to further extend the operation time of mobile appliances. On top of this, towards the end of the period under observation, OLED monitors could come into operation which are more efficient than today's LCD screens. For several appliances it is expected that power consumption will remain constant in the near future compared to 2004 levels.

This is the case for cameras, fixed network telephones and copiers since significant technical improvements are not anticipated here, at least in the household sector.

In spite of the declining trend observed for the majority of appliances since 2001, the present standby consumption of most audio-visual and data processing devices is still relatively high, 5-10 W on average. The large ranges occurring in the measurements also indicate the existence of considerable saving potentials (see Chapter 3).

Under present conditions, no significant changes in power consumption are reckoned with in the **off-mode** in the majority of appliance groups up to 2010/15. Between 2001 and 2004, a slight decline was only observed for individual devices. It is noticeable that many of the new consumer electronic appliances such as set-top-boxes, AV receivers, hard disc recorders or subwoofers do not even have off-switches and are thus always in normal or standby mode unless they are physically disconnected from the mains by pulling the plug or using a switchable power strip. Such technical solutions mean that off-mode operation no longer appears. In cases where the standby mode is only indicated by a light and no other functions are being fulfilled, it is questionable whether users have any benefit at all from this configuration and whether it would not be better to integrate an off-switch into the device.

Operating times of the appliances

The respective operating times in the various modes are the third significant component determining the power demand of appliances. Independent surveys were able to be used to a large extent to determine the operating times for the household sector. However, it should be noted that these primarily concern the normal operation of these devices (especially van Eimeren/Ridder 2001 and data of the German Media Analysis[5]). Splitting the remaining operating time into standby, off-mode and off is mainly based on our own estimates using existing literature values (among others, dena 2002; Schlomann et al. 2004).

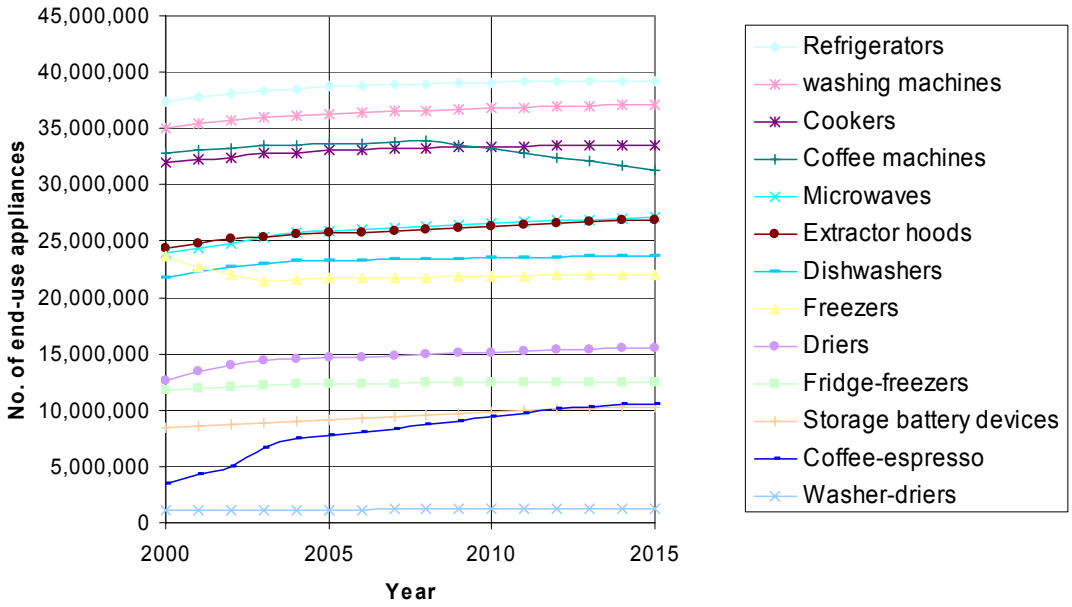
2.2 Electrical household appliances

It was possible to refer to an already existing broad database to determine the current **stock** of electrical household appliances (Statistisches Bundesamt 2004; Hofer et al. 2002; IKARUS 2004; ZVEI 2004; HEA 2004). The stock of appliances is characterised

5 The Media Analysis is the largest comprehensive survey conducted in Germany researching media utilization behaviour in Germany for daily papers, magazines and consumer electronics appliances.

by high levels of saturation in refrigerators and freezers, washing machines, cookers, coffee makers, microwave ovens, extractor hoods and dishwashers. The growth in stock has been correspondingly small in the past few years. Even for the medium term, the forecast is only for very moderate growth (Figure 2-1). Coffee-espresso machines constitute one exception here. These have only been available for a few years at reasonable prices and stronger growth is expected in the medium term.

Figure 2-1: Development of the stock of household appliances in Germany up to 2015



The present and future **power consumption** and **operating times** of the appliances in the various modes in the business-as-usual scenario (see Annex A1.2) was estimated based on existing studies (IKARUS 2004; Hofer et. al. 2002; Böde et al. 2000) and additional measurements carried out within the scope of this project. The operating life of the household appliances regarded is typically in the range of 10 to 15 years. As a result, and also due to the minor stock increase expected, it can be assumed that technical changes will only play a minor role in the average consumption of the stock up to 2015 in a "business-as-usual" scenario. Power consumption in normal mode for most large household appliances is characterized by the demand for heat and mechanical energy. Efficiency increases have already been achieved here in the past, some of which were initiated by statutory performance targets. Standby losses do not occur in simpler appliances since these do not feature electrically-powered functions (e.g. a clock). More complex devices require power input in standby mode due to electronic operating units, displays or programming units. Technical progress has been able to reduce this consumption slightly in the past few years. However, this is offset by the

trend towards more complex new appliances with additional functions, e.g. large, multi-colour displays or interface functions. An increase in standby power consumption should therefore be reckoned with for new appliances.

2.3 ICT end-use appliances in offices

Compared with the household sector, the available data on the **stock** of relevant ICT end-use devices in offices is much poorer, i.e. computers including all peripheral devices as well as office communication devices. Estimating the current stock and its development up to 2015 was done using the number of employees in office occupations or similar jobs and the standard equipment of office workplaces with information and communication end-use appliances. The group of those employed in office occupations has become much more significant over the past few years. According to existing projections, the number of office workers will probably rise from around 11.75 million in 2000 to around 12.6 million by 2010 (Weidig et al. 1999). This trend was carried forward for the year 2015 taking into account the population development. Assessing the equipment of office workplaces in Germany with ICT end-use appliances is done based on the most recent 1998/99 survey of the Federal Institute for Vocational Training (BIBB) and the Institute for Employment Research (IAB) on the qualifications and employment situation in Germany (Dostal et al. 2000; Troll 2000a-d). These surveys were supplemented in individual cases by referring to the statistics of associations and market and opinion research institutes. The number of ICT end-use appliances in the office sector for the base year 2004 as well as for the projections 2010 and 2015 results as the product of the number of employees and the respective level of equipment (see Annex A1.3). The following trends can be seen:

- in the field of communications, almost all the office workplaces in Germany today are equipped with *fixed network telephones*, but approx. 40 % still have simple telephones. Their number will drop sharply up to 2015, whereas the number of smart and cordless phones (relevant for power consumption) will grow by about a fifth from 10.9 million in 2004 to 13.2 million in 2015. In contrast, answering machines, which are widespread mainly in small offices, are showing signs of reaching saturation level since these devices are being increasingly integrated in other appliances. A stock increase from 5 to 5.4 million is expected for fax machines at least up to 2010 and in spite of the substitution effect of e-mail, since businesses want to be able to maintain contact with their customers via different media. In doing so, however, businesses will increasingly switch to multifunctional devices.
- A continued increase in *office computers* is estimated from around 17.5 million today to almost 19.4 million in 2015. However, this is entirely due to the expected strong growth in notebooks, whereas the number of today's predominant desktop computers will probably stagnate at around 10.5 million by 2015. Accordingly, there will no further growth in the number of monitors either. Here, LCD screens will completely

replace cathode screens by 2010. Only a slight increase in stock is anticipated for *printers, scanners and copiers* in the next decade.

The **power consumption** of ICT end-use devices in offices should not differ significantly from those used in private households as long as the performance requirements are also comparable. In these cases, the same assumptions were made for both sectors about power consumption in the three different operating modes. This is the case for cameras, telephones and answering machines, PDAs, matrix printers and projectors. For the other appliances, the office requirements are much greater and the appliances bigger than those in private households so that correspondingly more power is required in normal operating mode and, to some extent, in standby. This is particularly true for fax machines, laser printers and copiers. The monitors used in offices also tend to be larger than those at home and their power consumption in normal mode higher. In future, this size difference will probably diminish. For PCs and notebooks, the opposite is assumed, i.e. that the performance requirements for the majority of office applications are lower than for households and that, increasingly, secondary features such as noise development (Windeck 2001) or energy demand will become the focus of attention. For this reason, lower power consumption is assumed for the existing PCs and notebooks in offices than in households. However, this has no significant influence on standby consumption so that here – as for monitors – the same assumptions are made about power consumption for both households and offices. For copiers in offices, which are frequently used as multifunctional devices in combination with printers, a clear drop in standby power consumption is reckoned between 2004 and 2010 due to more efficient technical solutions for the rapid shift from standby to copy mode. According to information from experts (Weeren 2004), these technical improvements affecting the standby mode seem to be catching on faster than was expected in Cremer et al. (2003), at least for several large manufacturers (Ricoh, Canon). A continued moderate decrease in power consumption is also assumed in off-mode for the majority of office appliances for which this operating mode is relevant (cameras, computers, PDAs, monitors, inkjet printers). Consumption in this mode is expected to remain constant for the other appliances. Under these assumptions, the majority of appliances will still consume over 1 W of power in this technically actually superfluous operating mode in 2010.

Unlike households, there are no regular surveys of **operating times** of ICT appliances in the office sector. The times selected here for the various operating modes represent our own estimations based on existing figures in the literature. The following framework assumptions are made: the appliances are in operation for the usual office hours, on average eight to ten hours and 220 working days per year. The appliances are not used continuously during this time, but are permanently on standby.

2.4 Summary

According to the bottom-up analyses of individual appliances conducted here, the total electricity demand in Germany for electrical household and office appliances including the associated infrastructure amounted to around 100 TWh in 2004 (see Table 2-1). The share of standby consumption equalled almost 18 %. Electricity demand in normal mode is dominated by electrical household appliances which account for about 56 % of the total electricity demand. Electricity demand based only on ICT appliances including their infrastructure was 45 TWh in 2004. Compared to 2001, the base year in Cremer et al. (2003), this represents a 17 % increase of total power demand, most of which, however, can be assigned to the normal mode. The electricity demand in standby increased only slightly by 0.6 TWh, the demand in off-mode remained more or less constant. The share of standby consumption in the total power demand of ICT appliances thus dropped from 40% in 2001 to 36 % in 2004. A further increase in power demand for all electrical household and office appliances from 101 to 111 TWh is expected up to 2010. The growth in consumption is more apparent if only ICT appliances are regarded (from 45 to 54 TWh). This consumption increase is only due to operation in normal mode (above all due to the growth in ICT infrastructure in offices and telecommunications infrastructure). Standby consumption drops between 2004 and 2010 from 18 TWh[6] down to 15.8 TWh and remains more or less at this level until 2015.

However, if only those areas are regarded which are of greater significance for standby consumption and which form the focus of this study – i.e. ICT end-use appliances in households and offices as well as the ICT infrastructure – the share of standby in 2010 is still between 30 and 55 % according to the estimate made here. The share of standby consumption is relatively small among electrical household appliances at around 4 % because of the importance of normal operation, but it shows an increasing tendency and with around 1.8 TWh in 2004 and almost 2 TWh 2010 is in the same order of magnitude as ICT end-use appliances in offices and the ICT-infrastructure in households. Table 2-2 summarizes the standby consumption by appliance group estimated in the business-as-usual scenario for 2004, 2010 and 2015. Overall the standby consumption falls in the four sectors examined here between 2004 and 2010 from 17.8 TWh to 15.5 TWh and remains more or less at this level up to 2015. ICT end-use appliances in households, especially audio-visual devices, account for the biggest share. It is expected that the standby consumption of electrical household appli-

6 Measured against today's electricity consumption of all end-use energy sectors which totalled 497 TWh in 2003 according to data of the German Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen AGEB 2004), this corresponds to the standby consumption of 18 TWh estimated here for 2004 (split into standby operation 15 TWh, off-mode 3 TWh), a share of 3.6 %.

ances and the Internet infrastructure will increase in the near future, whereas a moderate decrease can be reckoned with in the remaining sectors.

Table 2-1: Electricity demand of household and office appliances in Germany between 2001 and 2015

	Electricity demand (GWh)				Share standby
	Normal mode	Standby		Total	
		Standby	Off-mode		
2001					
ICT end-use appl. households	10788	8549	1852	21189	**49.1%**
Electrical household appliances	55323	1659	283	57264	**3.4%**
ICT end-use appliances offices	4009	2665	645	7318	**45.2%**
ICT infrastructure households	557	1208	192	1957	**71.5%**
ICT infrastructure offices[1]	5153	273	0	5425	**5.0%**
Infrastructure telecommunication[1]	2250	0	0	2250	**0.0%**
Total	**78079**	**14353**	**2971**	**95403**	**18.2%**
Total excl. elec. HH appl.	**22757**	**12694**	**2689**	**38139**	**40.3%**
2004					
ICT end-use appliances HH	13573	8967	1965	24504	**44.6%**
Electrical household appliances	54401	1788	313	56502	**3.7%**
ICT end-use appliances offices	3881	2849	542	7272	**46.6%**
ICT infrastructure households	1099	1236	111	2446	**55.1%**
ICT infrastructure offices[1]	7584	273	0	7857	**3.5%**
Infrastructure telecommunication[1]	2646	0	0	2646	**0.0%**
Total	**83184**	**15112**	**2931**	**101227**	**17.8%**
Total excl. elec. HH appl.	**28783**	**13324**	**2618**	**44725**	**35.6%**
2010					
ICT end-use appl. households	20901	7126	1480	29506	**29.2%**
Electrical household appliances	55215	1983	339	57537	**4.0%**
ICT end-use appliances offices	3525	1792	411	5727	**38.5%**
ICT infrastructure households	1930	2396	0	4326	**55.4%**
ICT infrastructure offices[1]	11219	273	0	11492	**2.4%**
Infrastructure telecommunication[1]	2693	0	0	2693	**0.0%**
Total	**95482**	**13569**	**2230**	**111280**	**14.2%**
Total excl. elec. HH appl.	**40267**	**11586**	**1890**	**53743**	**25.1%**
2015					
ICT end-use appliances in HH	23165	7454	1244	31862	**27.3%**
Electrical HH appliances	55007	2128	334	57469	**4.3%**
ICT end-use appliances offices	3566	1558	355	5478	**34.9%**
ICT infrastructure HH	2123	2591	0	4715	**55.0%**
Total [2]	**83861**	**13731**	**1932**	**99524**	**15.7%**
Total excl. elec. HH appl.	**28854**	**11603**	**1598**	**42055**	**31.4%**

[1] taken from Cremer et al. 2003; [2] 2015 excl. office and telecommunications infrastructure

Sources: Cremer et al. 2003; calculations of Fraunhofer ISI and FfE

Table 2-2: Standby electricity demand by appliance group in areas relevant for standby consumption 2004, 2010, 2015 (BAU scenario)

Area/appliance group	2004 GWh	2010 GWh	2015 GWh
ICT end-use devices HH	**10932**	**8606**	**8697**
Audio appliances	2753	2315	2913
Televisions	2770	2142	1935
Video recorders	1182	948	921
Cameras/game consoles	210	131	176
Telephones (incl. mobiles)	1421	1242	1273
Computers	1165	737	568
Monitors	450	237	259
Printers	652	550	395
Others	328	303	258
Electrical HH appliances	**2101**	**2322**	**2462**
of which:			
Microwaves	403	450	495
Cookers	500	551	595
Coffee machines/autom.	591	699	741
Washing machines/driers	371	379	384
ICT end-use appliances offices	**3391**	**2203**	**1912**
Cameras	3	2	2
Telephones	725	733	753
Computers	389	234	159
Monitors	240	115	118
Printers	623	415	353
Others	1410	704	527
ICT infrastructure HH	**1347**	**2396**	**2591**
Televisions infrastructure	483	474	481
Internet connections (broadband)	109	609	743
DSL routers/WLAN	0	575	647
Telephone modems	34	0	0
Entryphones	721	738	721
Total	**17771**	**15527**	**15662**

Sources: calculations of Fraunhofer ISI and FfE

3 Technical application and design possibilities of a labelling obligation

3.1 Specification of the operating conditions in standby

To determine the saving potentials in standby mode in more detail, it is necessary to differentiate between the standby states defined in Figure 1-2. The energy consumption depends on the respective functions and tasks of the components in the appliances. This is why appliances were split into functional sub-groups and analysed with regard to their relevance in the specific operating modes. The criteria used were the main task and the electrotechnical implementation relevant for this:

- *Energy supply and transformation*: all the appliances examined here draw electricity from the mains; some have an additional power supply via storage batteries to maintain power for storage elements etc. Since the appliances not only use the 230 V power pre-set in the mains, but also require deviating voltages for sub functions, they are equipped with adaptors which are either incorporated into the device or externally plugged into the wall outlet. Usually, transformers are used. Cathode ray monitors and televisions require separate high-voltage power supplies. In audio devices, preamplification of the received signal takes place either within the device itself, or there is final amplification of the input signal before this is transmitted to loudspeakers or headphones. Other elements of this subgroup include heaters, e.g. in printers and household appliances.
- *Control electronics* for appliance functions, programming and processing operations, to save settings and in data processing for the computing power function with microprocessors.
- *Signal processing*: recording or receiving analogue or digital signals, e.g. transceivers of aerials, remote controls etc.
- *Information visualization* to display standby state or a certain function, e.g. LEDs on switches or buttons, displays, programmable LCD displays or touch screens.
- *Electrical engineering*: components powered by an electric motor such as disc drives, transport devices, vibrating elements, pumps, fans etc.

