Energy savings potential from simple standby reduction devices in the Netherlands

- Master Thesis -

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1. Introduction

1.1 Background & problem definition

Standby power is a new phenomenon. Two decades ago, consumers could simply switch off their devices, assured that their electricity meter would stop. However, nowadays, meters in most houses continue to run and standby consumption is the cause.

In order to identify standby consumption a focus need to be made in the energy consumption of households. The most important factor in the development of energy consumption in a household is lifestyle[1] changes. More specifically, new lifestyle choices influence an increasing demand for comfort that also leads to an increase in purchase and use of new electrical appliances [Meier Lebot 2002]. This demand is evident from the increase in purchases and ownership of household appliances that were unknown 10-20 years ago, such as dishwashers, microwaves and set top boxes.

A typical household usually has more than fifteen appliances that consume electricity in comparison with a household in the 1990s, when the number of appliances did not exceed the number of ten [Harrington, 2001]. New lifestyle trends and desire for amenities has resulted in a higher penetration of traditional appliances but also the introduction of new ones, leading to an increase in total electricity consumption and standby consumption [figure 1.1].

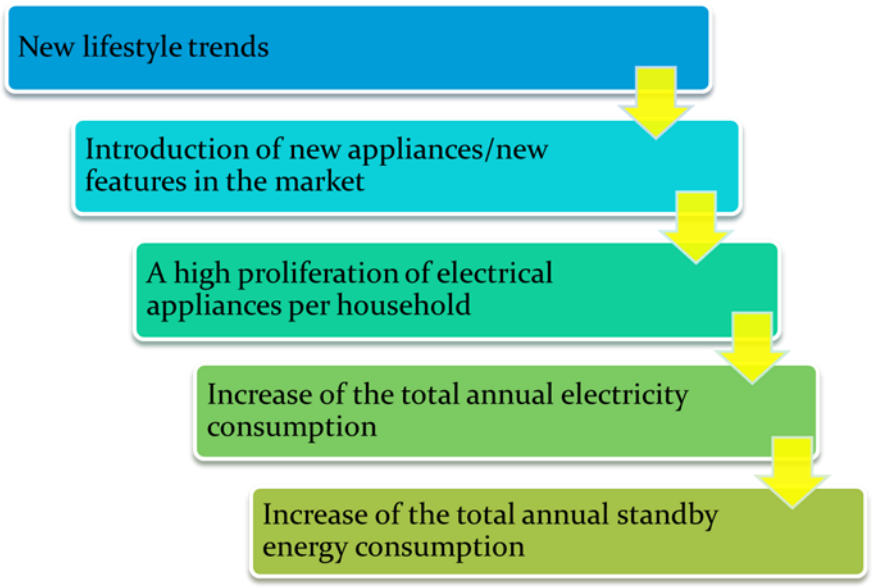


Figure 1.1: Steps leading to standby power growth

[1] Definition from Flora L. Williams, Purdue University: The term life style is used casually to point out differences in the way people live. Life style is assumed to be an important variable for studying consumer behavior.

Each household may have double or triple the number of a single type of appliance. Figure 1.2 shows the penetration rates of high energy appliances in the Netherlands, where the average electricity consumption has been increasing since 1988 [Lindt et. al., 2008]. Total domestic electricity consumption in the Netherlands amounted to approximately 55 PJ_e in the period 1980 - 1988 (CBS). The effect of the increase in the number of households was counterbalanced by a decrease in the average electricity consumption per household [Jeeninga 2007]. After 1988, total electricity consumption rose rapidly to 71PJ_e in 1995, because the number of households as well as the average electricity consumption per household increased [Jeeninga 2007]. The total electricity consumed increased to 89PJ_e in 2010 [Eurostat, 2010].

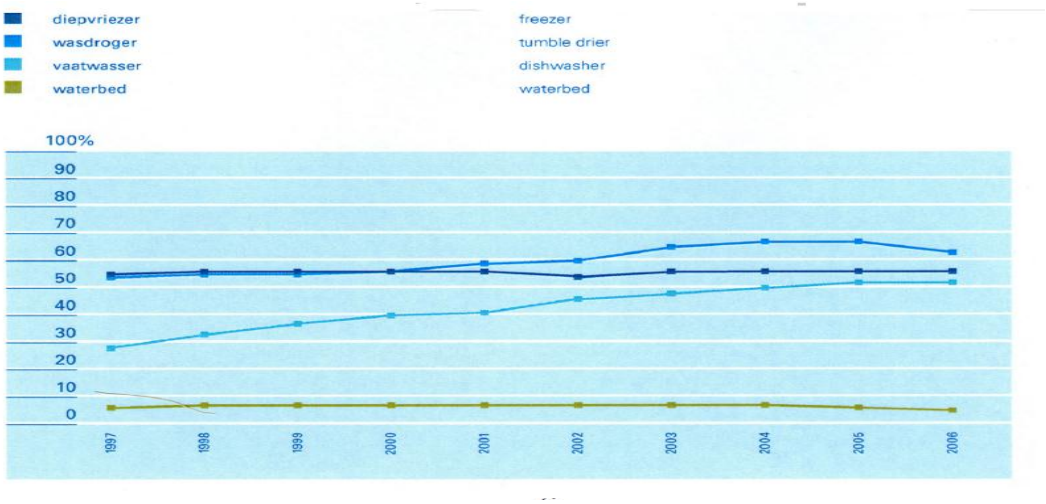


Figure 1.2: Penetration of high energy appliances (1997-2006). Figure retrieved from TNO report, 2008

Household appliances such as personal computers, televisions, audio devices and refrigerators, are some of the appliances sold in the market annually. All of them consume energy during their use-phase but also when they are not being used, for instance in standby mode. The reason is the need for extra energy for some of their features, such as remote controls, digital displays and clocks.

This high proliferation rate of domestic appliances raises overall energy consumption and results in both higher energy bills but also the use of fossil fuels for electricity generation and the associated carbon dioxide emissions produced. The power consumption may seem trivial, because the actual power consumed in standby mode is typically 0.5-30 W. However, increasingly more new appliances have features that consume standby power (at most 24 hours per day depending on the actual use of the device), it becomes an important fraction of the total energy consumption of a household [Meier, 2001]. If standby energy use from appliances is aggregated at the level of a city or a country, the amount of energy savings per year cannot be neglected. For the year 2005 the European Commission estimated that approximately 3.7billion€ [Valentova, 2009] installed products in the EU feature standby/off mode, leading to electricity consumption in standby/off mode of close to 50 TWh, corresponding to electricity costs of about €7

billion, and 20 million tons of CO_2 emissions [Valentova, 2009]. According to IEA[2], by 2030, 15% of the total appliances electricity consumption in Europe could be due to standby functions [Almeida, D., A., et al., 2010]. Studies in the Netherlands have shown that standby power accounts for as much as 10% of the national residential electricity use [Harrington, 2001; Siderius, 1998]. Ross and Meier [2002] also estimated that the average standby power use in the field measurements among 17 countries, was approximately 50 W and standby power was responsible for 3-12% of total residential electricity use.

As mentioned above, increasing household ownership of electrical goods and consequential rise of average electricity consumption per household has contributed also to the rapid growth of standby power usage [Jeeninga, 2007]. The problem is related not only to how many and the kinds of appliances purchased, but also how these appliances are being used and for how long. Consumer behavior[3] has a direct influence on product performance. The energy consumption of electrical appliances varies through the way in which these appliances are used over their lifetime (for instance, time spent in on/ off/ standby mode) and through the selection of new appliances. Due to different consumer preferences, energy performance is often not the first priority. In addition, it appears that, consumer awareness about the existence and the magnitude of standby losses and the possible behavioral changes to curb are still low. Once customers buy the appliances, the consumption will solely depend on: their habits; willingness to reduce energy and the technical options available. It is clear that in modern homes people are reluctant to sacrifice comfort and convenience by switching off equipment manually. The above statements imply that preferred solutions need to be able to manage all appliances at the same time and/or use remote controls for the comfort of their owners.