The configurations of appliances and functions were categorized with regard to power supply, switchability and the supply of auxiliary functions. The function group fulfils the main function of the respective appliance. Auxiliary functions which have low power consumption compared with the main function include, for example, remote control receivers, automatic switching to sleep-mode, displays, storage units etc. Another distinguishing feature is the positioning of the main power on/off switch. The functional sub groups which contribute to standby consumption can be identified in this way. Us-

ing the groups of appliances, individual end-use appliances were able to be analysed as well as clustered groups of appliances with similar functions.

Audio- and video appliances: the main function here consists of power or signal amplification as well as electromechanical drives and ejection mechanisms in normal mode. A certain minimum energy input is necessary for auxiliary functions such as saving channels, displaying the time and receiving transmission signals (remote control, radio-controlled signals for clocks, radio reception etc.). Usually the device can be switched into standby with a remote control. Part of the device can be switched off, although usually there is not a complete disconnection from the mains. In this case off-mode consumption occurs through losses at the power supply unit and using LEDs to show the standby mode.

Televisions and monitors: the main function comprises the visual and partial acoustic processing of the signal provided from preliminary devices or aerials. TV projectors and screens without loudspeakers or so-called plasma displays have a special status because other components are necessary to process the signal and for the audio function. In summary, the standby mode can be characterized for all television technologies by the mains adaptor and the active standby of the remote control. For CRT screens, standby demand is somewhat greater due to the power input of the high-voltage power supply. The power input during off-mode results from the secondary-side disconnection of the power supply unit from the mains.

Cable and set-top boxes, satellite decoders: there are additional appliances to extend the analogue, usually terrestrial television channels received via aerials or cable. These expand the range of information and entertainment offered. The appliances in this group are remote-controlled and usually have an integrated power supply, a control unit with the possibility of saving channels and a display showing the status, function and/or time. High quality devices are equipped with additional magnetic or optical bulk memory. As a rule there is no way to switch the appliances into off-mode or turn them off completely because they lack power on/off switches. The reception units named are also available as integrated digital televisions (IDTV), PC plug-ins, TV retrofit kits and multifunctional receivers. In these cases, there is generally an increase in the energy consumption of the main appliance.

Portable consumer electronic devices: this category includes mains leads, e.g. for video cameras, digital cameras and small audio/video devices. Standby power input takes place during mains operation of these devices if the mains adaptor is plugged into the wall socket and either the storage battery in the appliance is already fully char-

ged or the device has been disconnected from the power supply. Always pulling the plug when the device is not in use can make a significant contribution to energy saving.

Fixed network telephones: these include cordless telephones and corded smart phones. Cordless phones comprise a base station and the handset. The base unit transmits continuously even if there is no connection. The base unit has an internal charger for the storage batteries and a transmitter/receiver for the signals from the handset. More modern devices have additional displays and often an integrated answering machine. Smart phones do not have a separate power lead for the 230°V mains but are powered via the telephone infrastructure. It is difficult to distinguish the power consumption in different operating modes for telecommunications since the systems are permanently in use and the standby for transmitting/receiving can also be counted as normal operation.

Mobile phones have external power supplies; normal operation is without connection to the mains. Special attention was paid to energy consumption in normal mode during their development because of the grid-independent operation and the longest possible operating time required. As with fixed telephones it is not necessary to distinguish operating modes since the systems are in constant use. An exception is the mains charger if it is not being used to charge the mobile phone's internal batteries but is still plugged in.

Communications infrastructure: this group draws together the infrastructure elements of data processing communications. These include DSL splitters and modems, CATV modems, satellite modems, analogue and ISDN modems and WLAN access points. The appliance configurations are not standardized. Power supply is via internal or external power supply units. In general, the operating modes of the appliances can be characterized as follows: in normal mode the device transmits or receives data, in ready mode it is ready to transmit/receive. Distinguishing only two operating modes is done for example for appliance configurations with continuously running servers and networks which can transmit and process data at any time. The appliance is in standby mode if it is connected to a power supply but the data processing device is switched off.

Communications and data processing peripheral devices: as soon as the appliances have a communication function, it is not necessary to distinguish the power consumption by different operating modes since the systems are operated permanently. These include combined printer-scanner-fax devices, answering machines, fax machines and combined fax/answering machines. Appliances which are only used some of the time and have a standby mode include ink jet printers, laser printers, matrix

printers, scanners and copiers. A constant consumption of at least 1.8 W can be observed through the PSU in all the appliances during the off-mode (EDV) or standby operation (telecommunications). In addition, according to the type of appliance, there are other power inputs which accumulate depending on the function involved.

Household appliances for heating purposes such as, e. g. microwave ovens, cookers, coffee machines and espresso machines generally have higher standby consumption the more advanced they become. Simple appliances usually have no standby consumption because they can be switched off completely. However, there are often displays of temperature, time and other functions which lead to standby consumption if these are active in the standby mode and, for example, show the time. Furthermore, the more expensive cookers now feature touch screen displays to control the appliance's functions which are linked with higher standby consumption. Because they lack a mains switch, microwaves and cookers do not have an off-mode. The off-mode consumption of coffee and espresso machines is an average resulting from appliances which can be completely switched off and those for which power input is recorded because of mains adaptors and/or displays. The ready mode of coffee and espresso machines concerns both keeping the brewed coffee warm and preheating the espresso cups.

Large household appliances: no standby consumption could be identified for refrigerators. There are usually LCDs or displays in washing machines, driers, washer-driers and dishwashers which show information about time selected, programme progress etc. Standby consumption takes place in these devices if the start of normal operation has been programmed using a pre-selected time and as soon as the washing or drying programme has been completed. In both cases, there is power input to the control and the display.

Combination appliances: technically, there is no reason why a combination appliance should have greater power input in standby than the corresponding function of a corresponding single appliance. The consumption should therefore be the same in off-mode. In standby, power input will be reduced if there is a joint use of functional units (e. g. displays). If functional units are combined (e. g. TV, hard disc recorder), then it can be assumed that the total is the sum of each unit's consumption.

3.2 Technical energy saving potentials

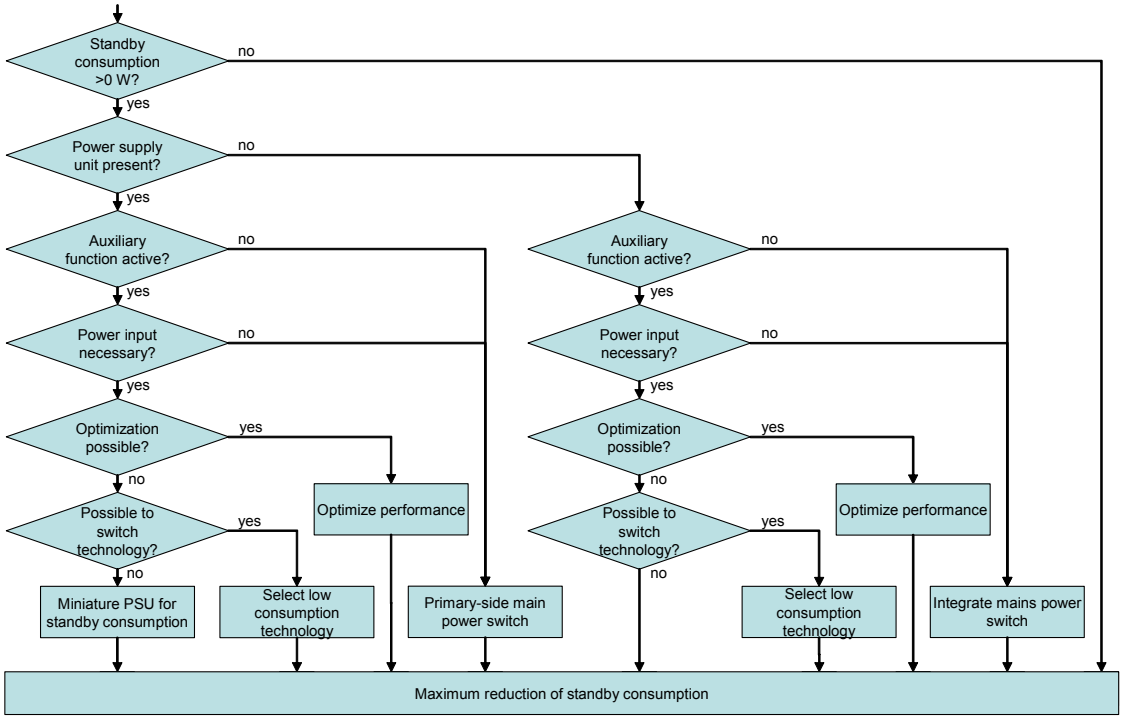
There are potentials to reduce standby losses depending on the appliance category and the functional unit. In the most straightforward case, the standby consumption can be avoided by integrating a primary-side power switch. However, this is the case in

only a few appliances. It is much more common to find functional units being operated in standby or off-mode. In these cases power consumption occurs not only to supply these functional units but also for the PSU. The decision tree in Figure 3-1 illustrates the basic procedure for determining saving potentials.

For appliances with PSUs, off-mode consumption is caused by the continued operation of the power supply unit if this is not disconnected from the mains by the appliance's off-switch. The power switch disconnects the appliance on the secondary side from the mains. The primary side has a constant power demand so that PSU losses take place. In order to reduce this standby consumption, first it should be examined whether necessary auxiliary functions have power input on the secondary-side. If this is not the case, the PSU could be disconnected from the mains on the primary-side and standby consumption would thus be eradicated. The energy supply of auxiliary functions which may be one reason for power consumption could also be achieved using batteries, storage batteries or so-called supercapacitors. On top of this there are storage units available today which do not lose stored data even without a constant energy supply (EEPROM). If the measures presented cannot be implemented, energy optimization would still be possible by breaking down the PSU into a miniature PSU. However, the extra effort and energy required here for production would have to be calculated.

Only a few appliances can manage without an internal or external PSU. In such appliances an unwanted power consumption of the main function of the appliance occurs if there are no auxiliary functions present or power input is not necessary to execute these auxiliary functions, but standby consumption occurs nevertheless. This can be avoided by integrating a mains power switch.

Figure 3-1: Decision tree to reduce the standby consumption of electrical appliances



If no auxiliary functions have to be powered, the off-mode can be completely avoided by integrating a primary-side power switch. For external PSUs, integrating a switch seems impracticable simply for reasons of size. As far as the user is concerned, this consumption can be prevented either by pulling the plug or using a switchable power outlet.

If a function is performed in standby, the mains on/off switch is only rarely an adequate solution. To guarantee the energy supply, the use of switchable power supplies instead of block and toroidal core transformers is the most important option for tapping the energy saving potential. Energy transformation is relevant in standby mode for processes involving heating up and maintaining a constant temperature. In coffee machines, for example, the warming plate would no longer be needed if thermal flasks were used to keep the coffee hot; in espresso machines, the additional luxury function of pre-warming the cups should be able to be switched off. For printers, copiers etc., advanced technologies make pre-warming superfluous.

Considerable energy saving potentials can be achieved in control electronics thanks to modern semiconductor switches. In signal processing, maintaining data storage and reception and transmission setups are relevant for energy consumption in standby mode. Due to new storage procedures and media it is possible to reduce the energy consumption for permanent storage and storing data in the off-mode to zero.

Information visualization appears in almost all appliances in various forms as part of the communication interface between appliance and user. Doing without this function to the maximum extent possible would bring about a reduction in the power consumption, but functions in standby and normal mode are frequently shown using displays. A power reduction could still be achieved using brightness-dependent dimming of the backlighting (LCD), or the display itself (LED), or turning off the backlighting or display. If a two-phase standby mode is involved, the greater degree of readiness shown by more or brighter displays and activation of sensors etc. could be triggered by pressing a switch or by approaching the device (motion detection). If the device is not switched on or no other operational activities are performed, it could return to the lower energy loss mode after, e.g. 5 minutes. Care should be taken that there is a restrained use of displays of an appropriate size and function fulfilment.

Components powered by electric motors are mostly needed to fulfil the main functions of appliances. Fans and data storage devices are relevant for standby energy consumption. More efficient motors could be used in fans. The constant operation of the storage drives could be avoided by additional memory chips.

3.3 Estimating future energy saving potentials

To determine the saving potentials, other factors were included apart from optimisation of the appliance-specific consumption: the development of the stock, the duration of use and the time of use of normal operation/standby modes.

The saving potentials are an essential criterion for the assessment of whether an appliance group is suitable for a label. If a falling stock development is able to be ascertained, e. g. since the appliance is based on an outdated technology, a label does not seem sensible. Long operating lives, e. g. as is the case with large household appliances, mean that even with a high technical saving potential per appliance there will be a comparatively long transitional phase until an impact on the total energy consumption in this appliance group becomes apparent. In contrast, there are particularly large potentials for technical improvements in appliances with short life cycles or in appliances which are still in the market introduction phase.

To supplement this, a theoretical potential is calculated to assess in which appliances the biggest savings would be possible today. The theoretical potential corresponds to the maximum possible saving based on the reference consumption in the base year 2004.

For the extrapolation of the feasible technical saving potential up to 2015 it must also be taken into account how many of the appliances from the stock of 2004 will have

been replaced by new, optimized appliances by this time. This depends mainly on the average useful life as well as the expected market development. It is assumed here that each appliance purchased in the future has the optimized power consumption determined in standby.

Compared to the reference scenario, standby consumption can be reduced by approx. 50 % through technical optimization of the appliances examined here up to 2010 (Table 3-1). In 2015, standby consumption may drop by approx. 65 % compared to the reference. In 2010 this corresponds to a possible reduction of the total power consumption by about 7.1 % and by about 9.1 % in 2015.

Table 3-1: Saving potentials from using consumption-optimized appliances

	Standby [GWh/]	Off-mode [GWh/]	Total [GWh/]	[%]
2010				
ICT end-use appliances HH	3,754	1,284	5,037	17.1 %
HH appliances	521	147	668	1.2 %
ICT end-use appl. offices	818	399	1,217	21.2 %
Infrastructure	952	0	952	5.1 %
Total	**6,045**	**1,830**	7,875	**7.1 %**
2015				
ICT end-use appliances HH	5,455	1,241	6,697	21.0 %
HH appliances	1,065	257	1,322	2.3 %
ICT end-use appl. offices	789	355	1,144	20.8 %
Infrastructure	1,160	0	1,160	6.2 %
Total	**8,470**	**1,853**	**10,322**	**9.1 %**

With possible savings of 5 TWh/a in 2010, ICT appliances in households have a 63.7 % share of the total potential. This ratio increases to 64.8 % by 2015. Of these, audio/video appliances have especially large saving potentials. Saving possibilities of 0.67 TWh/a in 2010 and 1.32 TWh/a in 2015 were identified for household appliances. They thus play only a subordinate role for the total potential. Exploiting this energy saving potential in large household appliances is delayed mainly due to their comparatively long operating lives. Exceptions to this are coffee-espresso machines which show large appliance-specific saving potentials and are in a relatively early market phase.

ICT-appliances in offices offer possible savings of 1.2 TWh/a in 2010. The potential remains more or less on the same level up to 2015 due to today's already foreseeable technical improvements in the reference case. Fax machines, printers and copiers

have the most obvious appliance-specific saving options. However, telephones have the biggest share in this sector because of their large numbers.

With 0.95 TWh/a in 2010 and 1.16 TWh/a in 2015, infrastructure in households has a share of 12 % and 11 % respectively in the overall potential. Optimizing the standby consumption of modems represents a major saving potential. However, in the future, this area will probably be dominated by the standby consumption of DSL-/WLAN-routers. They account for over 40 % of the saving potential in 2010 and 2015.

3.4 Criteria for exemptions from a labelling obligation

Those appliances should be exempted from the labelling obligation for which the application of a label is not thought to be productive from a technical viewpoint. The most important reason for exemption is the existence of only a small possible technical saving potential. This may be due to a long lifespan and thus a lower substitution demand, specialized appliances for a small clientele, expected crowding out of individual technologies in the market, very low standby consumption or foreseeable consumption optimization of future lines of appliances. Another reason for exemption may be that the measurement effort required to determine standby conditions exceeds the expected benefit. In addition it was examined whether to forgo a new label if other product labels are already available for the appliances (Energy Star, Eco-Label, GEEA-Label, TCO, "Blue Angel", EU- and “energy plus" label for household appliances). Some of the labels are not very prevalent. Comparing label requirements with the optimized values determined shows that sometimes the minimum requirements remain far below the technically achievable values. Therefore it is recommended to exempt only large household appliances, for which an obligatory EU label already exists and which, in addition, display a low saving potential in standby mode. Table 3-2 lists those appliances which are to be exempted from a labelling obligation for technical reasons or only labelled to a limited extent, and also lists the relevant reason for exemption.

Table 3-2: Appliances exempt or partially exempt from a labelling obligation

Appliance	Reasons	Comments
ICT end-use appliances in HH		
Cameras		no permanent mains supply
Phones (w/o own mains supply)	too difficult to measure	
Mobile telephones		no permanent mains supply
AV small devices		no permanent mains supply
Mains power cable		no permanent mains supply
PCs		not possible in every case
Household appliances		
Cookers	EU-Label	
Dishwashers	EU-Label	
Refrigerators	EU-Label, no potential	
Freezers	EU-Label, no potential	
Washing machines	EU-Label	
Driers	EU-Label	
Extraction hoods	small saving potential	
Charging stations of small devices	small saving potential, difficult to measure	
ICT end-use appl. in offices		
Cameras		no permanent mains supply
Phones (w/o own mains supply)	difficult to measure	
PCs		not possible in all cases
Infrastructure appliances		
Modems (w/o own mains supply)	influenced by PCs, very difficult to measure	
Antenna preamplifier	small saving potential	
Satellite systems	small saving potential	

Standardized measurement guidelines are a prerequisite for implementing a labelling obligation. The measurements concerned should always be done by the manufacturers – or even better – by independent test institutes. The clear definition of the operating conditions and clear specifications on how to determine the parameters for the appliances are of decisive significance for the conversion into an obligatory label in order to guarantee the comparability of appliances from different manufacturers. To determine stable and reproducible measurements, it is necessary to select one measurement method to a large extent. This must define the requirements made of the measuring devices, the measuring location, procedure and the documentation of the measurement results. The study discusses the demands made of the measurement technology and presents two methods as examples.

4 Legal application and design possibilities of a labelling obligation

4.1 The labelling obligation as part of the system of existing product labels

Against the objective of reducing the standby operation of electrical household and office appliances, the legal part of this report starts with an assessment of the existing obligatory or voluntary product labels at the level of Community law, namely those following from

- the Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances;
- Regulation (EC) No. 2422/2001 of the European Parliament and the Council of 6 November 2001 on a Community energy efficiency labelling programme for *office equipment*, which is affiliated to the Energy Star labelling system launched by the United States of America and
- Regulation (EC) No. 1980/2000 of the European Parliament and the Council of 17 July 2000 on a revised Community eco-label award scheme together with executive legal acts which lists the requirements for awarding the EU eco-label ("Flower").

In addition to this, an assessment is made of the other voluntary product labels, namely the GEEA label, the TCO label, the "Blue Angel" and the ECO Circle. Assessing the current situation showed that the product labelling systems listed do actually cover the standby consumption of electrical household and office appliances, but do not have the necessary degree of effectiveness. The estimation conducted within the scope of this study shows that the standby consumption of electrical household and office appliances still amounts to around 18 TWh in 2004 and will probably still account for almost 16 TWh by 2010/2015. Since this is equivalent to more than 3 % of the total electricity demand of final energy sectors in Germany, there is a substantial need here for follow-up regulation. The lack of effectiveness of the existing voluntary control system also supports a mandatory regulation. A detailed provision in the form of a parliamentary act would have the drawback of constantly having to be updated on account of the dynamic nature of technology developments. To this extent, practicable considerations favour the enactment of a binding legal regulation. The question thus arises as to the legal admissibility of such a procedure.

4.2 Legitimacy of a national legal ordinance

4.2.1 European law requirements

After a study of the pertinent legal competencies of the EU in the scope of the planned ordinance and the *secondary* legal acts passed by the responsible Community authorities in executing these competencies, this study came to the initial result that the applicable law of the European Community does not present the planned regulation with any insurmountable obstacles. In this context, however, the following must be taken into account:

- the European Commission would have to be notified of the planned ordinance in accordance with the applicable provisions.
- In connection with this, where necessary, a standstill period of up to 18 months has to be complied with, which commences with the notification of the Commission.
- The unilateral national plan conforms with primary law especially with view to the prerequisites of Article 28 ff. of the EC Treaty.
- For the section concerning the competence of the Community to harmonize the individual states laws within the domain of the internal market (Art. 95 EC Treaty), it can be reckoned that the European Commission will approve it in accordance with Article 95 paragraph 6 EC Treaty or possibly with adaptation measures under Article 95 paragraph 7 EC Treaty.
- A negative ruling by the Commission could be contested pursuant to Article 230 paragraph 2 EC Treaty with good chances of success.
- Conversely, any potential infringement proceedings by the Commission or another Member State pursuant to Article 226 ff. EC Treaty would have few chances of success in this regulation sector which has not been affected by any legal act of the Community to date.

4.2.2 Assessment under national law

Compatibility with the German Basic Law

The main issue when assessing the planned regulation from the perspective of constitutional law is its compatibility with the basic rights of the potentially affected manufacturers and importers of the relevant devices. Here fundamental rights of the freedom of occupational choice according to Art. 12 paragraph 1 of the Basic Law, property rights under Art. 14 paragraph 1 of the Basic Law and possibly general rights of liberty pursuant to Art. 2 paragraph 1 of the Basic Law are to be discussed; an infringement of the general right to equality before the law might also have to be considered pursuant to Art. 3 paragraph 1 of the Basic Law.

Right to choose an occupation pursuant to Art. 12 paragraph 1 of the Basic Law

Since the regulation being discussed does not in principle render the choice of profession completely impossible ("whether" the activity), it would represent an intervention in the form of regulating the practice of trades and professions ("how" the activity).

According to the statutory provisions under Art. 12 paragraph 1 s. 2 of the Basic Law, the planned ordinance would require a basic statutory power in the form of an act of parliament. A basis for such authorization can be found, as shown in the main text, in the form of granting the power to issue statutory instruments to the ministry in charge, the Federal Ministry of Economics and Labour of the Federal Government in § 1 Abs. 1 s. 1 No. 1 of the Act to enforce European Community legislation in the area of energy saving in appliances and vehicles (Energieverbrauchskennzeichnungsgesetz EnVKG, the German Energy Consumption Labelling Act) of the German Federal Government of 30 January 2002.

However, the provision itself and the ordinance based upon it would have to be constitutional in form and substance. Formally, for enacting the ordinance, only the approval of the Bundesrat has to be considered in accordance with § 1 paragraph 1 s. 1 EnVKG. As far as substance is concerned, the Enabling Act of § 1 paragraph 1 s. 1 No. 1 EnVKG fulfils the requirements of Art. 80 paragraph 1 s. 2 of the Basic Law with regard to an adequate determination of the content, purpose and extent of the statutory powers granted. In other respects the following has to be taken into account with regard to the substantive constitutionality of the planned ordinance:

- The *purpose* of the planned ordinance is a reduction of the standby mode of electrical household and other electrical appliances. According to the results of this study, this standby consumption accounts for 18 % (around 36 % without household appliances) of the total consumption of the appliances concerned and over 3 % of the total electricity demand of the final energy sectors in Germany. The standby share of the power demand in many appliances is over 80 or even 90 %. Standby consumption could be more than halved by technical measures, as a result of which the total consumption could be reduced by about 10 %.
- Therefore, consumers are to be motivated to purchase especially energy-efficient devices by *means* of labelling the standby consumption of the appliances concerned. With regard to influencing consumer behaviour, an indicator should be introduced for energy consumption in standby mode. This can be done by either indicating the power demand during standby or giving a daily energy demand. In line with the results of the technical study, the first alternative of a specific parameter is preferable (no differentiation of consumption groups along the lines of freezers etc.). It makes sense to refer to the pertinent standard IEC 62301 “Household Electrical Appliances – Measurement of Standby Power” for the measurement method to be applied. This is an international standard of high accuracy. However it also

requires substantial investments to be made in the measurement equipment required.

- For this reason, a general *hardship clause* should be incorporated into the planned ordinance, which exempts certain groups from the labelling obligation. For example, especially in the case of personal computers, it is significant that this kind of device is not only made by industrial mass producers. Instead their sizing and packaging is done to a considerable extent by smaller firms, who assemble the appliances from prefabricated components by customer order. These kinds of firms can thus legally be understood to be the producers of the thus resulting products. If they had to comply with the planned ordinance, these suppliers would have to subject their products to the obligatory measurements in line with the IEC 62301 “Household Electrical Appliances – Measurement of Standby Power”. Since there are no data provided on to what extent and under which conditions these kinds of measurements can be done by third parties in individual cases, it cannot be ruled out that the costs involved may reach a level which exceeds the supplier’s economic capacity in individual cases and thus make it virtually impossible for him to exercise his respective profession.
- On the other hand, adopting a *minimum limit* (such as *standby consumption of 1 W,* see Chapter 5.3), below which devices would be exempted from a labelling obligation since their standby consumption would be insignificant and can be neglected from the viewpoint of effectiveness, is *not* appropriate because possible *contraindications* of such a regulation are to be feared. For instance, consumers might think non-labelled devices are not energy-efficient even though they might be especially resource economic. In this case, under certain circumstances, the diffusion of electronic devices would actually be hindered which are especially worthy of promotion. It is true that this could be counteracted by increased educational efforts, but such additional measures would also involve considerable costs and, ultimately, it is hard to estimate their success.
- There are similar reservations with regard to the converse option, i. e. designing the planned label along the lines of existing labels as a *purely positive* one, which is only assigned to those devices which are below a specific, predefined energy consumption limit (e. g. the already mentioned 1 Watt limit). So far, it cannot be foreseen to what extent differentiated limit values would have to be introduced for the devices covered by the planned legal act. However, irrespective of such questions of detail, it is decisive that a positive label would not record the varying energy efficiencies of non-labelled goods at all. In this regard, the label would be completely ineffective at influencing the behaviour of final consumers. The target of the planned ordinance would not be met in this respect and therefore a positive label has to be dropped for reasons of *suitability*.
- The same arguments can be applied to the last remaining option of a standardized *negative label* for devices which exceed a corresponding minimum limit: this kind of labelling would also be specified based on the fixed measurement of a correspond-

ing limit value. As a result, all the labelled devices would be lumped together in an *undifferentiated heap* in which considerable differences in efficiency would get lost and in which it would not be possible to further influence the purchase behaviour of consumers. Such a regulation would also fail to meet its objective and is therefore to be discounted from the viewpoint of suitability.

Property rights pursuant to Art. 14 paragraph 1 of the Basic Law

So far as the labelling obligation has an impact on property rights, it would represent merely a so-called determination of the contents and limits of private property under the current formal perception of expropriation. The regulation is to be accepted on principle without compensation as a product of the social obligation of property in accordance with Art. 14 paragraph 2 of the Basic Law. For the rest, refer to the comments on Art. 12 paragraph 1 of the Basic Law.

General freedom of action pursuant to Art. 2 paragraph 1 of the Basic Law

As far as an encroachment on the collective fundamental rights of general freedom of action in terms of Art. 2 paragraph 1 of the Basic Law remains to be considered, especially for foreign producers and/or importers, this would be justified as a product of the constitutional order.

General right to equality pursuant to Art. 3 paragraph 1 of the Basic Law

Violations of the general right to equality by the labelling obligation are not expected since the planned hardship clause will cover most cases of unjustified equality violations. As far as any relevant unequal treatments of fundamentally equal or equal treatments of fundamentally unequal circumstances occur, these will probably also be justified from the view of the pursued targets of consumer information and environmental protection.

Compatibility with ordinary law

There is no discernible infringement of the ordinary statute law by the planned ordinance in view of the precedence of the law in accordance with Art. 20 paragraph 3 of the Basic Law.

4.3 Form and content of the regulation to be created

For reasons of the constitutional principle of clarity, the formulation of the draft legislation relies heavily on the pertinent ordinance on labelling household appliances with

information about the consumption of energy and other important resources of 30 October 1997 (BGBl. I 1997, 2616), amended 26 November 1999 (BGBl. I 1999, 2372), amended 19 June 2001 (BGBl. I 2001, 1149), most recently modified on 19 February 2004 (BGBl. I 2004, 311). This is also valid for the regulatory part in a stricter sense (§§ 6 and 7 of the draft legislation).

The following specific characteristics apply:

With a view to the ambit of the planned ordinance, first of all, the *devices covered* by it are to be identified. The legal evaluation follows the technical recommendations in this respect and adopts the list of the appliances to be labelled (Table 5-1). This list is integrated into the draft legislation modelled on the cited ordinance on the labelling of household appliances with information about the consumption of energy and other important resources of 30 October 1997.

On top of this, the *different standby conditions have to be defined*. Since each differentiation of the relevant standby conditions is subject to the constitutional requirements of certainty, it seems imperative to keep the planned regulation as lean as possible at this point. In § 2 No. 2 – 4, the draft legislation therefore adopts only a *minimum differentiation* between *standby operation,* in which the appliance fulfils at least one auxiliary but not its main function ("standby"), and the *off-mode*, in which the appliance has every appearance of being switched off, but still actually consumes power ("off"). This minimum differentiation goes hand in hand with an *unavoidable waiver* of formulating further information obligations with regard to other modes of standby consumption. We currently believe this waiver to be necessary because the adopted minimum differentiation itself already entails considerable definition problems which are described in more detail in the full version of this report.

As far as the *persons* affected are concerned, the labelling obligation is to be aimed categorically at the manufacturers of the respective appliances on the principles of selecting those who may hinder its implementation ("Grundsätze der Störerauswahl"). The ambit of the planned ordinance is so far restricted to the sovereign territory of the Federal Republic of Germany. Should a manufacturer be located outside this territory, the labelling obligation would have to address other suitable persons. The draft legislation takes this requirement of a differentiated regulation into account in § 3. According to paragraph 1 of this provision, the labelling obligation of a registered appliance always concerns its manufacturer. In case the manufacturer concerned is not resident in the Federal Republic of Germany, his proxy for this country is then the addressee of the labelling obligation in accordance with paragraph 2. If neither the manufacturer nor any proxy of his is resident in the Federal Republic of Germany, then the obligation

cited is incumbent upon the person responsible for marketing the appliance according to § 3 paragraph 3. This should cover all the relevant groups of persons, including mail order businesses.