The employment of standby reduction devices, such as switched socket power boards with a hard off switch[4] or more sophisticated standby killers with remote controls can be a solution. These devices reduce standby power to zero but have a low penetration rate in the market. There are several reasons that may prevent a larger penetration of standby reduction devices in Dutch households. The major barriers are first the lack of public campaign awareness[5] about the existence of these devices and secondly the apparently small share of standby consumption in total household electricity. These devices should be more effective than manual switching, as they generally do not require direct user intervention to be effective.

The European Union and policymakers identified the need to tackle the increased standby power use of appliances and its impact on the total energy consumption. The best moment to address this impact is during the design phase of products. Therefore, the European Union adopted in 2005 the Directive 2005/32/EC, establishing a framework for

[2] IEA: International Energy Agency

[3] www.Businessdictionary.com defines consumer behavior as the process by which individuals search for, select, purchase, use, and dispose of goods and services, in satisfaction of their needs and wants

[4] A hard-off switch is integrated into a device that completely disconnects that device from the electrical mains.

[5] Public campaign awareness as defined by European Environment Agency: An organized, systematic effort through various communications media to alert the general population of a given area to anything of significant interest or concern

the setting of Ecodesign requirements for energy-using products and implemented this in all EU countries. In 2009, the Commission put forward a proposal to enlarge the scope of the Ecodesign Directive to include energy-related products. Ecodesign Directive is a framework which sets standards for the electricity-increasing devices by implementing measures on specific product requirements for energy-using products. An appliance can be available in the market only if the energy standards from Ecodesign have been confirmed. There is however, virtually no policy from the Dutch government specifically focused on electricity savings from the reduction of energy consumption of appliances [Boonekamp, 2006].

Along with the growth in political will, there have been both significant technological developments and enhanced knowledge in this field during the recent years. However, there are still many groups of appliances that are not included in standby reduction process that consume high amounts of standby energy. According to the Ecodesign Directive, a product group can potentially be regulated under Ecodesign if it has more than 200.000 units sold annually in the EU, has a significant environmental effect, as judged by the number of products in use and has significant improvement potential. Before 2011, twelve types of products have been regulated under Ecodesign Directive. Major product groups, among them boilers, water heaters and computers, are still pending the approval of an Ecodesign Implementing Measure as revealed by reports from Ecofys [Molenbroek, 2012] and CSES[6] [2012]. Table 1.1 shows which electrical appliances are covered and which are not included under the Ecodesign Directive's scope up to 2012.

It will take many years for the replacement of the entire stock by the most efficient appliances in the market [Meier, 2001]. That is why, until these measures are fully implemented, consumers can mainly contribute to the reduction of standby energy consumption through their willingness to invest in standby reduction devices.

Ecodesign Directive: Adopted implemented measures	**Ecodesign Directive: No regulation as of January 2012 (under consideration)**
Simple set top boxes	Computers: Laptop / Desktop / tablet PC & PC monitors
Televisions	Laundry dryers
Domestic Dishwashers	Commercial refrigerator / Freezer
Domestic Washing machines	Sound and imaging equipment[7]
Electric motors	Complex set top boxes (digital tv recoder)
Circulators	Electric pumps
Fans	Water heaters
Domestic refrigeration	Water boilers
Tertiary sector lighting	
External power supplies	
Domestic lighting	
Standby and off mode losses of electrical & electronic equipment (household & office)	

Table 1.1: Overview of appliances regulated and unregulated up until 2012 [Molenbroek, 2012]

[6] CSES: Center of Strategy and Evaluation Services, Oxford, UK

[7] Game consoles, stereo hifi, projectors musical instruments, pc speakers, radio

1.2 Objective & Research Questions

This analysis will take place by assessing appliance ownership and use on a household level. The decision to focus on the household instead of the individual person has to do with the fact that many choices that have an effect on energy consumption are made at this level, for example which appliances are purchased, how many hours they will be active, or when they should be replaced. These choices may be further determined by the age of consumers and the income [Jeeninga, 2007]. In addition, behavior is relevant in three phases of the consumption chain. The first is the purchase of an electrical appliance in which the consumer has the choice between efficient and inefficient products. The second phase is the usage of the appliance, which is the user's responsibility. The third has to do with the awareness, which is relevant to the energy losses and motivation for energy savings that are covered in this study.
The objective of the study is to estimate the energy savings and CO_2 reduction potential and the economic benefits in a Dutch household in two situations: (1) the use of the best available technology that already exists in the market in order to investigate the technological improvements compared with the existing appliance stock (2) the willingness of consumers to use switch off devices in their households in order to investigate consumer's behavior. The above can be formulated in the following research question:

Main research question

What is the final energy savings potential, CO_2 reduction potential and economic benefit from standby energy use in electrical appliances in Dutch households, resulting from consumer adoption of the best available domestic appliances and by their willingness to use standby reduction devices that already exist in the market?

The main research question is being followed by a number of subquestions. Subquestion 1, 2 and 3, will be answered empirically by the use of a suitable questionnaire that will provide the data needed. Subquestion 4 will be answered by empirical analysis achieved through the use of energy loggers in Dutch households. Subquestion 5 will be addressed by the report based on measurements taken with energy loggers using the best available appliances provided by shops. In case of the inability for measuring best technologies, literature reviews will provide the missing data. For subquestion 6, the collected data is going to be used to assess the effectiveness of Ecodesign Directive, in contrast to the use of standby reduction devices or best available technology.

Sub-questions

1. How is standby power consumption correlated with an occupant's characteristics and ownership of domestic appliances?
2. What is the penetration rate of the most common appliances in a Dutch household, and what is their lifetime?
3. To what extent are consumers aware of the standby reduction devices and what is the penetration of these devices in Dutch households?
4. What is the actual standby energy consumption of appliances in a Dutch household?
5. What are the best appliances that could replace the existing stock in a Dutch household?
6. What is Ecodesign Directive's effectiveness with respect to the reduction of standby energy consumption?

1.3 Scope of the research

This research focuses specifically on the standby consumption of electrical appliances in Dutch households. Commercial and public buildings and also other sources of energy consumption such as lighting, heating, and cooling systems will not be part of this research. Hence, the number of appliances that will be measured is limited to a maximum of ten appliances per household with a focus on entertainment and ICT equipment. Large appliances and the ones that are working continuously during the day, such as refrigerators, modem-routers, telephone chargers etc., will be reported for the market penetration and ownership but will be excluded from the measurements.
For the best available technologies in the market (BAT), electrical appliances have been measured up to the period of May 2012. These measurements covered a vast variety of products already in the market. These products were the most efficient and technologically improved available in the Netherlands during the period of measurements. In this study the investment costs will be excluded.

1.4 Definition of standby power mode within the study

Before the description of data collection is given, it is important to identify the standby consumption. There have been many definitions for standby power. The original IEC[8] definition defines standby as "*a product's minimum power consumption while plugged in*." This definition does not distinguish between appliances that are inactive and others that are providing some functions in the lowest power mode. The Lawrence Berkeley National Laboratory defines standby as, "*the power draw of an appliance in its lowest power mode. For appliances without a power switch, such as battery chargers, power draw is measured while the units are plugged in, but are not being used by the consumer*." As a summary, "*standby power is the electricity consumed by end use*

[8] IEC: International Electrotechnical Commission

electrical equipment, when it is switched off or not performing its main function" [Meier & Lebot, 2002]. This is the definition that will be adopted in this study. Further explanation on standby measurements per category/appliance is presented below.

- **Entertainment equipment**

In entertainment equipment, such as televisions, game consoles, decoders etc., standby measurements occurred when appliances were in reactivation mode: closed by a remote control and not performing their main function.

- **ICT equipment**

There were different measurement modes between appliances in this category. Laptops[9] and desktops were in sleep mode[10] and did not provide their main functions, but instead the user had to reactivate them.
Printers/scanners, copiers, PC monitors and PC speakers, were in reactivation mode with a power switch and not performing their main function. Paper cutter, external hardrives and battery chargers were plugged in but not being used by the consumer.