With regard to *the design of the label*, first of all, one of the two possibilities shown in Figure 5-1 (simple label without classification) and Figure 5-3 (label with classification) has to be selected. The variant with classification closely follows the design of the EU energy label and thus involves a not insignificant danger of confusing the consumer. In principle, such confusion is harmless under Art. 7 b) s. 2 of the Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources. All the same, in order to emphasize the fundamental difference between labelling normal operation and standby mode for the final consumer, the obvious thing would be to design a label which stands out optically from the product label offered under Community law. Subject to the approval of the responsible Federal Ministry of Economics and Labour, the design alternative 1 (Figure 5-1) should therefore be preferred. This variant consists of a circle divided into two halves by a horizontal line. The top half of the circle shows the energy consumption in standby and the bottom half the energy consumption in off-mode.

There are *two other subvariants* for standby operation, either to record one fixed value or two values for the minimum and maximum power consumption (see Figure 5-1 and Figure 5-2). If only one fixed value is selected, this could be the value reached 15 minutes after completion of the main function in its delivered condition. This variant would have the advantage of a uniform definition. It would avoid any other definition problems and would probably be less confusing for the final user. This variant was therefore adopted in § 5 paragraph 2 of the draft.

With regard to the relevant measurements for the label in the upcoming legal act, reference should be made to the IEC 62301: Household Electrical Appliances – Measurement of Standby Power, as already pointed out.

The necessity of a *hardship clause* has already been mentioned. The term "unreasonable hardship" was used here. This is an indeterminate legal term which has found its way into many public and private law standards and is open to further judicial revision in case of litigation.

A *minimum limit* of 1 Watt is not included in the design for the reasons already elaborated.

Within the scope of this survey, draft legislation was also formulated in concrete terms based on the Energy Consumption Labelling Act. After a preamble, this informal draft

contains a provision about its potential ambit to start with (§ 1), followed by definitions (§ 2) and rules and regulations about the addressees of the labelling obligation (§ 3), the prerequisites for marketing the appliances covered (§ 4) and the design of the product label itself (§ 5). After a regulation of the legal powers of the competent authority (§ 6), an administrative offence norm (§ 7) and a stipulation of when it should come into effect (§ 8), the draft closes with a final clause, followed by two annexes with an index of appliances and the label design.

5 Conclusions and recommendations for the design of a mandatory label

5.1 Preliminary considerations

A labelling obligation has several direct and indirect goals which have to be considered for it to be accepted, put into practice and bring about the desired effects. It affects a multitude of players and general framework conditions. The main players involved are manufacturers, buyers and retailers. The objectives of the regulation are the following:

- motivate manufacturers to offer electricity-saving appliances – i.e. here, specifically appliances with low standby consumption.
- It should be possible for buyers to easily obtain information about the standby consumption of the desired appliance and they should be motivated to buy energy-saving appliances wherever possible.
- Retailers, who function as important multiplicators for private consumers, should be made aware of the issue of standby consumption and be informed about the range of appliances offered in order to be able to convince and advise customers making a purchase decision.

The frame conditions necessary for designing such a labelling obligation, any obstacles to its implementation and measures to overcome these were determined based primarily on extensive telephone interviews with experts and key players in the various groups involved but also literature research, related conferences and the workshop of 11, November 2004. At the same time, supporting instruments to promote the implementation and the effectiveness of the label were also brought up for discussion.

On the supply side, considerable reservations were detected on the part of **manufacturers** about this kind of ordinance with regard to the frame conditions for implementing a labelling obligation as well as possible obstacles and instruments to overcome them. The arguments put forward included current technical improvements, existing voluntary measures, the high number of labels already present – especially the generally accepted and requested Energy Star – and the lack of interest on the part of buyers in the energy efficiency of appliances. In general it became clear that manufacturer organizations sometimes have a more restrictive attitude towards acceptance issues than do some of the manufacturers themselves who may actually champion energy saving in their appliances in order to get a competitive advantage. These pioneering manufacturers would use the label to enhance their image and to promote the sales of high-quality appliances.

On the demand side, a distinction has to be made between **private consumers** for whom the aim of such a label on the appliance is to influence the purchase decision and **professional buyers** who purchase appliances based on lists or requirement specifications. The label is not actually important for the latter, but the labelling in product descriptions, appliance lists, databases etc. would help in making selections or calls for tenders. The role of institutional buyers, who are able to exert a certain market pressure, is emphasized not only by manufacturers, but also by independent experts. These insights result in the claim that policy measures can only be successful on the manufacturers' side if they are accompanied by measures on the demand side. As far as private consumers are concerned, it is important to stimulate the buyer directly at the point of sale. A sensible approach would be a conspicuous and easily comprehensible label on every appliance that the potential buyer looks at or takes from a shelf. This effect at the point of sale distinguishes the label from all other promotion instruments.

5.2 Proposed mandatory label

It is recommended to restrict the labelling to the following appliance groups due to the technical exemption criteria (Table 5-1):

- Audio devices, televisions, video recorders and video game consoles,
- fixed network telephones with autonomous power supply,
- computers (with the exception of PDAs), monitors, printers, scanners and photocopiers, microwave ovens and coffee-espresso machines.

Mains supply units, some appliances with low potential (e.g. extractor hoods) and household appliances which are already covered by the EU-label should not be included.

In compliance with the study's objectives, the labelling obligation should be explicitly imposed on manufacturers and importers not – as is the case with household appliances – on retailers. Only those supplying appliances via mail order and Internet trading would have to include the labels in their catalogues.

In order to achieve the intended purpose, that is to support customers in their purchase decision in favour of an energy-efficient appliance, the label has to be conspicuous to the buyer. Since it usually the case that some appliances are displayed, but others are sold packaged, it is necessary for manufacturers to apply the label to the packaging as well as to the appliance itself and, on top of this, to incorporate it into the operating instructions.

Table 5-1: List of the appliances to be labelled

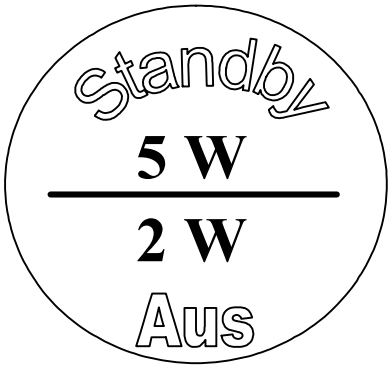
Function	End-use appliances		Building-internal infrastructure
Main group	Households	Offices	
Entertainment (Audio visual)	**Audio** Compact system Hifi amplifier Cassette recorder CD player Minidisc player Other media players Clock radio Radio recorder **Televisions** Cathode ray TV LCD TV Plasma TV Front-projection Rear-projection SAT boxes DVB boxes Cable boxes **Video** Video recorder (analogue) DVD player DVD recorder Hard disc recorder AV receiver Subwoofer **Other devices** Video game consoles		
Communications	**Telephones (fixed network)** Cordless (DECT) Smart Answering machines Fax machines	**Telephone (fixed network)** Cordless (DECT) Smart Answering machines Fax machines	**Communications infrastruc.** DSL modem CATV modem Satellite modem WLAN sender/router Telephone modem
Data processing	**Computers** Personal Computer (PC) Notebook **Monitor** Cathode ray Flat screen **Printers** Ink jet Laser Matrix **Other devices** Scanner Copier (desktop)	**Computers** Personal Computer (PC) Notebook **Monitor** Cathode ray Flat screen **Printers** Ink jet Laser Matrix **Other devices** Scanner Copiers Projectors	
Domestic	**Household appliances** Microwave ovens Coffee-espresso machines		

The proposed label should contain two pieces of information: the power consumption in Watt in standby mode split into “standby” and “off”. This distinction seems sensible because the technical possibilities to reduce or even prevent the power consumption caused by these two operating modes are completely different. It would also have the advantage of informing the buyer of the existence of off-mode consumption as long as

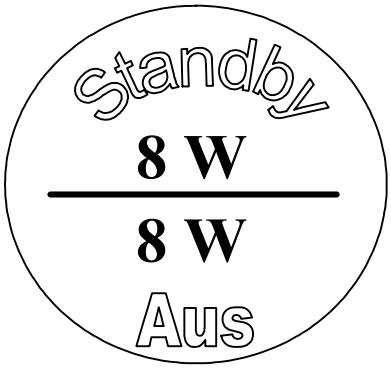
this superfluous operating mode exits. Figure 5-1 shows two examples of the label ("Aus" means "off").

Figure 5-1: Proposal for a label showing standby consumption

Television



Set-top box

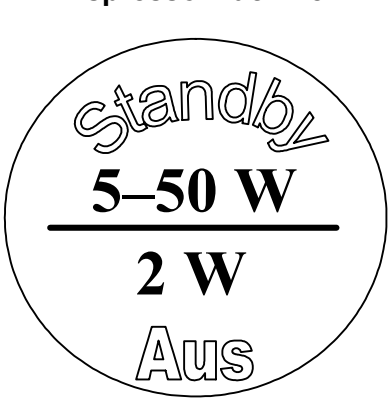


If, e.g. the television can be completely turned off using a switch, the power input when off would be indicated with “0 Watt”; there is no off-mode in such an appliance. The right-hand label shows an appliance which does not have an off-switch, such as a set-top box. In this case, the values on the label for “standby” and “off” are identical.

It becomes more difficult to indicate the power consumption in standby mode if an appliance can have several different values, e. g. a coffee or espresso machine. Two variants are possible here: either indicating the lowest automatically achieved power consumption which, e. g. occurs 15 minutes after completion of a main function and is neither influenced by the type of main function nor the user. This could take into account auto-off functions if these become effective after 15 minutes at the latest. Or a range could be indicated, i. e. the minimum and maximum power consumption in this operating mode (Figure 5-2).

From a technical perspective, indicating the range seems sensible so as to not discriminate against appliances with energy-saving functions. From a legal viewpoint, in contrast, a label containing only one value is preferable because this variant would have the advantage of a uniform concept and would also avoid other definition problems. Experts were primarily concerned about the comprehensibility of indicating a range of values for many buyers. It is therefore suggested to favour the first variant with only one value.

Figure 5-2: Label for an appliance with a range of power consumption



The experts also had reservations about whether the term "Watt" might be incomprehensible for some buyers or confusing (high Watt figures are actually positive for some appliances) but the advantage of stating power consumption in Watt is its relatively unproblematic and precise measurability. All the possible alternatives which were discussed at the workshop, such as showing a daily or annual energy demand, or the standby consumption as a monetary value, have serious drawbacks in this respect. At the same time, parallel information measures are indispensable in order to ensure the effectiveness of the regulation.

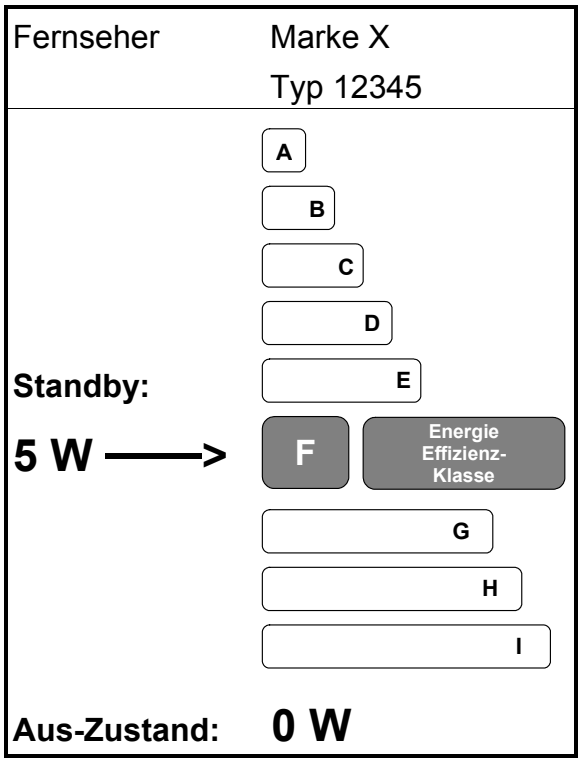
5.3 Alternatives to the proposed label

One basic alternative to the reference figures given, which was favoured by a representative of the industry, is the development of an energy efficiency index which shows the total efficiency of an appliance and includes all its operating modes. The buyer would thus be given a relative figure indicating whether an appliance is energy-efficient or not. This suggestion should be followed up since it represents a good alternative to the measurement figures used so far, at least in the medium to long term. Considering the overall energy efficiency of appliances is sensible since electricity consumption is expected to increase primarily in normal mode in the near future. A first approach to take the overall efficiency of an appliance as a base has been made with the new voluntary commitment of industry to improve the energy efficiency of consumer electronic appliances, although this is restricted to CRT televisions. However since the focus of attention in this study is on the examination of standby consumption, this option was not looked at in more detail.

Other possibilities for the label design were discussed with specialists but finally abandoned on account of various drawbacks. The well known EU household appliance classi-

fication label (as a possible design for standby consumption see Figure 5-3) refers only to normal operation; the same design for standby consumption would confuse the consumers. Furthermore, classifying a device in comparison with other appliances would be very difficult to do and would have to be continually updated.

Figure 5-3: Possible design of a classification label



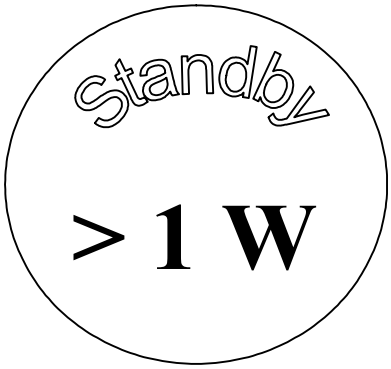
In principle, such a classification label would be welcomed by the workshop experts because of the extra information gained. However, there were varying views about transferring the classification used in the EU energy label, which so far has only referred to normal mode, to the standby mode. The familiarity of the label was seen to be a positive attribute, but other experts fear that the transfer of the EU label to standby consumption will be difficult to communicate to buyers and could give rise to confusion. From a legal viewpoint, designing the label in this way would also pose problems. In addition, using a coloured label in line with the EU energy label would be desirable to make it easily recognizable for the consumer, but in the case of the standby label is probably difficult to realize on account of the high costs due to the large number of appliances and because of having to attach it to the packaging as well. The size of the label would also be impracticable in this case.

In general, a classifying label means considerable additional administration compared to a simple label without classification due to the necessary plausible division of the classes and their adjustments over time which would definitely be a problem in the rapidly changing sector of ICT.

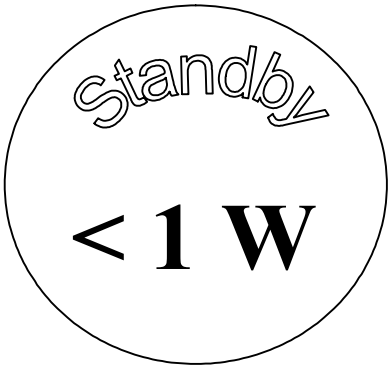
The demand to limit standby consumption to one Watt wherever possible and to label appliances as positive or negative in accordance with this (<1 W or >1 W) is behind another frequently suggested solution, the "1-Watt label", shown in Figure 5-4. The meaning of such a label might be easier to communicate to appliance buyers than a distinction between standby and off-modes. The idea of a 1-Watt limit has already been pursued in numerous initiatives at both national and international levels (Meier et al. 1998, Anderson 2004, www.innovationsoffensive-deutschland.de, and www.action1watt.com).

Figure 5-4: Positive or negative 1-Watt label

negative 1-Watt label indicating inefficient appliances



positive 1-Watt label indicating efficient appliances



Appliances which use more than one Watt in standby would be indicated with the "negative" label; other appliances would not be labelled. In contrast, the "positive" label would pick out especially efficient appliances and the less efficient ones would not be labelled. A series of counter arguments, both technical and legal, offset the advantages of this solution with regard to the execution and the simplicity from the consumer's point-of-view. One argument against the "negative" label is that no differentiation is made between standby and off-mode and that the blanket 1-Watt limit does not do justice to the wide range of power consumption of the appliances in standby. The 1-Watt threshold has already been reached in some appliances and in others cannot be reached at all at present or only at considerable cost. Furthermore, the lack of a label might be misinterpreted by buyers of appliances, especially in the most efficient appliances, since a label usually means a quality characteristic among the voluntary labels

dominant up to now. On top of this, there is no way to distinguish appliances which are not labelled by manufacturers although their power consumption in standby is over 1 Watt. In the "positive" labelling of efficient appliances, some of these technical concerns would no longer be applicable, but not the objection that varying energy efficiencies above 1 Watt would not be covered at all. This would fail to meet the objective of the regulation to the extent that the desired influence on the behaviour of the end-users would not be achieved.