- **Cooking appliances**

Cooking appliances, such as microwaves (with and without timer display) were plugged in but not performing their main function[11].
Coffee machines were plugged in and were in reactivation mode with a power switch and not performing their main function.

- **Large appliances**

From large appliances, dishwashers and washing machines were measured. The units were plugged in, but not being used by the consumer. Some of them also had a display which provided additional information.

- **Miscellaneous equipment & lighting**

Aquariums and lights were plugged in but were not being used by the consumer. Electric toothbrushes were plugged into the mains but not charging.

[9] For standby measurement of laptops, the battery was removed. For laptops with a built in battery that could not be removed, the battery was fully charged. Measurements with this technique ensure that no energy consumption through charging conditions of appliances will affect measurements.
[10] Sleep mode also called standby mode, is an inactive state of a computer or electronic device that is quickly brought back into action by touching any keyboard key or pressing the on/off switch
[11] Standby mode in microwaves is considered where they display time or are plugged into the mains.

2. Methodology

2.1 Research Method

In this study, a bottom up method is used as it is considered most suitable. Other research methods are briefly described in Box 1. A common measurement methodology was developed using the same equipment (Voltcraft Energy Logger 4000) and a scientific questionnaire applied to households under study. In this way, it was possible to collect comparable values between households. In the following paragraphs of this chapter, there will be an analytical explanation of the methodology as shown is figure 2.1.

The research approach is divided into two parts. In the first part, data related with the electrical appliances in Dutch households was collected with the use of energy loggers. In this phase, standby consumption of existing appliance stock, BAT and standby consumption with standby reduction devices was measured. During this phase, this data was further analyzed. In the second part, the questionnaire of participants was analyzed in order to investigate consumer behavior and patterns, market penetration of appliances but also their level of awareness in standby energy, standby reduction devices, and willingness to change their behavior. These methods were compared in order to investigate the effectiveness of the Ecodesign Directive requirements, with a focus on the stock turnover of old appliances.

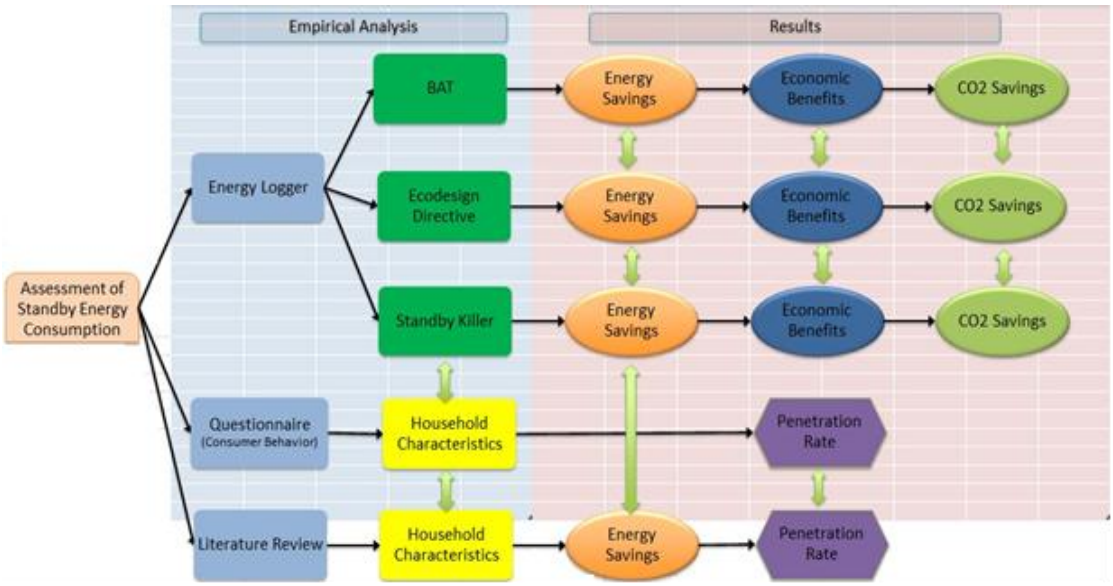


Figure 2.1:Description of the methodology steps followed in this study

Box 1: Current research methods

There are three separate methods that can be used to identify energy savings potential achieved through a reduction of standby power use. These methods are:

- Whole-house measurements
- New product measurements
- Bottom-up estimates

According to Meier [2002], whole-house measurements involve visiting a home and measuring the standby power use of every device consuming standby power. By monitoring a representative sample of homes a survey can establish a reasonably accurate and credible estimate of standby power use.

New product measurements involve visiting a store or factory and measuring the standby power use of many new products at one time. This is a good technique to quickly assess levels of standby. However, the results from these measurements may not match the in-home ones. New appliances are, in most cases, expected to consume less standby power than those found in homes.

Bottom-up estimates are used to estimate either average standby per home or national standby power consumption [Meier, 2001]. This method is accurate for common appliances with a large number of measurements and with a known penetration.

2.2 Literature review

A literature review has been conducted in order to discuss the most recent published information in relevance with standby consumption. The focus of this review is to summarize the methods and results of other author's reports and compare with the results of this study. The form of the literature review is thematic with the topics as are presented in bulletin points below.

- **Standby consumption estimates per household**: There have been various national studies conducted worldwide to estimate standby power losses in households. Standby power use, the average standby consumption as a fraction of total electricity use and the number of appliances and households measured, will be reviewed.

- **Ownership and Penetration rate:** The number of appliances owned by consumers and their penetration rate from international studies will be surveyed.

- **Relationship between standby consumption and household characteristics**: Household characteristics that may affect the standby consumption of households such as income, age of participants and level of education will be showed. Consumer awareness and behavioral changes will be also reviewed.

2.3. Consumer behavior

2.3.1 The Survey sample

The first step of the methodology was the choice of households. The term household refers to a housing unit including all the persons occupying the house. A survey of a forty-four random household sample in the Netherlands was conducted. The sample consists of households from a wide range of distributive backgrounds, such as families, working single persons or couples, and students. Except for differences in the types of households, there were also spatial, aging[12] and income categorizations. Households were measured from 12 different regions in the Netherlands, but the majority is from the city of Utrecht. This will create a representative sample. For the income categorization, the ranges of income were sub-divided in order to cover, with higher accuracy, income fluctuations [Table 2.1].

	Monthly income in €
1	> 500
2	500 – 1000
3	1000 – 2500
4	2500 – 4000
5	4000 – 5500
6	5500 – 7000

Table 2.1: Categorization of monthly income

[12] For the Aging dispersion only participants who answered the survey were reported. Children or other family member / roommates where excluded from the aging dispersion

2.3.2 Data collection: Questionnaire

After the initial survey of all electrical appliances, a second survey on consumers, with respect to standby consumption, followed. This questionnaire was created in order to investigate trends regarding behavioral aspects toward electricity consumption, awareness, standby equipment uses, and the general comfort needs of consumers. Energy use in a home is determined by technical and architectural characteristics (home characteristics) on one hand, and behavior of the residents (household characteristics) on the other. A particular attitude related to energy use may be an important determinant of behavior [Paauw, 2010]. Consumer interviews took place where each participant had to answer a predefined questionnaire. The questionnaire was answered by the same participants whose households were measured for standby consumption, but also from another 26 participants, giving the number of 70 questionnaires in total. The head of household[13] was the one who answered the questionnaire (especially for families). Income was calculated cumulatively among household members. The questionnaire is based on Selina's project questionnaire [Silva et al, 2010]. It consists of six major sections: general information, housing, market-retailer, appliances and standby reduction devices. The full questionnaire can be found in Appendix I.

- **I & II General Information and Housing:**

In this section, household determinants such as age, income, level of education, region, and members per household were collected, in order to have a general overview of the sample.

- **III & IV Appliances and Behavior:**

The goal of this section is to identify the reasoning behind the purchase of certain appliances. To discover which behavioral factors trigger consumer choices, the following were investigated; interest in energy performance, awareness of standby consumption, appliance usage, and economic parameters.

- **V Market-retailer:**

This section aims to evaluate how often a retailer referred to the energy efficiency of an appliance, the interest of the consumer, and the level of awareness for the energy labels of appliances.

- **VI Standby reduction devices:**

In the last section, the consumer awareness for the existence and use of standby switch off devices was investigated.

[13] An individual in one family setting who provides actual support and maintenance to one or more individuals who are related to him or her through adoption, blood, or marriage.

2.4 Standby consumption measurements

2.4.1 Selected household appliances

After choosing the appropriate household sample, the next phase was to report and subsequent categorization of electrical appliances within households. The report of all appliances per household will give their penetration rate. Appliance penetration rates are used to indicate the total number of an appliance found in a specified population of households [Shuma-Iwisi, 2009]. Appliance penetration rates may exceed 100% in cases where a household has more than one appliance of the same type. With this categorization, the penetration rate will go a step further, in order to identify the rate of influence per category of products. The different types of electrical appliances were classified into six key categories depending on their usage. These categories are: lighting, miscellaneous, entertainment, ICT, cooking, and large appliances. In table 2.2 this division is presented. The total number of electrical appliances measured is 387, the vast majority of which come from the ICT and entertainment equipment categories. It has to be noticed that specific types of appliances such as lights, modem routers, refrigerators and telephone chargers were excluded from the measuring process but included in the reporting step. Due to technical difficulties in measuring all appliances reported in a household, for 31 appliances (8% of the total sample) the average value per type of category is used. This raises the total number of appliances reported to 418.

After this classification, a description of the characteristics of each appliance was captured. The description was used to create a database. Manufacturer, year of production[14], year of replacement, ownership, and specific characteristics of appliances such as screen size for televisions, laptops and PC monitors, were collected. The actual time each appliance remains in standby mode during weekdays and the weekend was also provided by the participants, in order to calculate the actual annually standby consumption. Furthermore, the age of appliances found in the survey sample can be used to determine the appliance turnover rates. The appliance turn over rates may prove helpful in predicting the standby power load. High turnover rates would imply that the standby power load will change over short periods of time as complete new appliances or the advancement of old appliance technologies enter the households. Long appliance turnover rates would mean that the determined load can be assumed to be constant over a longer period of time without a significant change unless there is a step change in the market.

[14] Information for the production year was not available for all appliances

Lighting	Lights Light with dimmer
Miscellaneous equipment	Vacuum cleaner iron Razor charger Hair dryer Aquarium gardening equipment alarm system electric toothbrush electric massage
Large appliances	dehumidifier Air conditions systems (heating cooling) Dryer Heater (portable) Gas boiler Refrigerator pumps Freezer Dishwasher Washing Machine
cooking appliances	oven rice cooker Microwave Blender mixer cooking plates Toaster Coffee machine Juicer Fryer kettle
ICT	paper cutter Pc speakers pc monitor Modem router Hub, USB Digital frames Laptop - Desktop battery charger External hardrive Printer / Scanner / Copier Telephone Answering Device Telephone charger (for cell phones) Telephone, cordless with answering machine alarm clock Fax
entertainment equipment	game console Projector VCR/DVD player - recorder Set-top Box, DVR Subwoofer Cd player Mp3 charger Hi Fi (stereo) Musical Instruments Television Amplifier decoder Clock radio docking station camera charger

Table 2.2: Categorization & list of most common measured electrical appliances

2.4.2 Data collection: Energy logger

In this section the actual standby consumption with the use of energy loggers will be presented. Figure 2.2 presents the steps of standby power measurement. The data was collected using the Voltcraft Energy Logger 4000 metering equipment provided by Utrecht University [figure 2.3]. It is a device that measures the exact energy use in Watts for the appliance that is plugged into the logger. The appliance categories covered by this study were presented previously in table 2.2. Each appliance was measured individually.
The accuracy of the energy logger depends on the amount of energy it measures [table 2.3]. Here are the values provided by the manufacturer:

For 5-3500 W: +/- 1%.	For 2-5W: +/- 5%	For >2 W: +/- 15%

Table 2.3: Accuracy of energy logger in different standby power measurements

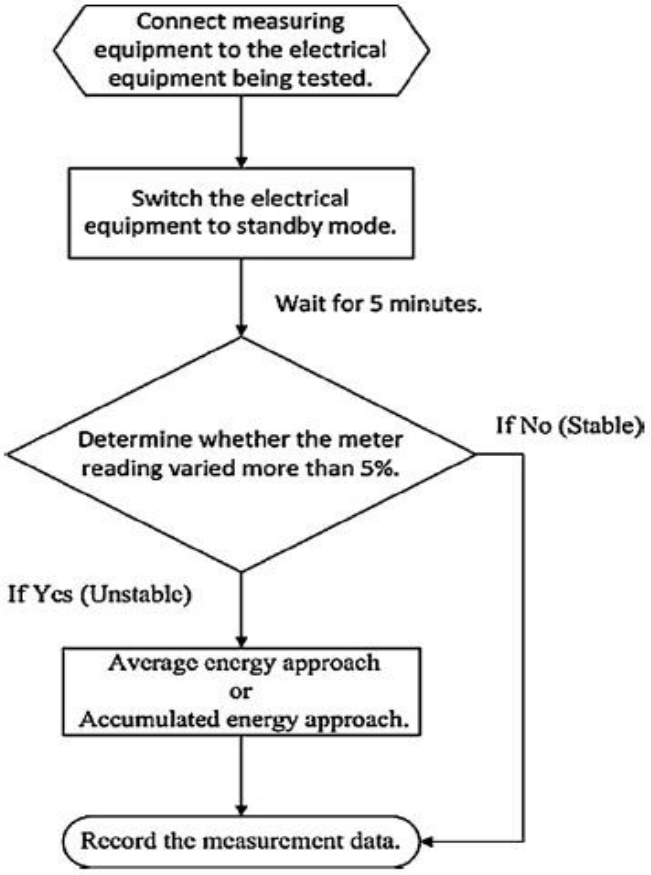


Figure 2.2: Standby power measurement process. Figure retrieved from Tai Ken Lun, et al. 2011

The energy logger was connected to the mains and the electrical appliance was plugged into the logger. The appliance was then put into standby mode[15]. After connecting it to the logger, the data displayed as shown in figure 2.3. If no device is connected, no symbol appears. Each measurement can last for a specific time period between 1 and 10 minutes, depending on the stability of the power consumption. In the majority of the measurements, the minimum time period an appliance was plugged in was four minutes[16]. When power was stabilized on the main screen of the logger, the period of measurements was started. The logger's technical characteristics can be found in Appendix III.

Figure 2.3: Voltcraft Energy Logger 4000

After each measurement, the appliance was unplugged and the data of was saved on the SD memory card inside the logger, and then via the SD slot, transferred for further processing with the Energy Logger Viewer on the computer [Figure 2.4]. The energy logger creates two .bin files for each measurement. With the Energy Viewer, an Excel data sheet was created, giving the voltage, current, power factor, actual and apparent consumption. Further, an image is provided by the Logger Viewer after each measurement, presenting standby consumption as shown in figure 2.5. By knowing the actual period of time an appliance is in standby mode annually - from the participant questionnaire survey – and then totaling standby consumption of all electrical appliances per household, the annual standby consumption of a household in kWh is measured.