5.4 Parallel measures

The labelling ordinance alone will not be sufficient to promote appliances with low standby consumption on the market as quickly and comprehensively as possible. Studies show that development, marketing and purchase decisions which favour energy-efficient appliances are most influenced by several instruments working together (IEA 2001). This is why supportive measures are recommended for the introduction of a mandatory label:

- campaign for private consumers and professional buyers in connection with the introduction of a label,
- information and motivation campaigns for retailers as important multiplicators,
- entering consumption figures to those databases referred to especially by bulk buyers,
- awarding prizes to particularly energy-efficient appliances such as, e. g. is done by the GEEA (www.energielabel.de) or by the TopTen in Switzerland (www.topten.ch),
- occasional checking of the measurements since the standby labelling is basically a self-declaration,
- regular consumer surveys on the role of the energy label and purchase behaviour as well as an empirical survey before its introduction on the acceptance and design of the label, e. g. within the scope of intensive group discussions with selected groups of buyers.

5.5 Estimating the effectiveness of the proposed regulation

Based on the technical saving potentials which could be achieved by reducing standby electricity consumption, the effectiveness of the labelling obligation was estimated for the two years 2010 and 2015. Since only new appliances are to be labelled, the effects only occur if new appliances are purchased or old ones replaced. It is assumed that the effect of a labelling ordinance is backed by the supportive measures described.

Estimating the effectiveness of the proposed regulation was based on criteria such as the degree of compliance with the ordinance, technical improvements initiated, support by the retail trade as well as the influence on the purchase decision and user behaviour. Each of these criteria was evaluated as to the contribution it could make to exploiting the technically possible saving potential. In addition the estimation of effectiveness drew upon the existing expert knowledge at the Fraunhofer ISI and a comprehensive survey of existing national and international literature on the impacts of obligatory and voluntary energy and environmental labels (e. g. IEA 2001, Weil/McMahon 2001, Rubik/Scholl 2002, Müller 2002, eceee 2003, SAFE 2004). Even so, only a rough estimate of an effective saving potential is possible since so far there has been very little experience gained with obligatory product labels (Schlomann et al. 2001, Waide 1998, 2000, 2001).

Depending on the type of appliance, 30 to 80 % of the technical saving potential can be achieved by the labelling obligation, i. e. almost 5,000 GWh for end-use appliances in households, 650 GWh in office appliances and 360 GWh in infrastructure appliances up to 2015. In total, 6,200 GWh or two thirds of the technical potential could be tapped in this way (Table 5-2).

The estimates were made for individual types of appliances. Audio devices account for the biggest effective potential in households (1,810 GWh up to 2015), followed by televisions (1,170 GWh by 2015). Of the household appliances, only microwave ovens and coffee-espresso machines were included; in both cases the potential is set to increase quite a lot in the future. The number of coffee-espresso machines will continue to grow, particularly in the office sector; this could not be taken into account, however, because there are no stock data available.

Table 5-2: Effective saving potential of a mandatory label

Appliance group	**technical saving potential**		**effective saving potential**	
	2010 GWh	**2015 GWh**	**2010 GWh**	**2015 GWh**
ICT appliances in HH	4,810	6,390	3,345	4,920
Household appliances	270	660	150	270
ICT office appliances	1,210	1,140	680	650
Infrastructure appliances	880	1,020	305	360
Sum	**7,170**	**9,210**	**4,480**	**6,200**

The same basic assumptions were made for ICT end appliances in households and offices, the factors of influence, however, were weighted differently. The label should have greater influence in the office sector - provided it appears in the goods declaration

and corresponding databases – than it does on private consumers, whereas the influence of user behaviour will probably be bigger in households than workplaces. All in all, the potential for computers, monitors, printers and telephones in offices is much smaller than in households. Infrastructure appliances in households have growing significance, e.g. modems. However, since the scope for changes in consumption is small, the label will probably only make a minor contribution to tapping the potential here.

In spite of a multitude of technical, legal and organisational frame conditions which would have to be taken into account; this study showed that substantial energy savings could be achieved in the majority of the appliances considered by labelling the standby consumption in a simply designed way.

5.6 Additional and alternative ways to lower standby consumption

Among experts, there is relatively little acceptance of the concept of an obligatory label such as was examined here. It is argued that other measures are better suited to lower standby consumption or to completely eliminate the off-mode.

In principle, there are a whole series of available instruments besides obligatory labelling to promote the market diffusion of appliances with low standby consumption: voluntary labels, minimum requirements, voluntary agreements with manufacturers, grant programmes, tax concessions, co-operative procurement in connection with corporate energy management as well as information and motivation campaigns.

Voluntary agreements with manufacturers via minimum requirements and voluntary commitments are already ongoing for several kinds of appliance. Measures of co-operative procurement as well as information and motivation campaigns are recommended as supportive measures for an obligatory label, but are also useful if no labelling ordinance is passed. Grants and tax concessions for electricity-saving appliances are not suggested on account of their high "free rider" effect.

Particularly appropriate supplementary instruments include:

- setting minimum efficiency specifications, especially for appliances excluded from the labelling such as power supply units,
- a general ban of the off-mode or the requirement to install a mains power switch as well as
- the continued use and expansion of existing voluntary labels, e. g. Energy Star, European Eco-Label, "Blue Angel" and the GEEA label.

An obligatory declaration as an alternative to the obligatory labelling is conceivable in which the standby consumption is listed in the appliance description according to pre-defined criteria. This could be linked to the obligation to enter such data into a data-base so that up-to-date information would always be available to organisations such as the GEEA and professional buyers. This solution is supported by the proposal for a framework directive of the European Parliament and the Council to define requirements for the environmentally-compatible design of energy-using products.

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Annex 1: Updated results of the evaluation model

A1.1 ICT end-use appliances households (for the years 2001, 2004, 2010 and 2015)

Year: 2001		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Audio							
	Compact system	22	1250	27.5	10	6259	62.6
	Hifi system [1]	40	1250	50.0	10	3755	37.6
	Clock radio	3	90	0.3	1.7	8670	14.7
	Radio recorder	6	220	1.3	1.8	3416	6.1
Televisions							
	Cathode ray TVI[2]	75	1646	123.5	7	3305	23.1
	LCD TV	40	1646	65.8	5	3305	16.5
	Plasma TV	350	1646	576.1	7	3305	23.1
	Front-projection TV (beamer)	180	1646	296.3	7	3305	23.1
	Rear-projection TV	180	1646	296.3	2	3305	6.6
	SAT boxes	20	1873	37.5	9	6887	62.0
	DVB boxes	-	-	-	-	-	-
	Cable boxes	17	1873	31.8	9	6887	62.0
Video							
	Video recorder (analogue)	17	440	7.5	6	5547	33.3
	DVD player	17	110	1.9	6	5767	34.6
	DVD recorder	-	-	-	-	-	-
	Hard disc recorder	-	-	-	-	-	-
	AV-Receiver	-	-	-	-	-	-
	Subwoofer	-	-	-	-	-	-
Cameras							
	Video camera/camcorder	9	60	0.5	6	120	0.7
	Digital camera	9	60	0.5	6	60	0.4
Other devices							
	Video game consoles	15	100	1.5	0	0	0.0
Telephone (fixed network)	Cordless telephone (DECT)	3.5	150	0.5	2.5	8610	21.5
	Smart phones	4	150	0.6	2.5	8610	21.5
	Answering machines	3.5	50	0.2	3	8710	26.1
	Fax machines[5]	13	20	0.3	4	8740	35.0
Telephone (mobile)	GSM[3]	11.64	62	0.7	0.36	4318	1.6
	UMTS[3]	-	-	-	-	-	-
	Mobile phone charger[4]				2	2190	4.4
Computers							
	Personal Computer (PC)	55	370	20.4	25	1250	31.3
	Notebook	18	370	6.7	6	671	4.0
	PDA	1.5	60	0.1	1.2	2436	2.9
Monitors							
	Cathode ray screen	70	370	25.9	15	625	9.4
	LCD screen	20	370	7.4	5	875	4.4
Printer [6]							
	Ink jet	20	30	0.6	6	698	4.2
	Laser	150	30	4.5	20	698	14.0
	Matrix	30	30	0.9	16	698	11.2
Other devices							
	Scanner	18	15	0.3	6	5896	35.4
	Copier (desktop)	200	5	1.0	40	25	1.0
	Active loudspeakers	3	185	0.6	1.5	772	1.2
Total	**ICT end-use appliances HH**						

[1] Consists of Hifi-Amplifier and cassette recorder or CD player or audio DVD or minidisc player
[2] incl. TV-Video combination and portable TV
[3] Power used taking into account the efficiency during charging
[4] Electricity consumption of charging devices not disconnected from the mains
[5] Incl. fax/answering machine combinations
[6] Incl. combined printer, scanner and copiers (poss. also with additional fax function)

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						1989.6	**2689.3**	**207.0**	**4885.8**
1.5	500	0.8	751	90.8	19834	545.4	1241.4	14.9	1801.7
4	1255	5.0	2500	92.6	28392	1419.6	1066.1	142.5	2628.2
0	0	0.0	0	15.0	19846	5.4	292.5	0.0	297.9
1	3416	3.4	1708	10.9	14514	19.2	89.2	49.6	158.0
						7511.1	**2438.3**	**209.5**	**10158.9**
2	1905	3.8	1904	150.4	54417	6717.8	1258.9	207.3	8184.0
2	1905	3.8	1904	86.2	485	31.9	8.0	1.8	41.8
2	1905	3.8	1904	603.0	25	14.4	0.6	0.1	15.1
5	1905	9.5	1904	328.9	25	7.4	0.6	0.2	8.2
0.1	1905	0.2	1904	303.1	133	39.4	0.9	0.0	40.3
0	0	0	0	99.4	17701	663.1	1097.2	0.0	1760.2
-	-	-	-	-	-	-	-	-	-
0	0	0	0	93.8	1164	37.1	72.1	0.0	109.2
						183.8	**889.3**	**74.1**	**1147.2**
2	1387	2.8	1387	43.5	23897	178.7	795.3	66.3	1040.3
2	1442	2.9	1442	39.4	2717	5.1	94.0	7.8	106.9
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
						5.3	**6.3**	**31.2**	**42.8**
1.5	2249	3.4	6331	4.6	7556	4.1	5.4	25.5	35.0
1.5	1704	2.6	6936	3.5	2252	1.2	0.8	5.8	7.8
1.5	2898	4.3	5762	5.8	9818	14.7	0.0	42.7	57.4
						15.3	**1050.1**	**0.0**	**1065.5**
0	0	0.0	0	22.1	15653	8.2	336.9	0.0	345.1
0	0	0.0	0	22.1	4862	2.9	104.7	0.0	107.6
0	0	0.0	0	26.3	16181	2.8	422.8	0.0	425.6
0	0	0.0	0	35.2	5312	1.4	185.7	0.0	187.1
						33.8	**278.2**	**0.0**	**312.0**
0	0	0.0	4380	2.3	46877	33.8	72.9	0.0	106.7
-	-	-	-	-	-	-	-	-	-
0	0	0.0	6570	4.4	46877	0.0	205.3	0.0	205.3
						452.1	**689.0**	**483.7**	**1624.8**
4	4998	20.0	2142	71.6	21509	437.7	672.2	430.0	1539.9
4	5286	21.1	2433	31.8	2121	14.1	8.5	44.8	67.5
1	3132	3.1	3132	6.1	2835	0.3	8.3	8.9	17.4
						541.2	**197.3**	**248.6**	**987.1**
3	3883	11.6	3883	46.9	20648	534.8	193.6	240.5	968.9
2.5	3758	9.4	3758	21.2	861	6.4	3.8	8.1	18.2
						29.4	**133.5**	**446.3**	**609.3**
4	6460	25.8	1572	30.6	14572	8.7	61.0	376.5	446.3
3	4801	14.4	3231	32.9	4404	19.8	61.5	63.4	144.7
2	3231	6.5	4801	18.5	984	0.9	11.0	6.4	18.2
						11.9	**177.6**	**108.8**	**298.2**
3	500	1.5	2349	37.1	4462	1.2	157.8	6.7	165.7
2	4365	8.7	4365	10.7	2290	2.3	2.3	20.0	24.6
1	5454	5.5	2349	7.2	15056.3	8.4	17.4	82.1	107.9
						10788.2	**8548.8**	**1852.0**	**21189.0**

Year: 2004		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Audio							
	Compact system	22	1250	27.5	8	6259	50.1
	Hifi system [1]	40	1250	50.0	10	3755	37.6
	Clock radio	3	90	0.3	1.7	8670	14.7
	Radio recorder	6	220	1.3	1.8	3416	6.1
Televisions							
	Cathode ray TVI[2]	90	1727	155.4	6	4420	26.5
	LCD TV	90	1727	155.4	3	4420	13.3
	Plasma TV	350	1727	604.5	3	4420	13.3
	Front-projection TV (beamer)	210	1727	362.7	7	4420	30.9
	Rear-projection TV	180	1727	310.9	2	4420	8.8
	SAT boxes	17	2000	34.0	8	6760	54.1
	DVB boxes	8.5	2000	17.0	6	6760	40.6
	Cable boxes	17	2000	34.0	8	6760	54.1
Video							
	Video recorder (analogue)	17	462	7.9	6	5532	33.2
	DVD player	12	231	2.8	5	5686	28.4
	DVD recorder	25	462	11.6	10	5532	55.3
	Hard disc recorder	32	462	14.8	8	5532	44.3
	AV-Receiver	35	2352	82.3	2	6408	12.8
	Subwoofer	15	1727	25.9	8	5861	46.9
Cameras							
	Video camera/camcorder	9	60	0.5	6	120	0.7
	Digital camera	9	60	0.5	6	60	0.4
Other devices							
	Video game consoles	40	105	4.2	0	0	0.0
Telephone (fixed network)	Cordless telephone (DECT)	3.5	150	0.5	2	8610	17.2
	Smart phones	4	150	0.6	2	8610	17.2
	Answering machines	3.5	50	0.2	2.5	8710	21.8
	Fax machines[5]	13	20	0.3	3.5	8740	30.6
Telephone (mobile)	GSM[3]	7.2	88	0.6	0.1	4292	0.3
	UMTS[3]	15.8	131	2.1	0.4	4979	2.0
	Mobile phone charger[4]	0	0	0.0	2	2190	4.4
Computers							
	Personal Computer (PC)	75	425	31.9	15	1417	21.3
	Notebook	30	425	12.8	5	667	3.3
	PDA	1.5	70	0.1	1	2426	2.4
Monitors							
	Cathode ray screen	73	425	31.0	15	709	10.6
	LCD screen	25	425	10.6	2	992	2.0
Printer [6]							
	Ink jet	20	35	0.7	6	698	4.2
	Laser	150	30	4.5	20	698	14.0
	Matrix	30	30	0.9	16	698	11.2
Other devices							
	Scanner	16	18	0.3	4	5908	23.6
	Copier (desktop)	200	5	1.0	40	25	1.0
	Active loudspeakers	3	213	0.6	1.5	879	1.3
Total	**ICT end-use appliances HH**						

[1] Consists of Hifi-Amplifier and cassette recorder or CD player or audio DVD or minidisc player
[2] incl. TV-Video combination and portable TV
[3] Power used taking into account the efficiency during charging
[4] Electricity consumption of charging devices not disconnected from the mains
[5] Incl. fax/answering machine combinations
[6] Incl. combined printer, scanner and copiers (poss. also with additional fax function)