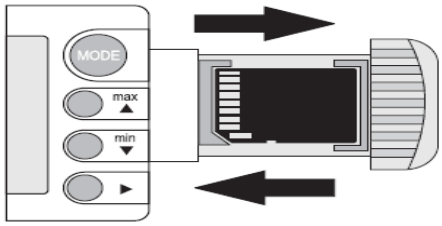


Figure 2.4: Data transmission from Energy logger

[15] Standby mode definition was defined in the previous step of the study

[16] Due to logger malfunctions, for some measurements only instant measurements occurred or data was collected via reviewed literature of standby consumption provided by the manufacturer

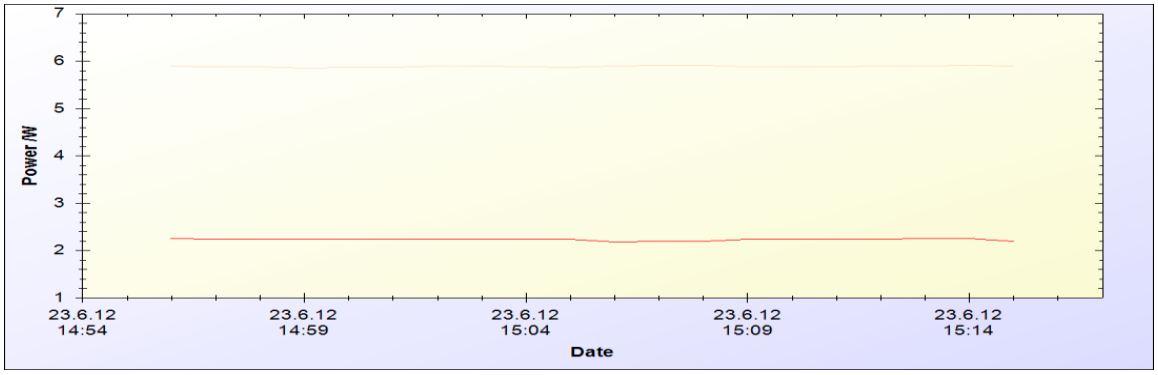


Figure 2.5: Standby power consumption of Sony television as presented by Energy Logger Viewer. Figure retrieved from a measurement

It is important to take note that in order to make valuable data analysis, measurements had to extrapolate from the sample of 44 households to the total number of households in the Netherlands. This is a more realistic approach in study's results with respect to the energy savings potential, economic benefits and CO_2 reduction potential. In 2010, the number of households in the Netherlands was 7.4Million (CBS, 2010). CBS also predicted that in 2025, the expected number will reach 8Million. At that point three assumptions have been made. Firstly, the study assumed that the growth rate of households will be 40000 households per year until it reaches the 8Million at year 2025. The second assumption has to do with the consumer awareness and policy changes. It is assumed that until 2025 no changes in consumer habits will occur and as a consequence no changes in the standby consumption. The same occurred for policy regulations. The average energy consumption in a Dutch household for 2012 was 3350kWh [CBS, 2012c[17]]. With the annual electricity consumption via energy bills or electric meters an estimation of the fraction of standby consumption in the total electricity consumption per household is determined [Meier, 2001]. From knowing the number of households in the Netherlands the national share can be calculated.

The mathematical equation that has been used to define standby energy consumption (kWh) of an appliance (j) in a year is:

$$SEC_j = (P_{sb}/1000)*t_{sb}$$

Where P_{sb} is the average real power consumed in standby mode in Watts obtained for each appliance of interest from the measurements and t_{sb} is the time in hours spent in standby mode for each appliance in a year estimated from this study's questionnaire survey.

[17] CBS, 2012c, Kerncijfers wijken en buurten 2004-2010.

2.5 Standby Energy Consumption Cases

2.5.1 Standby reduction devices (standby killer)

Standby reduction devices or simply standby killers are devices that minimize the standby consumption of an appliance to zero. Measurements with these devices are expected to give the lowest standby power reading as compared to measurements of appliances that do not have standby killers. The energy logger was connected to the mains and the standby killer device was plugged into the logger. Appliances were then plugged into the standby device. In the next step, the standby killer was turned on and the standby consumption of appliances was presented on the energy logger's display. Measurements with the standby killer devices were instant. The reason was that standby consumption was always zero without any power fluctuations during time. The penetration rate of standby switch reduction devices in the market was estimated as a percentage of the devices which already existed in each household. The standby killer used for the measurements was manufactured by Belkin (model F7C01008q) and the main characteristics are presented in Figure 2.6. The advantage of this device was the remote control, which assisted in the investigation of the significance of comfort in consumer's choices[18].

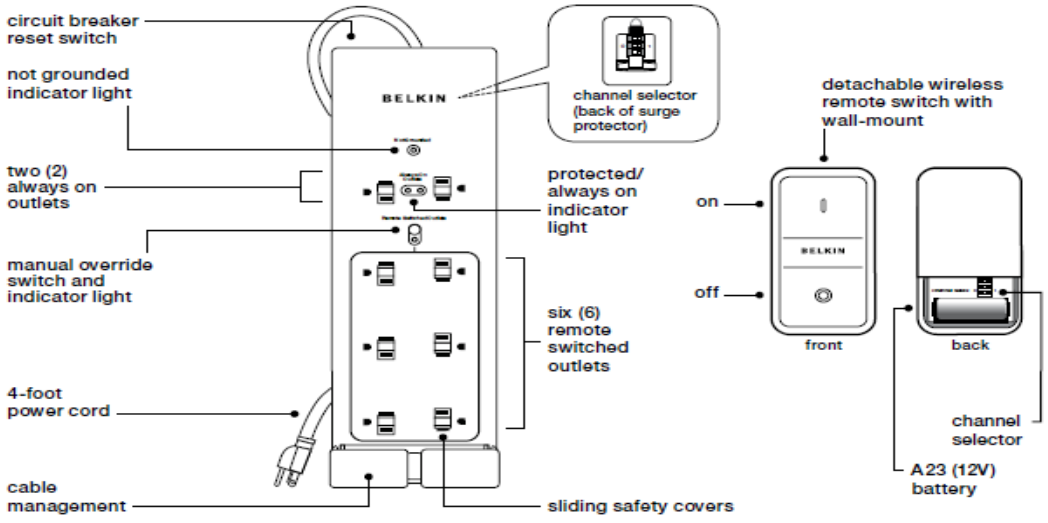


Figure 2.6: Technical characteristics of the Belkin's conserve switch with remote control

[18] The results of comfort in consumer choices in regard to remote controls and standby consumption will be presented in the chapter

2.5.2 Best available technology in the market (BAT)

The term BAT will be used in this study as a term for best available technologies. For the BAT analysis, a survey of the market's most efficient products was conducted. These efficient appliances will replace all the existing stock in households. The criteria for the best appliance per group will be the energy performance and the production year.
Measurements of the standby power of new appliances occurred within the stores. Media Markt, the German chain of stores provided the appliances for the BAT analysis and the additional information needed. The choice of this brand has to do with the big quantity and quality of appliances and the numerous stores in the Netherlands. It is one of Europe's largest retailers of consumer electronics. As explained in previous steps, an energy logger was connected to the mains and the BAT appliances were plugged into the logger. Then, appliances were plugged into the standby logger and put into standby mode. As presented in section 2.4.2, each measurement can last for a specific time period between 1 and 10 minutes, depending on the stability of the power consumption. In the majority of the measurements, the minimum time an appliance was plugged in was four minutes. When power was stabilized in the main screen of the logger, the period of measurements was started. A list of the best available appliances in the market was reported, in order the comparison between BAT and common appliances in households to be feasible. In Appendix IV and V the user guide and the complete list of BAT appliances are presented respectively.

2.5.3 Investigation of Ecodesign directive effectiveness

The objective of the Ecodesign Directive is that manufacturers of energy-using products will, at the design stage, be obliged to reduce the standby energy and off mode energy consumption of their appliances. For this reason, maximum requirements of standby consumption were adopted to ensure the lowest possible energy use for household appliances. The main criteria and modes are presented in table 2.4:

	2010 requirements	**2013 requirements**
Off mode (W)	1	0.5
Standby mode – Appliances with no display (W)	1	0.5
Network Standby mode – Appliances with network features[19] (W)	2	1

Table 2.4: Maximum values in different modes of standby consumption by Ecodesign Directive

[19] Set top boxes and decoders were the only types of appliances with a Watt value.

2.6 Comparison of cases: calculation of energy – CO_2 savings potential & economic benefits

After the data collection from the previous sections, the study moved on to examining measurements of energy savings potential, CO_2 reduction and related economic benefits. The standby consumption from existing appliances in households will act as a reference point. The energy potential savings are derived from three cases: first, the use of standby killer devices; second, the case in which when the existing stock will be replaced the new appliances will be the BAT appliances; and third, the case in which when the existing stock will be replaced the new appliances will have the Ecodesign Directive's values. The timeframe of this study is until the year 2025. The results will be presented for Dutch households. Many steps were included in this methodology. Firstly, standby consumption per household is determined. The replacement rate of each electrical appliance is known from the questionnaire. Thus a simple stock turn over model can be made. For standby killers the measurements are instant and provide with the data needed. For Ecodesign, the maximum value an appliance should have is the 0.5W (table 2.4), but if there are more efficient products in the market with less standby power than the regulation (for instance, BAT) these appliances are then be preferred[20]. For BAT case, the existing stock will be replaced by the best available technologies in the market. For this reason a list of BAT appliances has been created (table 2.5). This list is used to inform the replacement of the existing stock. Due to difficulties in measuring of specific types of appliances in the store, standby consumption provided through literature review or with the use of the most efficient and newest appliances measured in the household[21]. Following, the energy savings in kWh for each case are calculated and thus the economic benefits and CO_2 savings until the year 2025.

Even though it is assumed that the Ecodesign Directive is implemented uniformly across all new appliances, this is not completely true since only some types of appliances have been accepted in the Directive's framework (table 1.1). For this reason, a second Ecodesign case is created (business as usual). A comparison between the two Ecodesign cases is also presented for the same time frame (2012-2025). This comparison is useful to draw conclusions with regard to the gap in energy savings potential of the Ecodesign Directive based on the type of appliances covered.

BAT per type of appliance	Standby consumption in Watt
Coffee machine	0.21
Television	0.1
Set top box	1
Radio	0.33
Decoder	0.5
Stereo hifi	1.21

[20] With this approach the use of products with increased standby power is avoided.
[21] E.g. For electric keyboards, a Yamaha 2008 model was used with standby consumption of 1.79 watt

BAT per type of appliance	Standby consumption in Watt
DVD player	0.21
Pc speaker	1.09
Printer	0.1
Game console	0.15
Laptop	0.08
Microwave	0.05
Desktop	0.3
Pc monitor	0.13
Electric toothbrush	0.68
Alarm clock	1.23
External hardrive	2
DVD recorder	1.93
Amplifier	0.3
Vacuum cleaner	0.52
Electric keyboard	1.79
Dishwasher	0.16
Washing machine	0.08

Table 2.5: List of the most efficient appliances measured in store

A) Energy savings

- **Annual energy savings (ES) per household, in TWh**

From the perspective of consumer willingness and habits, the energy potential savings (ES) will be estimated with the use of standby killers. For the standby killer case the reference point is the standby energy consumption (SEC) of the household without the use of these devices. Due to the fact that standby killers nullified standby consumption [section 2.5.1] the percentage of standby consumption calculated (SEC) will be converted directly into energy savings (ES_{SK}). For the calculations, the standby energy consumption (SEC) will be used. The value is 261.3kWh (see section results).

For the BAT case, the difference will be calculated between standby consumption (SEC) in the household and standby consumption when existing stock replaced by the BAT appliances (SEC_{BAT}). This difference will give the energy savings[22] (ES_{BAT}).

For Ecodesign case, the difference will be calculated between standby consumption in the household (SEC) and standby consumption when existing stock is replaced by Ecodesign values (SEC_{ECO}). This difference will give the energy savings (ES_{ECO}).

[22] Investment costs will be excluded from this research

Equation 2.1 for standby killer: $ES_{SK} = SEC_{SK}$

Equation 2.2 for BAT: $ES_{BAT} = \sum_{j=1}^{n} SEC - \sum_{j=1}^{n} SEC_{BAT}$

Equation 2.3 for Ecodesign: $ES_{ECO} = \sum_{j=1}^{n} SEC - \sum_{j=1}^{n} SEC_{ECO}$

n = total number of appliances
SEC= SEC_{SK} = 261.3kWh

- **Annual energy savings of total households in the Netherlands (HES), in TWh for year 2013**

For each case, the average standby energy consumption of hh (SEC) will be multiplied with the total number of households (z) in year 2013.

Equation 2.4 for standby killer: $HES_{SK} = \sum_{j=1}^{z} SEC_{SK}$

Equation 2.5 for BAT: $HES_{BAT} = \sum_{j=1}^{z} SEC_{BAT}$

Equation 2.6 for Ecodesign: $HES_{ECO} = \sum_{j=1}^{z} SEC_{ECO}$

z = number of households in the Netherlands for year 2012
SEC = 261.3 kWh

- **Energy savings of total hh in the Netherlands (THES) for period 2013-2025, in TWh**

For each case, the sum of all annual energy savings of households (TES) for period 2013-2025 with current appliances is calculated

Equation 2.7 for standby killer: $THES_{SK} = \sum_{2013}^{2025} HSEC_{SK}$

Equation 2.8 for BAT: $THES_{BAT} = \sum_{2013}^{2025} HSEC_{BAT}$

Equation 2.9 for Ecodesign: $THES_{ECO} = \sum_{2013}^{2025} HSEC_{ECO}$

B) Economic benefits

Economic benefits (EB) will be calculated by taking into account the average electricity price provided by Eneco. For a normal rate until 2015, the price of 0.2076€/kWh (E_p) was used. It should be noted that different time periods have fluctuations in the electricity price, but due to the fact that the measurements will occur within a specific period of time

the average electricity price is adequate. It is assumed that the price of electricity will not be change before 2025. Since this assumption is highly uncertain, the price of electricity is included in the sensitivity analysis (section 4.5). The economic benefits are provided for consumers in order to investigate their willingness to use standby reduction devices for which an upfront cost has to be taken into consideration.

- **Annual economic benefits (EBF) per household in €:**

For each case the economic benefits (EBF) will be calculated with annual standby energy consumption per household[23] (ES) multiplied with electricity price (E_P).

Equation 3.1 for standby killer: $EBF_{SK} = ES_{SK} * E_P$

Equation 3.2 for BAT: $EBF_{BAT} = ES_{BAT} * E_P$

Equation 3.3 for Ecodesign: $EBF_{ECO} = ES_{ECO} * E_P$

E_P = cost of electricity = 0.2076€/kWh

- **Annual economic benefits of total households in the Netherlands (HEBF) for year 2013 in €:**

For each case the annual standby energy consumption (EBF) in year 2013 is multiplied with total number of households (z) in year 2013.

Equation 3.4 for standby killer: $HEBF_{SK} = \sum_{1}^{z} EBF_{SK}$

Equation 3.5 for BAT: $HEBF_{BAT} = \sum_{1}^{z} EBF_{BAT}$

Equation 3.6 for Ecodesign: $HEBF_{ECO} = \sum_{1}^{z} EBF_{ECO}$

z = number of households in the Netherlands for year 2012

- **Total economic benefits of total households (THEBF) in the Netherlands for period 2013-2025 in B€:**

For each case, the sum of the annual economic benefits[24] (HEBF) of total households for the period 2013-2025 in B€ is calculated.

Equation 3.7 for standby killer: $THEBF_{SK2013,\,2025} = \sum_{2013}^{2025} HEBF_{SK}$

[23] The percentage of the average standby consumption on the total electricity consumption, which was calculated in this study will be used

[24] All annual economic benefits were calculated above for each case

Equation 3.8 for BAT: $THEBF_{BAT2013,\ 2025} = \sum_{2013}^{2025} HEBF_{\ BAT}$

Equation 3.9 for Ecodesign: $THEBF_{ECO2013,\ 2025} = \sum_{2013}^{2025} HEBF_{\ ECO}$

C) CO_2 reduction potential per household

Apart from the energy savings (ES) and economic benefits (BF), there is also the potential of reducing CO_2 emissions, through the energy savings that can be achieved. The associated CO_2 emissions can be estimated from all the above cases with the use of appropriate methods. In this study the values provided by Harmsen and Graus [2012] will be used. The chosen approach was the power and heat method, which allocates the total CO_2 emissions based on heat and electricity production, thus taking into account the large combined heat and power production capacity in the Netherlands. The value as given by the report is 400gr/CO_2 per kWhe (E_f). Note that this CO_2 intensity factor is the lowest among the other factors calculated by Harmsen and Graus [2012] using other methods. This entails that the CO_2 reduction potential per household as defined in this study, is conservative if other CO_2 intensity methods were to be accounted for.