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						2076.5	**2536.7**	**216.8**	**4830.0**
1.5	500	0.8	751	78.3	20441	562.1	1023.5	15.3	1601.0
4	1255	5.0	2500	92.6	29776	1488.8	1118.1	149.5	2756.4
0	0	0.0	0	15.0	20452	5.5	301.4	0.0	307.0
1	3416	3.4	1708	10.9	15224	20.1	93.6	52.0	165.7
						9459.1	**2660.6**	**109.3**	**12228.9**
1.5	1307	2.0	1306	183.9	53170	8264.2	1410.1	104.2	9778.5
2	1307	2.6	1306	171.3	1595	247.9	21.1	4.2	273.2
1.5	1307	2.0	1306	619.7	90	54.4	1.2	0.2	55.8
5	1307	6.5	1306	400.1	97	35.2	3.0	0.6	38.8
0.1	1905	0.2	708	319.9	350	108.8	3.1	0.1	112.0
0	0	0	0	88.1	18976	645.2	1026.2	0.0	1671.4
0	0	0	0	57.6	2320	39.4	94.1	0.0	133.5
0	0	0	0	88.1	1881	64.0	101.7	0.0	165.7
						205.6	**1107.8**	**74.2**	**1387.6**
1.5	1383	2.1	1383	43.1	20912	164.2	694.1	43.4	901.7
1.5	1442	2.2	1401	33.4	14256	39.5	405.3	30.8	475.7
0	0	0.0	2766	66.9	144	1.7	8.0	0.0	9.6
0	0	0.0	2766	59.0	10	0.1	0.4	0.0	0.6
0	0	0.0	0	95.1	noch offen				
4	1172	4.7	0	77.5	noch offen				
						10.4	**10.2**	**37.8**	**58.4**
1	2249	2.2	6331	3.5	8915	4.8	6.4	20.0	31.3
1	1704	1.7	6936	2.6	10403	5.6	3.7	17.7	27.1
5.2	2597	13.5	6058	17.7	12034	50.5	0.0	162.5	213.1
						19.8	**1084.7**	**0.0**	**1104.6**
0	0	0.0	0	17.7	20177	10.6	347.4	0.0	358.0
0	0	0.0	0	17.8	6963	4.2	119.9	0.0	124.1
0	0	0.0	0	22.0	18653	3.3	406.2	0.0	409.4
0	0	0.0	0	30.9	6905	1.8	211.2	0.0	213.0
						46.0	**336.0**	**0.0**	**381.9**
0	0	0.0	4380	1.0	70644	44.9	23.3	0.0	68.3
0	0	0.0	3650	4.1	500	1.0	1.0	0.0	2.0
0	0	0.0	6570	4.4	71144	0.0	311.6	0.0	311.6
						955.7	**621.3**	**544.1**	**2121.1**
3.5	4834	16.9	2084	70.0	28134	896.8	598.0	476.0	1970.8
2.5	5251	13.1	2417	29.2	4597	58.6	15.3	60.3	134.3
0.75	3132	2.3	3132	4.9	3297	0.3	8.0	7.7	16.1
						690.0	**221.5**	**228.5**	**1140.0**
2	3813	7.6	3813	49.3	19172	594.8	203.8	146.2	944.8
2.5	3672	9.2	3672	21.8	8962	95.2	17.8	82.3	195.3
						43.5	**178.3**	**473.5**	**695.2**
3	6457	19.4	1570	24.3	19411	13.6	81.3	376.0	470.9
3	4799	14.4	3233	32.9	6539	29.4	91.3	94.1	214.9
2	3228	6.5	4804	18.5	513	0.5	5.7	3.3	9.5
						15.3	**210.1**	**117.9**	**343.3**
2	500	1.0	2349	24.9	7852	2.3	185.6	7.9	195.7
2	4365	8.7	4365	10.7	2290	2.3	2.3	20.0	24.6
1	5334	5.3	2349	7.3	16880	10.8	22.3	90.0	123.1
						13572.5	**8967.2**	**1964.5**	**24504.2**

Year: 2010		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Audio							
	Compact system	22	1250	27.5	4	6259	25.0
	Hifi system [1]	40	1250	50.0	10	3755	37.6
	Clock radio	3	90	0.3	1.7	8670	14.7
	Radio recorder	6	220	1.3	1.8	3416	6.1
Televisions							
	Cathode ray TVI[2]	110	1810	199.1	3	6150	18.5
	LCD TV	110	1810	199.1	2	6150	12.3
	Plasma TV	350	1810	633.5	2	6150	12.3
	Front-projection TV (beamer)	220	1810	398.2	6	6150	36.9
	Rear-projection TV	180	1810	325.8	2	6150	12.3
	SAT boxes	12	2300	27.6	5	6460	32.3
	DVB boxes	20	5600	112.0	5	3160	15.8
	Cable boxes	30	5600	168.0	5	3160	15.8
Video							
	Video recorder (analogue)	17	484	8.2	5	5517	27.6
	DVD player	9	231	2.1	3	5686	17.1
	DVD recorder	25	484	12.1	5	5517	27.6
	Hard disc recorder	40	550	22.0	8	5475	43.8
	AV-Receiver	37	2435	90.1	2	6325	12.7
	Subwoofer	15	1810	27.2	7	5791	40.5
Cameras							
	Video camera/camcorder	9	60	0.5	6	120	0.7
	Digital camera	9	60	0.5	6	60	0.4
Other devices							
	Video game consoles	50	110	5.5	0	0	0.0
Telephone (fixed network)	Cordless telephone (DECT)	3.5	150	0.5	2	8610	17.2
	Smart phones	4	150	0.6	2	8610	17.2
	Answering machines	3.5	50	0.2	2.5	8710	21.8
	Fax machines[5]	13	20	0.3	3	8740	26.2
Telephone (mobile)	GSM[3]	5.8	120	0.7	0.1	4260	0.3
	UMTS[3]	7.1	182	1.3	0.1	4928	0.6
	Mobile phone charger[4]	0	0	0.0	0.5	2190	1.1
Computers							
	Personal Computer (PC)	95	480	45.6	6	1656	9.9
	Notebook	40	480	19.2	3	662	2.0
	PDA	1.5	78	0.1	0.8	2418	1.9
Monitors							
	Cathode ray screen	75	480	36.0	5	828	4.1
	LCD screen	30	480	14.4	1.5	1159	1.7
Printer [6]							
	Ink jet	15	40	0.6	4	698	2.8
	Laser	150	30	4.5	10	698	7.0
	Matrix	30	40	1.2	16	698	11.2
Other devices							
	Scanner	14	20	0.3	3	5904	17.7
	Copier (desktop)	200	5	1.0	40	25	1.0
	Active loudspeakers	3	240	0.7	1.5	1068	1.6
Total	**ICT end-use appliances HH**						

[1] Consists of Hifi-Amplifier and cassette recorder or CD player or audio DVD or minidisc player
[2] incl. TV-Video combination and portable TV
[3] Power used taking into account the efficiency during charging
[4] Electricity consumption of charging devices not disconnected from the mains
[5] Incl. fax/answering machine combinations
[6] Incl. combined printer, scanner and copiers (poss. also with additional fax function)

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						2170.8	**2097.2**	**218.2**	**4486.1**
1	500	0.5	751	53.0	20718	569.7	518.7	10.4	1098.8
4	1255	5.0	2500	92.6	31526	1576.3	1183.8	158.3	2918.4
0	0	0.0	0	15.0	20729	5.6	305.5	0.0	311.1
1	3416	3.4	1708	10.9	14502	19.1	89.2	49.5	157.9
						15902.4	**2108.5**	**33.3**	**18044.2**
1.5	400	0.6	400	218.2	34523	6873.5	636.9	20.7	7531.2
1.5	400	0.6	400	212.0	18669	3717.0	229.6	11.2	3957.8
1.5	400	0.6	400	646.4	1560	988.3	19.2	0.9	1008.4
5	400	2.0	400	437.1	200	79.6	7.4	0.4	87.4
0.1	400	0.0	400	338.1	530	172.7	6.5	0.0	179.2
0	0	0	0	59.9	25131.5	693.6	811.7	0.0	1505.4
0	0	0	0	127.8	15078.9	1688.8	238.2	0.0	1927.1
0	0	0	0	183.8	10052.6	1688.8	158.8	0.0	1847.7
						380.1	**926.6**	**21.3**	**1328.0**
1.5	1380	2.1	1380	37.9	4750	39.1	131.0	9.8	179.9
1.5	1442	2.2	1401	21.3	5300	11.0	90.4	11.5	112.9
0	0	0.0	2759	39.7	13781	166.8	380.1	0.0	546.9
0	0	0.0	2735	65.8	7421	163.3	325.0	0.0	488.3
0	0	0.0	0	102.7	noch offen				
4	1159	4.6	0	72.3	noch offen				
						23.8	**20.7**	**41.2**	**85.7**
0.5	2249	1.1	6331	2.4	13318	7.2	9.6	15.0	31.8
0.5	1704	0.9	6936	1.8	30786	16.6	11.1	26.2	53.9
2	2595	5.2	6055	10.7	13295	73.1	0.0	69.0	142.1
						22.9	**1118.5**	**0.0**	**1141.5**
0	0	0.0	0	17.7	22615	11.9	389.4	0.0	401.3
0	0	0.0	0	17.8	10803	6.5	186.0	0.0	192.5
0	0	0.0	0	22.0	19546	3.4	425.6	0.0	429.0
0	0	0.0	0	26.5	4479	1.2	117.4	0.0	118.6
						82.8	**123.3**	**0.0**	**206.1**
0	0	0.0	4380	1.0	30000	20.9	8.0	0.0	28.9
0	0	0.0	3650	1.9	48178	61.9	29.7	0.0	91.6
0	0	0.0	6570	1.1	78178	0.0	85.6	0.0	85.6
						1684.6	**356.9**	**380.4**	**2421.9**
2	4637	9.3	1987	64.8	33528	1528.9	333.1	310.9	2172.9
1.5	5216	7.8	2402	29.0	8086	155.3	16.1	63.3	234.6
0.5	3132	1.6	3132	3.6	3972	0.5	7.7	6.2	14.4
						486.2	**58.7**	**178.8**	**723.7**
1	3726	3.7	3726	43.9	157	5.7	0.6	0.6	6.9
1.5	3560	5.3	3560	21.5	33370	480.5	58.0	178.2	716.8
						56.0	**128.8**	**421.6**	**606.4**
2	6452	12.9	1570	16.3	22043	13.2	61.5	284.4	359.2
3	4796	14.4	3236	25.9	9487	42.7	66.2	136.5	245.4
2	3226	6.5	4796	18.8	95	0.1	1.1	0.6	1.8
						17.7	**186.8**	**116.0**	**320.5**
1	500	0.5	2349	18.5	8684	2.4	153.8	4.3	160.6
2	4365	8.7	4365	10.7	770	0.8	0.8	6.7	8.3
1	5216	5.2	2349	7.5	20117	14.5	32.2	104.9	151.6
						20900.5	**7125.9**	**1479.7**	**29506.1**

Year: 2015		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Audio							
	Compact system	22	1250	27.5	8	6259	50.1
	Hifi system [1]	40	1250	50.0	10	3755	37.6
	Clock radio	3	90	0.3	1.7	8670	14.7
	Radio recorder	6	220	1.3	1.8	3416	6.1
Televisions							
	Cathode ray TVI[2]	110	1810	199.1	2	6150	12.3
	LCD TV	110	1810	199.1	2	6150	12.3
	Plasma TV	350	1810	633.5	2	6150	12.3
	Front-projection TV (beamer)	220	1810	398.2	5	6150	30.8
	Rear-projection TV	180	1810	325.8	2	6150	12.3
	SAT boxes	12	2300	27.6	4	6460	25.8
	DVB boxes	20	5600	112.0	4	3160	12.6
	Cable boxes	40	5600	224.0	4	3160	12.6
Video							
	Video recorder (analogue)	17	484	8.2	5	5517	27.6
	DVD player	9	231	2.1	1.5	5686	8.5
	DVD recorder	25	484	12.1	4	5517	22.1
	Hard disc recorder	40	600	24.0	8	5450	43.6
	AV-Receiver	40	2435	97.4	2	6325	12.7
	Subwoofer	15	1810	27.2	7	5791	40.5
Cameras							
	Video camera/camcorder	9	60	0.5	6	120	0.7
	Digital camera	9	60	0.5	6	60	0.4
Other devices							
	Video game consoles	50	110	5.5	0	0	0.0
Telephone (fixed network)	Cordless telephone (DECT)	3.5	150	0.5	2	8610	17.2
	Smart phones	4	150	0.6	2	8610	17.2
	Answering machines	3.5	50	0.2	2.5	8710	21.8
	Fax machines[5]	13	20	0.3	3	8740	26.2
Telephone (mobile)	GSM[3]	0.0	0	0.0	0.0	0	0.0
	UMTS[3]	7.1	182	1.3	0.1	4928	0.6
	Mobile phone charger[4]	0	0	0.0	0.5	2190	1.1
Computers							
	Personal Computer (PC)	80	500	40.0	5	1800	9.0
	Notebook	50	500	25.0	2.5	662	1.7
	PDA	1.5	78	0.1	0.8	2418	1.9
Monitors							
	Cathode ray screen	75	480	36.0	3	900	2.7
	LCD screen	30	480	14.4	1.5	1260	1.9
Printer [6]							
	Ink jet	15	40	0.6	2	698	1.4
	Laser	150	30	4.5	7	698	4.9
	Matrix	0	0	0.0	0	0	0.0
Other devices							
	Scanner	14	20	0.3	3	5904	17.7
	Copier (desktop)	200	5	1.0	40	25	1.0
	Active loudspeakers	3	240	0.7	1.5	1068	1.6
Total	**ICT end-use appliances HH**						

[1] Consists of Hifi-Amplifier and cassette recorder or CD player or audio DVD or minidisc player
[2] incl. TV-Video combination and portable TV
[3] Power used taking into account the efficiency during charging
[4] Electricity consumption of charging devices not disconnected from the mains
[5] Incl. fax/answering machine combinations
[6] Incl. combined printer, scanner and copiers (poss. also with additional fax function)

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						2248.1	**2683.9**	**229.2**	**5161.2**
1.5	500	0.8	751	78.3	20990	577.2	1051.0	15.7	1644.0
4	1255	5.0	2500	92.6	32931	1646.6	1236.6	165.3	3048.4
0	0	0.0	0	15.0	21002	5.7	309.5	0.0	315.2
1	3416	3.4	1708	10.9	14108	18.6	86.7	48.2	153.6
						17897.5	**1901.5**	**33.4**	**19832.4**
1.5	400	0.6	400	212.0	8780	1748.1	108.0	5.3	1861.4
1.5	400	0.6	400	212.0	43872	8734.9	539.6	26.3	9300.9
1.5	400	0.6	400	646.4	2000	1267.0	24.6	1.2	1292.8
5	400	2.0	400	431.0	300	119.5	9.2	0.6	129.3
0.1	400	0.0	400	338.1	680	221.5	8.4	0.0	229.9
0	0	0	0	53.4	31488.5	869.1	813.7	0.0	1682.7
0	0	0	0	124.6	18893.1	2116.0	238.8	0.0	2354.8
0	0	0	0	236.6	12595.4	2821.4	159.2	0.0	2980.6
						494.0	**917.4**	**3.1**	**1414.5**
1.5	1380	2.1	1380	37.9	1497	12.3	41.3	3.1	56.7
1.5	1442	2.2	1401	12.8	0	0.0	0.0	0.0	0.0
0	0	0.0	2759	34.2	13342	161.4	294.4	0.0	455.9
0	0	0.0	2710	67.6	13342	320.2	581.7	0.0	901.9
0	0	0.0	0	110.1	noch offen				
4	1159	4.6	0	72.3	noch offen				
						36.8	**37.4**	**67.8**	**142.0**
0.5	2249	1.1	6331	2.4	35818	19.3	25.8	40.3	85.4
0.5	1704	0.9	6936	1.8	32327	17.5	11.6	27.5	56.6
2	2595	5.2	6055	10.7	13713	75.4	0.0	71.2	146.6
						24.4	**1138.5**	**0.0**	**1162.9**
0	0	0.0	0	17.7	22858	12.0	393.6	0.0	405.6
0	0	0.0	0	17.8	13679	8.2	235.6	0.0	243.8
0	0	0.0	0	22.0	19770	3.5	430.5	0.0	434.0
0	0	0.0	0	26.5	3006	0.8	78.8	0.0	79.6
						100.7	**134.1**	**0.0**	**234.8**
0	0	0.0	0	0.0	0	0.0	0.0	0.0	0.0
0	0	0.0	3650	1.9	78385	100.7	48.3	0.0	149.0
0	0	0.0	6570	1.1	78385	0.0	85.8	0.0	85.8
						1682.5	**350.0**	**218.0**	**2250.4**
1	4473	4.5	1987	53.5	36178	1447.1	325.6	161.8	1934.5
1	5216	5.2	2382	31.9	9392	234.8	15.5	49.0	299.3
0.5	3132	1.6	3132	3.6	4561	0.5	8.8	7.1	16.5
						521.9	**68.5**	**190.8**	**781.2**
1	3690	3.7	3690	42.4	5	0.2	0.0	0.0	0.2
1.5	3510	5.3	3510	21.6	36233	521.8	68.5	190.8	781.0
						65.4	**87.2**	**307.4**	**460.0**
1	6452	6.5	1570	8.4	21646	13.0	30.2	139.7	182.9
3	4796	14.4	3236	23.8	11655	52.4	56.9	167.7	277.1
0	0	0.0	0	0.0	0	0.0	0.0	0.0	0.0
						18.0	**135.0**	**122.8**	**275.8**
1	500	0.5	2349	18.5	5617	1.6	99.5	2.8	103.9
2	4365	8.7	4365	10.7	770	0.8	0.8	6.7	8.3
1	5216	5.2	2349	7.5	21707	15.6	34.8	113.2	163.6
						23164.7	**7453.5**	**1243.6**	**31861.8**