- **Annual CO_2 savings (COS) per household in Kg**

For each case the annual energy savings (ES) per household (kWh) is multiplied by the CO_2 intensity of power production (E_f).

Equation 4.1 for standby killer: $COS_{SK} = ES_{SK} * E_f$

Equation 4.2 for BAT: $COS_{BAT} = ES_{BAT} * E_f$

Equation 4.3 for Ecodesign: $COS_{ECO} = ES_{ECO} * E_f$

E_f = 400 gr/CO_2 per kWhe, ES = annual energy savings in kWh

- **Annual CO_2 savings of total hh (HCOS) in the Netherlands, in kWh for year 2013 in Million tons**

For each case the annual energy savings of total households (HES) in the Netherlands for year 2013 is multiplied by the CO_2 intensity of power production (E_f).

Equation 4.4 for standby killer: $HCOS_{SK} = HES_{SK} * E_f$

Equation 4.5 for BAT: $HCOS_{BAT} = HES_{BAT} * E_f$

Equation 4.6 for Ecodesign: $HCOS_{ECO} = HES_{ECO} * E_f$

E_f = 400 gr/CO_2 per kWhe

- **CO_2 savings of total hh (TCOS) in the Netherlands for period 2013-2025 in Million tons:**

For each case, the sum of all CO_2 savings of total hh (HCOS) in the Netherlands for the period 2013-2025 is calculated.

Equation 4.7 for standby killer $$TCOS_{SK2013,\,2025} = \sum_{2013}^{2025} HCOS_{SK}$$

Equation 4.8 for BAT $$TCOS_{BAT2013,\,2025} = \sum_{2013}^{2025} HCOS_{BAT}$$

Equation 4.9 for Ecodesign $$TCOS_{ECO2013,\,2025} = \sum_{2013}^{2025} HCOS_{ECO}$$

3. Results

In this chapter the results of this study will be presented, taking into account the measurements that occurred at the different steps of the methodology.

3.1 Empirical results:

3.1.1. Household characteristics

As mentioned before, the sample consists of households from a wide range of backgrounds, such as families, working single persons, couples and students. Figure 3.1.1 shows the different types of households. Family and student houses occupy more than half of the study's sample (60%). Figure 3.1.2 and figure 3.1.3 shows the distribution of occupants per household and the education level respectively. Houses with two or three residents cover the 53% of the sample. Further, 50% of the sample has an MSc degree or a PhD and 45% a bachelor degree. Figure 3.1.4 – 3.1.6 shows the categorizations with spatial, income and aging dispersion respectively. Measurements occurred in twelve different regions in the Netherlands, but the majority from the city of Utrecht (>50%). As for income dispersion, 85% of participant's income vary from 1000€ to 5500€ per month (cumulatively per household) and 68% is among the 21-30 year old category.