A1.2 Electrical household appliances (for the years 2001, 2004, 2010 and 2015

Year: 2001		Energy use per appliance								
						standby			off-mode	
		power input	time of use	consumption	power input	time of use	consumption	power input	time of use	consumption
Main group	Appliance type	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]
Household appliances	Microwave ovens	700	75	52.5	3	8685	26.1	0	0	0.0
	Cookers	1,220	300	366.0	3.2	8460	27.1	0	0	0.0
	Extraction hoods	150	300	45.0	2	8460	16.9	0	0	0.0
	Coffee machines	450	50	22.5	30	95	2.9	2	8615	17.2
	Coffee-espresso machines	1,650	14	23.1	45	1095	49.3	3	7651	23.0
	Dishwashers	890	290	258.1	2	880	1.8	0	0	0.0
	Refriderators	34	8,760	297.8	0	0	0.0	0	0	0.0
	Fridge-freezers	46	8,760	403.0	0	0	0.0	0	0	0.0
	Freezers	46	8,760	403.0	0	0	0.0	0	0	0.0
	Washer-driers	500	550	275.0	3.6	1100	4.0	1.5	7110	10.7
	Washing machines	430	350	150.5	5.7	1100	6.3	1.5	7310	11.0
	Tumble driers	1,800	150	270.0	3	1100	3.3	1.5	7510	11
	Battery chargers/stations	10	200	2.0	0	0	0.0	0.5	8560	4
Total	Household appliances									

Year: 2004		Energy use per appliance								
		normal operation				standby			off-mode	
		power input	time of use	consumption	power input	time of use	consumption	power input	time of use	consumption
Main group	Appliance type	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]
Household appliances	Microwave ovens	700	75	52.5	3	8685	26.1	0	0	0.0
	Cookers	1,200	300	360.0	3	8460	25.4	0	0	0.0
	Extraction hoods	150	300	45.0	2	8460	16.9	0	0	0.0
	Coffee machines	450	50	22.5	30	95	2.9	2	8615	17.2
	Coffee-espresso machines	1,600	14	22.4	40	1095	43.8	2.5	7651	19.1
	Dishwashers	880	270	237.6	2	880	1.8	0.15	7610	1.1
	Refriderators	33	8,760	289.1	0	0	0.0	0	0	0.0
	Fridge-freezers	45	8,760	394.2	0	0	0.0	0	0	0.0
	Freezers	45	8,760	394.2	0	0	0.0	0	0	0.0
	Washer-driers	490	550	269.5	3.6	1100	4.0	1.2	7110	8.5
	Washing machines	410	350	143.5	5.7	1100	6.3	1.2	7310	8.8
	Tumble driers	1,780	140	249.2	3	1100	3.3	1.2	7520	9
	Battery chargers/stations	8	200	1.6	0	0	0.0	0.5	8560	4
Total	Household appliances									

Year: 2010		Energy use per appliance								
						standby			off-mode	
		power input	time of use	consumption	power input	time of use	consumption	power input	time of use	consumption
Main group	Appliance type	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]
Household appliances	Microwave ovens	700	75	52.5	3	8685	26.1	0	0	0.0
	Cookers	1,200	300	360.0	3	8460	25.4	0	0	0.0
	Extraction hoods	150	300	45.0	2	8460	16.9	0	0	0.0
	Coffee machines	450	48	21.6	30	95	2.9	2	8617	17.2
	Coffee-espresso machines	1,550	14	21.7	40	1095	43.8	2.3	7651	17.6
	Dishwashers	875	270	236.3	2	880	1.8	0.15	7610	1.1
	Refriderators	34	8,760	293.5	0	0	0.0	0	0	0.0
	Fridge-freezers	45	8,760	389.8	0	0	0.0	0	0	0.0
	Freezers	44	8,760	385.4	0	0	0.0	0	0	0.0
	Washer-driers	480	550	264.0	3.4	1100	3.7	1.2	7110	8.5
	Washing machines	410	350	143.5	5.7	1100	6.3	1.2	7310	8.8
	Tumble driers	1,780	140	249.2	3	1100	3.3	1.2	7520	9
	Battery chargers/stations	7	200	1.4	0	0	0.0	0.45	8560	4
Total	Household appliances									

Year: 2015		Energy use per appliance								
						standby			off-mode	
		power input	time of use	consumption	power input	time of use	consumption	power input	time of use	consumption
Main group	Appliance type	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]	[W]	[h/a]	[kWh/a]
Household appliances	Microwave ovens	700	75	52.5	3	8685	26.1	0	0	0.0
	Cookers	1,200	300	360.0	3	8460	25.4	0	0	0.0
	Extraction hoods	150	300	45.0	2	8460	16.9	0	0	0.0
	Coffee machines	450	48	21.6	30	95	2.9	2	8617	17.2
	Coffee-espresso machines	1,500	14	21.0	40	1095	43.8	2	7651	15.3
	Dishwashers	870	270	234.9	2	880	1.8	0.15	7610	1.1
	Refriderators	32	8,760	280.3	0	0	0.0	0	0	0.0
	Fridge-freezers	44	8,760	385.4	0	0	0.0	0	0	0.0
	Freezers	44	8,760	385.4	0	0	0.0	0	0	0.0
	Washer-driers	475	550	261.3	3.4	1100	3.7	1.2	7110	8.5
	Washing machines	410	350	143.5	5.7	1100	6.3	1.2	7310	8.8
	Tumble driers	1,780	140	249.2	3	1100	3.3	1.2	7520	9
	Battery chargers/stations	7	200	1.4	0	0	0.0	0.4	8560	3
Total	Household appliances									

		Stock	Share of appl. in mode			Total energy use			
off time of use [h/a]	total energy use [kWh/a]	[in Tsd.]	normal mode [%]	stand-by [%]	off-mode [%]	normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
0	78.6	24,420	100	60	0	1282.0	381.8	0.0	1663.8
0	393.1	32,303	100	60	0	11822.9	524.7	0.0	12347.6
0	61.9	24,804	100	40	0	1116.2	167.9	0.0	1284.1
0	42.6	33,072	100	70	10	744.1	66.0	57.0	867.1
0	95.3	4,230	100	100	100	97.7	208.4	97.1	403.3
7590	259.9	22,304	100	100	5	5756.8	39.3	0.0	5796.0
0	297.8	37,764	100	0	0	11247.6	0.0	0.0	11247.6
0	403.0	11,960	100	0	0	4819.3	0.0	0.0	4819.3
0	403.0	22,689	100	0	0	9142.8	0.0	0.0	9142.8
0	289.6	1,154	100	100	20	317.3	4.6	2.5	324.3
0	167.7	35,380	100	100	20	5324.6	221.8	77.6	5624.0
0	284.6	13,460	100	100	20	3634.1	44.4	30.3	3708.8
0	6.3	8,576	100	0	50	17.2	0.0	18.4	35.5
						55322.5	**1658.8**	**282.8**	**57264.2**

		Stock	Share of appl. in mode			Total energy use			
off time of use [h/a]	total energy use [kWh/a]	[in Tsd.]	normal mode [%]	stand-by [%]	off-mode [%]	normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
0	78.6	25,782	100	60	0	1353.6	403.0	0.0	1756.6
0	385.4	32,831	100	60	0	11819.0	499.9	0.0	12319.0
0	61.9	25,567	100	40	0	1150.5	173.0	0.0	1323.5
0	42.6	33,565	100	70	10	755.2	67.0	57.8	880.0
0	85.3	7,416	100	100	100	166.1	324.8	141.8	632.7
0	240.5	23,222	100	100	10	5517.6	40.9	2.7	5561.1
0	289.1	38,561	100	0	0	11147.1	0.0	0.0	11147.1
0	394.2	12,255	100	0	0	4831.0	0.0	0.0	4831.0
0	394.2	21,633	100	0	0	8527.9	0.0	0.0	8527.9
0	282.0	1,171	100	100	20	315.5	4.6	2.0	322.2
0	158.5	36,141	100	100	20	5186.2	226.6	63.4	5476.2
0	261.5	14,513	100	100	20	3616.6	47.9	26.2	3690.7
0	5.9	9,055	100	0	50	14.5	0.0	19.4	33.9
						54400.8	**1787.8**	**313.3**	**56501.9**

		Stock	Share of appl. in mode			Total energy use			
off time of use [h/a]	total energy use [kWh/a]	[in Tsd.]	normal mode [%]	stand-by [%]	off-mode [%]	normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
0	78.6	26,565	100	65	0	1394.7	449.9	0.0	1844.6
0	385.4	33,390	100	65	0	12020.5	550.8	0.0	12571.4
0	61.9	26,343	100	40	0	1185.5	178.3	0.0	1363.7
0	41.7	33,177	100	70	10	716.6	66.2	57.2	840.0
0	-	9,383	100	100	100	203.6	411.0	165.1	779.7
0	239.2	23,502	100	100	15	5552.4	41.4	4.0	5597.8
0	293.5	39,102	100	0	0	11474.9	0.0	0.0	11474.9
0	389.8	12,442	100	0	0	4850.0	0.0	0.0	4850.0
0	385.4	21,894	100	0	0	8438.9	0.0	0.0	8438.9
0	276.3	1,185	100	100	20	312.8	4.4	2.0	319.3
0	158.5	36,794	100	100	20	5280.0	230.7	64.6	5575.2
0	261.5	15,133	100	100	20	3771.2	49.9	27.3	3848.4
0	5.3	9,874	100	0	50	13.8	0.0	19.0	32.8
						55214.9	**1982.6**	**339.2**	**57536.8**

		Stock	Share of appl. in mode			Total energy use			
off time of use [h/a]	total energy use [kWh/a]	[in Tsd.]	normal mode [%]	stand-by [%]	off-mode [%]	normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
0	78.6	27,141	100	70	0	1424.9	495.0	0.0	1919.9
0	385.4	33,516	100	70	0	12065.9	595.5	0.0	12661.3
0	61.9	26,931	100	40	0	1211.9	182.3	0.0	1394.1
0	41.7	31,320	100	70	10	676.5	62.5	54.0	793.0
0	80.1	10,562	100	100	100	221.8	462.6	161.6	846.0
0	237.8	23,667	100	100	20	5559.4	41.7	5.4	5606.5
0	280.3	39,250	100	0	0	11002.4	0.0	0.0	11002.4
0	385.4	12,488	100	0	0	4813.6	0.0	0.0	4813.6
0	385.4	22,048	100	0	0	8498.2	0.0	0.0	8498.2
0	273.5	1,189	100	100	20	310.7	4.4	2.0	317.2
0	158.5	37,118	100	100	20	5326.4	232.7	65.1	5624.3
0	261.5	15,574	100	100	20	3881.0	51.4	28.1	3960.5
0	4.8	10,308	100	0	50	14.4	0.0	17.6	32.1
						55007.2	**2128.0**	**333.9**	**57469.1**

A1.3 ICT end-use appliances offices (for the years 2001, 2004, 2010 and 2015)

Year: 2001		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Cameras							
	Video camera/camcorder	9	15	0.1	6	30	0.2
	Digital camera	9	15	0.1	6	15	0.1
Telephone							
(fixed network) [1]	Cordless telephone (DECT)	3.5	330	1.2	2.5	8430	21.1
	Smart phones	4	330	1.3	2.5	8430	21.1
	Answering machines	3.5	50	0.2	3	8710	26.1
	Fax machines	55	330	18.2	12	8430	101.2
Computers							
	PC	50	1870	93.5	25	330	8.3
	Notebook	18	1430	25.7	6	770	4.6
	PDA	1.5	65	0.1	1.2	2575	3.1
Monitors							
	Cathode ray screen	80	1870	149.6	15	550	8.3
	LCD screen	22	1870	41.1	5	550	2.8
Printers							
	Ink jet	30	110	3.3	6	2200	13.2
	Laser	350	150	52.5	50	2160	108.0
	Matrix	30	440	13.2	16	3080	49.3
Other devices							
	Scanner	18	110	2.0	8	5750	46.0
	Copier	800	220	176.0	100	2090	209.0
	Beamer	180	110	19.8	7	1730	12.1
Total	**ICT end-use appliances offices**						

Year: 2004		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Cameras							
	Video camera/camcorder	9	15	0.1	6	30	0.2
	Digital camera	9	15	0.1	6	15	0.1
Telephone							
(fixed network) [1]	Cordless telephone (DECT)	3.5	330	1.2	2	8430	16.9
	Smart phones	4	330	1.3	2	8430	16.9
	Answering machines	3.5	50	0.2	2.5	8710	21.8
	Fax machines	55	330	18.2	11	8430	92.7
Computers							
	PC	60	1540	92.4	15	660	9.9
	Notebook	25	1430	35.8	5	770	3.9
	PDA	1.5	110	0.2	1	2530	2.5
Monitors							
	Cathode ray screen	80	1540	123.2	15	880	13.2
	LCD screen	28	1540	43.1	2	880	1.8
Printers							
	Ink jet	30	110	3.3	6	2200	13.2
	Laser	350	150	52.5	50	2160	108.0
	Matrix	0	0	0.0	0	0	0.0
Other devices							
	Scanner	18	110	2.0	8	5750	46.0
	Copier	800	220	176.0	95	2090	198.6
	Beamer	210	165	34.7	7	1719	12.0
Total	**ICT end-use appliances offices**						

[1] Taken into account in the residential sector

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						0.4	**0.4**	**3.7**	**4.4**
1.5	871	1.3	7844	1.6	1410	0.2	0.3	1.8	2.3
1.5	873	1.3	7857	1.5	1410	0.2	0.1	1.8	2.2
						74.1	**621.0**	**0.0**	**695.1**
0	0	0.0	0	22.2	2351	2.7	49.5	0.0	52.3
0	0	0.0	0	22.4	6817	9.0	143.7	0.0	152.7
0	0	0.0	0	26.3	3174	0.6	82.9	0.0	83.5
0	0	0.0	0	119.3	3409	61.9	344.9	0.0	406.7
						1150.6	**119.1**	**309.3**	**1579.0**
4	5248	21.0	1312	122.7	10461	978.1	86.3	219.6	1284.0
4	3280	13.1	3280	43.5	6700	172.5	31.0	87.9	291.3
1	3060	3.1	3060	6.2	588	0.1	1.8	1.8	3.7
						1503.4	**84.0**	**172.9**	**1760.3**
3	5072	15.2	1268	173.1	9403	1406.7	77.6	143.1	1627.3
2.5	5072	12.7	1268	56.6	2351	96.7	6.5	29.8	133.0
						229.6	**496.6**	**83.8**	**809.9**
4	5160	20.6	1290	37.1	1763	5.8	23.3	36.4	65.5
2	5160	10.3	1290	170.8	4114	216.0	444.3	42.5	702.8
2	4192	8.4	1048	70.9	588	7.8	29.0	4.9	41.7
						1050.6	**1343.6**	**75.0**	**2469.2**
4	1312	5.2	1588	53.2	2351	4.7	108.1	12.3	125.1
2	5160	10.3	1290	395.3	5877	1034.4	1228.3	60.7	2323.3
2	1730	3.5	5190	35.4	588	11.6	7.1	2.0	20.8
						4008.8	**2664.6**	**644.7**	**7318.1**

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						0.4	**0.4**	**2.8**	**3.7**
1	871	0.9	7844	1.2	1449	0.2	0.3	1.3	1.7
1	873	0.9	7857	1.1	1811	0.2	0.2	1.6	2.0
						106.4	**724.5**	**0.0**	**830.9**
0	0	0.0	0	18.0	3622	4.2	61.1	0.0	65.3
0	0	0.0	0	18.2	7245	9.6	122.2	0.0	131.7
0	0	0.0	0	22.0	3260	0.6	71.0	0.0	71.6
0	0	0.0	0	110.9	5072	92.1	470.3	0.0	562.4
						1207.8	**135.6**	**253.5**	**1596.9**
3.5	5248	18.4	1312	120.7	10264	948.4	101.6	188.5	1238.5
2.5	3280	8.2	3280	47.8	7245	259.0	27.9	59.4	346.3
0.75	3060	2.3	3060	5.0	2415	0.4	6.1	5.5	12.1
						1197.6	**118.0**	**122.5**	**1438.1**
2	5072	10.1	1268	146.5	8453	1041.4	111.6	85.7	1238.7
2	5072	10.1	1268	55.0	3623	156.2	6.4	36.8	199.4
						259.6	**545.5**	**77.9**	**883.0**
3	5160	15.5	1290	32.0	1811	6.0	23.9	28.0	57.9
2	5160	10.3	1290	170.8	4830	253.6	521.6	49.8	825.1
0	0	0.0	0	0.0	0	0.0	0.0	0.0	0.0
						1109.3	**1324.5**	**85.4**	**2519.2**
4	1312	5.2	1588	53.2	2415	4.8	111.1	12.7	128.5
2	5160	10.3	1290	384.9	6038	1062.7	1198.8	62.3	2323.8
5	1719	8.6	5157	55.3	1208	41.9	14.5	10.4	66.8
						3881.1	**2848.5**	**542.1**	**7271.7**

Year: 2010		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Cameras							
	Video camera/camcorder	9	15	0.1	6	30	0.2
	Digital camera	9	15	0.1	6	15	0.1
Telephone							
(fixed network) [1]	Cordless telephone (DECT)	3.5	330	1.2	2	8430	16.9
	Smart phones	4	330	1.3	2	8430	16.9
	Answering machines	3.5	50	0.2	2	8710	17.4
	Fax machines	55	330	18.2	10	8430	84.3
Computers							
	PC	70	1430	100.1	6	770	4.6
	Notebook	30	1430	42.9	3	770	2.3
	PDA	1.5	220	0.3	0.8	2420	1.9
Monitors							
	Cathode ray screen	0	0	0.0	0	0	0.0
	LCD screen	30	1430	42.9	1.5	990	1.5
Printers							
	Ink jet	30	110	3.3	4	2200	8.8
	Laser	350	150	52.5	30	2160	64.8
	Matrix	0	0	0.0	0	0	0.0
Other devices							
	Scanner	18	110	2.0	5	5750	28.8
	Copier	800	220	176.0	40	2090	83.6
	Beamer	220	220	48.4	6	1708	10.2
Total	**ICT end-use appliances offices**						

Year: 2015		Energy use per appliance					
		normal operation			standby		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Cameras							
	Video camera/camcorder	9	15	0.1	6	30	0.2
	Digital camera	9	15	0.1	6	15	0.1
Telephone							
(fixed network) [1]	Cordless telephone (DECT)	3.5	330	1.2	2	8430	16.9
	Smart phones	4	330	1.3	2	8430	16.9
	Answering machines	3.5	50	0.2	2	8710	17.4
	Fax machines	55	330	18.2	10	8430	84.3
Computers							
	PC	60	1430	85.8	5	770	3.9
	Notebook	30	1430	42.9	2.5	770	1.9
	PDA	1.5	220	0.3	0.8	2420	1.9
Monitors							
	Cathode ray screen	0	0	0.0	0	0	0.0
	LCD screen	30	1430	42.9	1.5	990	1.5
Printers							
	Ink jet	30	110	3.3	2	2200	4.4
	Laser	350	150	52.5	20	2160	43.2
	Matrix	0	0	0.0	0	0	0.0
Other devices							
	Scanner	18	110	2.0	5	5750	28.8
	Copier	800	220	176.0	25	2090	52.3
	Beamer	220	220	48.4	5	1708	8.5
Total	**ICT end-use appliances offices**						

[1] Taken into account in the residential sector.

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						0.5	**0.4**	**1.5**	**2.4**
0.5	871	0.4	7844	0.8	1513	0.2	0.3	0.7	1.1
0.5	873	0.4	7857	0.7	1892	0.3	0.2	0.8	1.3
						115.2	**733.4**	**0.0**	**848.5**
0	0	0.0	0	18.0	5045	5.8	85.1	0.0	90.9
0	0	0.0	0	18.2	7819	10.3	131.8	0.0	142.1
0	0	0.0	0	17.6	3405	0.6	59.3	0.0	59.9
0	0	0.0	0	102.5	5423	98.4	457.2	0.0	555.6
						1390.4	**76.8**	**157.1**	**1624.2**
2	5248	10.5	1312	115.2	10090	1010.0	46.6	105.9	1162.5
1.5	3280	4.9	3280	50.1	8828	378.7	20.4	43.4	442.5
0.5	3060	1.5	3060	3.8	5045	1.7	9.8	7.7	19.2
						541.1	**18.7**	**96.0**	**655.7**
0	0	0.0	0	0.0	0	0.0	0.0	0.0	0.0
1.5	5072	7.6	1268	52.0	12612	541.1	18.7	96.0	655.7
						271.1	**343.6**	**71.6**	**686.3**
2	5160	10.3	1290	22.4	1892	6.2	16.6	19.5	42.4
2	5160	10.3	1290	127.6	5045	264.9	326.9	52.1	643.8
0	0	0.0	0	0.0	0	0.0	0.0	0.0	0.0
						1206.4	**619.1**	**84.5**	**1910.0**
1	1312	1.3	1588	32.0	2522	5.0	72.5	3.3	80.8
2	5160	10.3	1290	269.9	6306	1109.9	527.2	65.1	1702.1
5	1708	8.5	5124	67.2	1892	91.6	19.4	16.2	127.1
						3524.6	**1792.0**	**410.6**	**5727.2**

power input [W]	off-mode time of use [h/a]	consumption [kWh/a]	off time of use [h/a]	total energy use [kWh/a]	**Stock** [in Tsd.]	**Total electricity use** normal mode [GWh]	standby [GWh]	off-mode [GWh]	**total** [GWh]
						0.5	**0.5**	**1.5**	**2.5**
0.5	871	0.4	7844	0.8	1554	0.2	0.3	0.7	1.2
0.5	873	0.4	7857	0.7	1943	0.3	0.2	0.8	1.3
						118.3	**753.1**	**0.0**	**871.4**
0	0	0.0	0	18.0	5180	6.0	87.3	0.0	93.3
0	0	0.0	0	18.2	8029	10.6	135.4	0.0	146.0
0	0	0.0	0	17.6	3497	0.6	60.9	0.0	61.5
0	0	0.0	0	102.5	5569	101.1	469.5	0.0	570.5
						1279.5	**67.4**	**92.0**	**1438.9**
1	5248	5.2	1312	94.9	10360	888.9	39.9	54.4	983.1
1	3280	3.3	3280	48.1	9065	388.9	17.5	29.7	436.1
0.5	3060	1.5	3060	3.8	5180	1.7	10.0	7.9	19.7
						555.6	**19.2**	**98.5**	**673.3**
0	0	0.0	0	0.0	0	0.0	0.0	0.0	0.0
1.5	5072	7.6	1268	52.0	12950	555.6	19.2	98.5	673.3
						342.1	**282.6**	**70.2**	**694.8**
1	5160	5.2	1290	12.9	648	2.1	2.9	3.3	8.3
2	5160	10.3	1290	106.0	6475	339.9	279.7	66.8	686.5
0	0	0.0	0	0.0	0	0.0	0.0	0.0	0.0
						1270.1	**434.9**	**92.3**	**1797.3**
1	1312	1.3	1588	32.0	2590	5.1	74.5	3.4	83.0
2	5160	10.3	1290	238.6	6475	1139.6	338.3	66.8	1544.7
5	1708	8.5	5124	65.5	2590	125.4	22.1	22.1	169.6
						3565.9	**1557.6**	**354.6**	**5478.1**

A1.4 ICT infrastructure households (for the years 2001, 2004, 2010 and 2015)

Year: 2001		Energy use per appliance								
		normal operation			standby			off-mode		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Television										
	Antenna preamplifier	4	1873	7.5	4	6887	27.5	0	0	0
	LNB	4	1873	7.5	4	6887	27.5	0	0	0
Communications infrastructure										
	DSL splitter	4	8760	35.0	0	0	0.0	0	0	0
	DSL modem	7	389	2.7	4	568	2.3	3	5462	16.4
	CATV modem	12	389	4.7	5	568	2.8	3	5462	16.4
	Satellite modem	24	389	9.3	13	8371	108.8	0	0	0
	DSL-Router/WLan	12	1261	15.1	0	0	0.0	0	0	0
	Telephone modem	12	122	1.5	5	835	4.2	3	5462	16.4
	ISDN-Box	5.8	8760	50.8	0	0	0.0	0	0	0
	Entryphone	10	4	0.0	4.5	8756	39.4	0	0	0
Total	**ICT infrastructure HH**									

Year: 2004		Energy use per appliance								
		normal operation			standby			off-mode		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Television										
	Antenna preamplifier	4	1996	8.0	4	6764	27.1	0	0	0
	LNB	4	2300	9.2	4	6460	25.8	0	0	0
Communications infrastructure										
	DSL splitter	4	8760	35.0	0	0	0.0	0	0	0
	DSL modem	7	243	1.7	4	849	3.4	3	5368	16.1
	CATV modem	12	243	2.9	5	849	4.2	3	5368	16.1
	Satellite modem	24	243	5.8	13	8517	110.7	0	0	0
	DSL-Router/WLan	12	998	12.0	0	0	0.0	0	0	0
	Telephone modem	12	91	1.1	5	1001	5.0	3	5368	16.1
	ISDN-Box	5.8	8760	50.8	0	0	0.0	0	0	0
	Entryphone	10	4	0.0	4.5	8756	39.4	0	0	0
Total	**ICT infrastructure HH**									

Year: 2010		Energy use per appliance								
		normal operation			standby			off-mode		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Television										
	Antenna preamplifier	4	2128	8.5	4	6632	26.5	0	0	0
	LNB	4	2800	11.2	4	5960	23.8	0	0	0
Communications infrastructure										
	DSL splitter	4	8760	35.0	0	0	0.0	0	0	0
	DSL modem	7	730	5.1	3	8030	24.1	2	0	0.0
	CATV modem	12	730	8.8	4	8030	32.1	2	0	0.0
	Satellite modem	24	730	17.5	13	8030	104.4	0	0	0
	DSL-Router/WLan	10	730	7.3	8	8030	64.2			0
	Telephone modem	0	0	0.0	0	0	0.0	0	0	0.0
	ISDN-Box	5.8	8760	50.8	0	0	0.0			0
	Entryphone	10	4	0.0	4.5	8756	39.4	0	0	0
Total	**ICT infrastructure HH**									

Year: 2015		Energy use per appliance								
		normal operation			standby			off-mode		
Main group	Appliance type	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]	power input [W]	time of use [h/a]	consumption [kWh/a]
Television										
	Antenna preamplifier	4	2128	8.5	4	6632	26.5	0	0	0
	LNB	4	2800	11.2	4	5960	23.8	0	0	0
Communications infrastructure										
	DSL splitter	4	8760	35.0	0	0	0.0	0	0	0
	DSL modem	7	730	5.1	3	8030	24.1	2	0	0.0
	CATV modem	12	730	8.8	4	8030	32.1	2	0	0.0
	Satellite modem	24	730	17.5	13	8030	104.4	0	0	0
	DSL-Router/WLan	10	730	7.3	6	8030	48.2			0
	Telephone modem	0	0	0.0	0	0	0.0	0	0	0.0
	ISDN-Box	5.8	8760	50.8	0	0	0.0			0
	Entryphone	10	4	0.0	4.5	8756	39.4	0	0	0
Total	**ICT infrastructure HH**									

off time of use [h/a]	total energy use [kWh/a]	Stock [in Tsd.]	Total electricity use normal mode [GWh]	standby [GWh]	off-mode [GWh]	total [GWh]
			127.9	**470.2**	**0.0**	**598.0**
0	35.0	4883	36.6	134.5	0.0	171.1
0	35.0	12184	91.3	335.6	0.0	426.9
			429.2	**738.1**	**191.8**	**1359.1**
0	35.0	2200	77.1	0.0	0.0	77.1
2341	21.4	2200	6.0	5.0	36.0	47.0
2341	23.9	86	0.4	0.2	1.4	2.1
0	118.2	10	0.1	1.1	0.0	1.2
0	15.1	231	3.5	0.0	0.0	3.5
2341	22.0	9418	13.8	39.3	154.3	207.4
0	50.8	6449	327.7	0.0	0.0	327.7
0	39.4	17573	0.7	692.4	0.0	693.1
			557.1	**1208.2**	**191.8**	**1957.1**

off time of use [h/a]	total energy use [kWh/a]	Stock [in Tsd.]	Total electricity use normal mode [GWh]	standby [GWh]	off-mode [GWh]	total [GWh]
			163.6	**482.9**	**0.0**	**646.5**
0	35.0	5023	40.1	135.9	0.0	176.0
0	35.0	13427	123.5	347.0	0.0	470.5
			935.4	**753.0**	**111.1**	**1799.5**
0	35.0	5000	175.2	0.0	0.0	175.2
2300	21.2	5000	8.5	17.0	80.5	106.0
2300	23.3	294	0.9	1.2	4.7	6.8
0	116.6	54	0.3	6.0	0.0	6.3
0	12.0	974	11.7	0.0	0.0	11.7
2300	22.2	1608	1.8	8.0	25.9	35.7
0	50.8	14493	736.4	0.0	0.0	736.4
0	39.4	18291	0.7	720.7	0.0	721.4
			1099.0	**1235.8**	**111.1**	**2446.0**

off time of use [h/a]	total energy use [kWh/a]	Stock [in Tsd.]	Total electricity use normal mode [GWh]	standby [GWh]	off-mode [GWh]	total [GWh]
			202.6	**473.9**	**0.0**	**676.4**
0	35.0	5070	43.2	134.5	0.0	177.7
0	35.0	14235	159.4	339.4	0.0	498.8
			1727.4	**1921.6**	**0.0**	**3649.0**
0	35.0	15434	540.8	0.0	0.0	540.8
0	29.2	15434	78.9	371.8	0.0	450.7
0	40.9	6022	52.8	193.4	0.0	246.2
0	121.9	421	7.4	43.9	0.0	51.3
0	71.5	8945	65.3	574.6	0.0	639.9
0	0.0	0	0.0	0.0	0.0	0.0
0	50.8	19318	981.5	0.0	0.0	981.5
0	39.4	18726	0.7	737.8	0.0	738.6
			1929.9	**2395.5**	**0.0**	**4325.5**

off time of use [h/a]	total energy use [kWh/a]	Stock [in Tsd.]	Total electricity use normal mode [GWh]	standby [GWh]	off-mode [GWh]	total [GWh]
			206.1	**481.3**	**0.0**	**687.4**
0	35.0	5070	43.2	134.5	0.0	177.7
0	35.0	14549	162.9	346.8	0.0	509.8
			1917.1	**2110.0**	**0.0**	**4027.1**
0	35.0	18461	646.9	0.0	0.0	646.9
0	29.2	18461	94.3	444.7	0.0	539.1
0	40.9	6971	61.1	223.9	0.0	285.0
0	121.9	708	12.4	73.9	0.0	86.3
0	55.5	13424	98.0	646.8	0.0	744.8
0	0.0	0	0.0	0.0	0.0	0.0
0	50.8	19755	1003.7	0.0	0.0	1003.7
0	39.4	18291	0.7	720.7	0.0	721.4
			2123.2	**2591.4**	**0.0**	**4714.6**