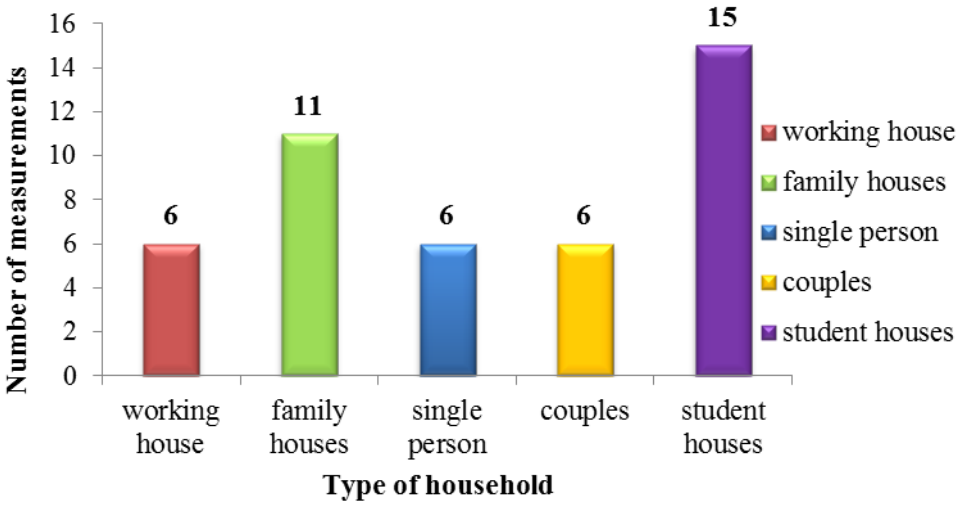


Figure 3.1.1: Different types of Dutch households

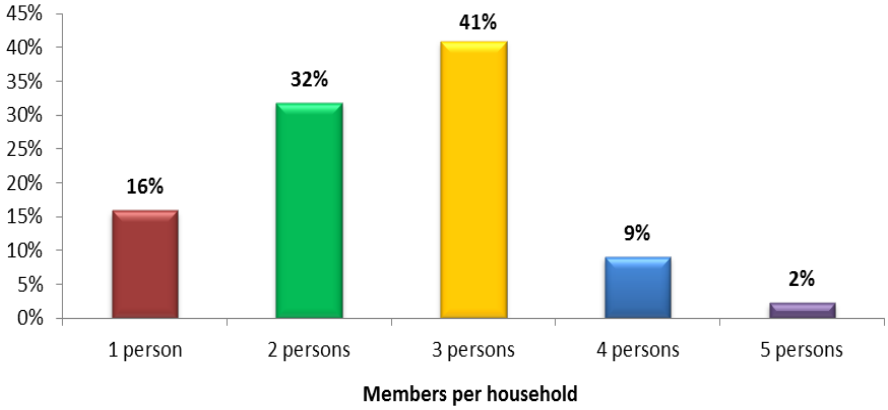


Figure 3.1.2: Distribution of the number of persons per Dutch household

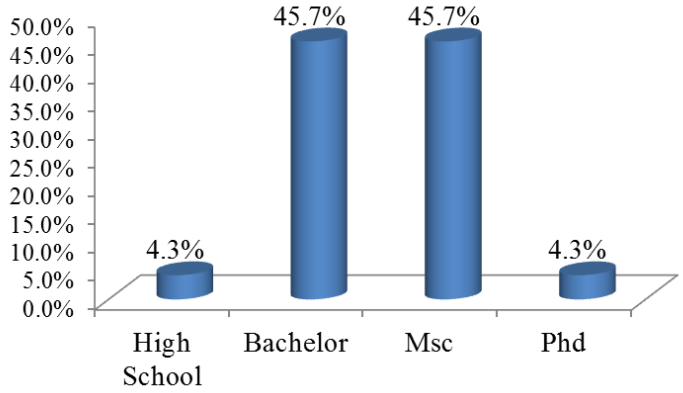


Figure 3.1.3: Education level as measured in total sample

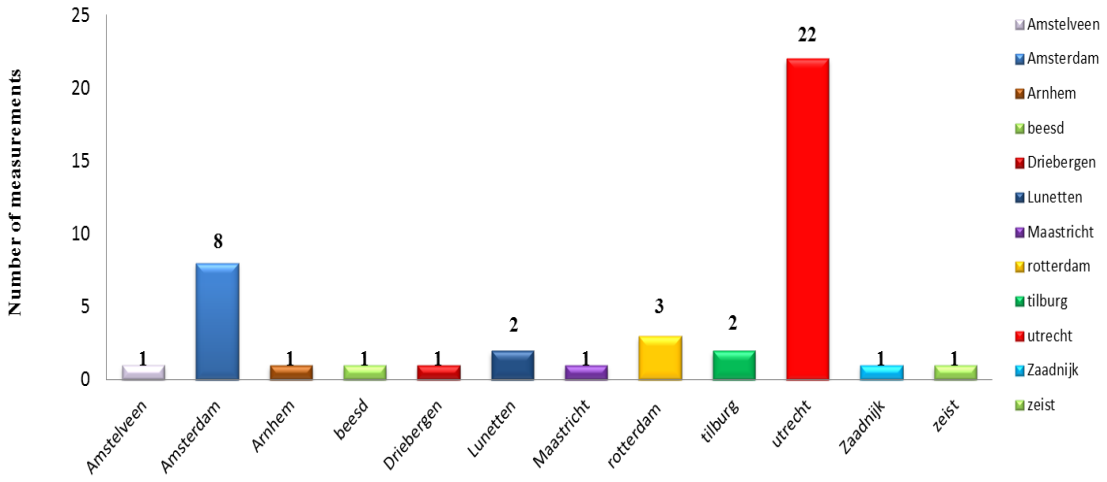


Figure 3.1.4: Spatial dispersion of Dutch households in the Netherland

Figure 3.1.5: Income dispersion in €/month

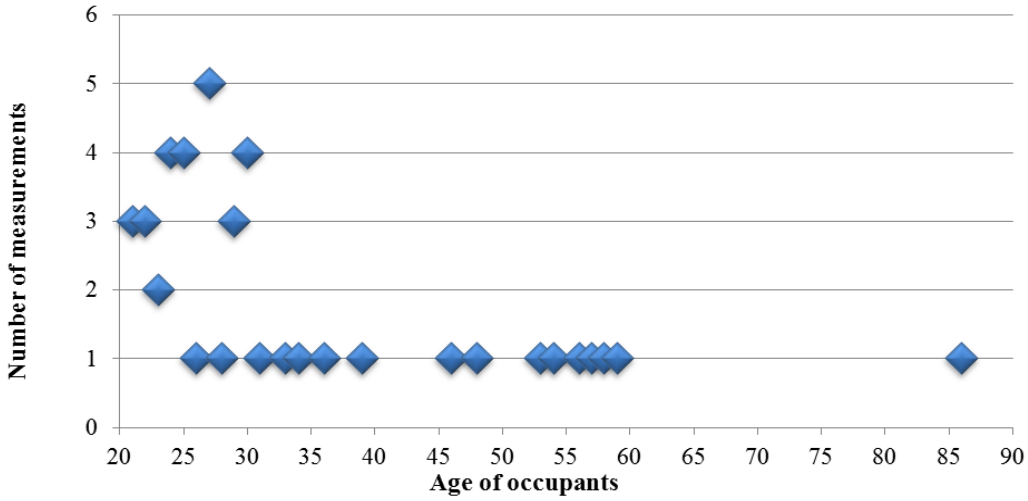


Figure 3.1.6: Aging dispersion of all participants in years

3.1.2 Correlations between standby consumption & household characteristics

In the figures below, the relationship between standby consumption and household characteristics are presented. Their possible correlations are estimated with the R-square[25] correlation coefficient. The R-square value reveals that there is no correlation between household income and the standby consumption [figure 3.1.7]. Figure 3.1.8, shows the relationship between monthly income and ownership of appliances. In this figure the R-square value indicates a very good correlation. The lower the income the lower is the number of purchases in the household. The ownership levels show stability after the monthly income of 2500€-4000€ with 36 appliances per household.

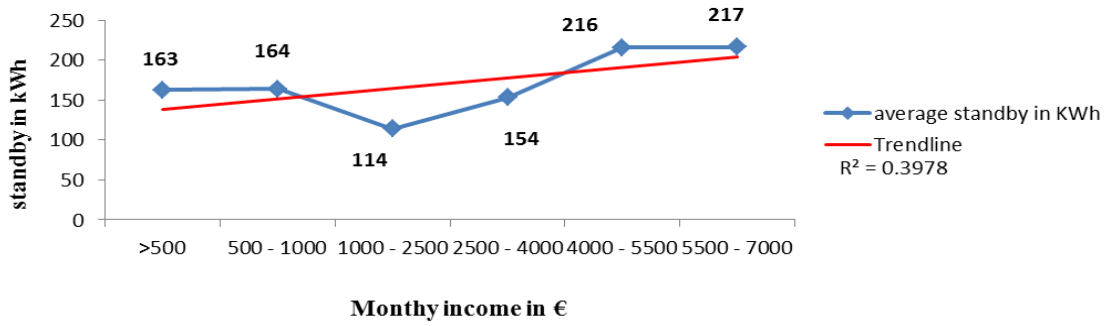


Figure 3.1.7: Relationship between average standby consumption and monthly income in Dutch households

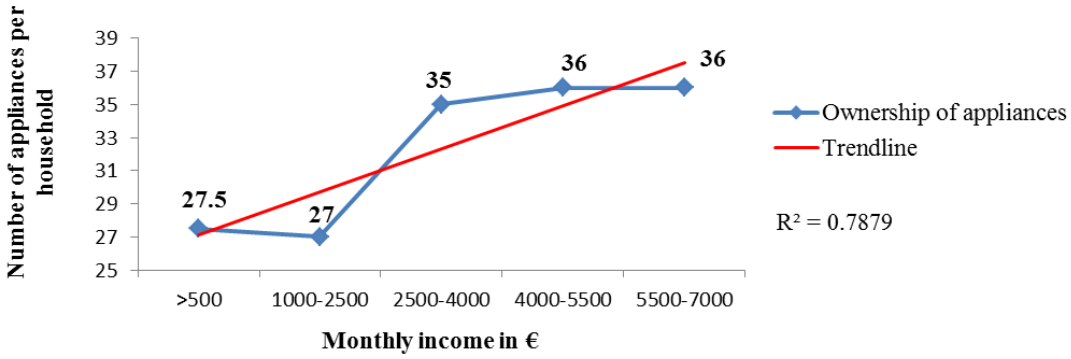


Figure 3.1.8: Relationship between monthly income in euro and level of ownership

[25] R-square ranges from 0 to 1. Zero means that there is no correlation and one means that there is perfect correlation.

No correlation appears between the age of participants and the standby consumption [figure 3.1.9]. In this case R-square has the lowest value (0.1). In the household of participant number 15, who is the oldest participant (87 years old) the standby consumption was zero. In that unique case, all the appliances were unplugged for safety reasons (participant's response).

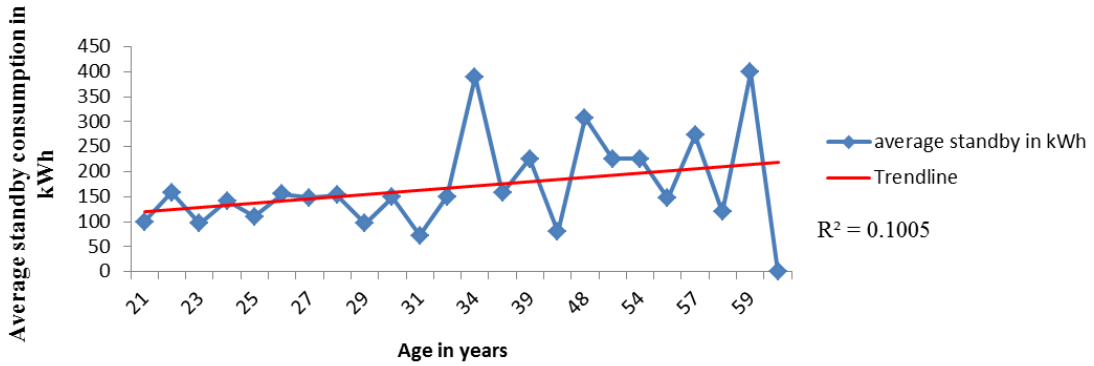


Figure 3.1.9: Comparison of average standby consumption and age of occupants in Dutch households

The relationship between member of a household and standby consumption can be seen in figure 3.1.10. The results from the high R-square value (0.99) indicate that as the number of persons residing in a house increases, the standby consumption of the household increases as well [figure 3.1.10]. This exponential increase in standby consumption can be explained by the fact that a higher number of occupants will use the same appliances more often or will purchase an increased number of appliances in comparison with a household with less people [see previous figure 3.1.2].

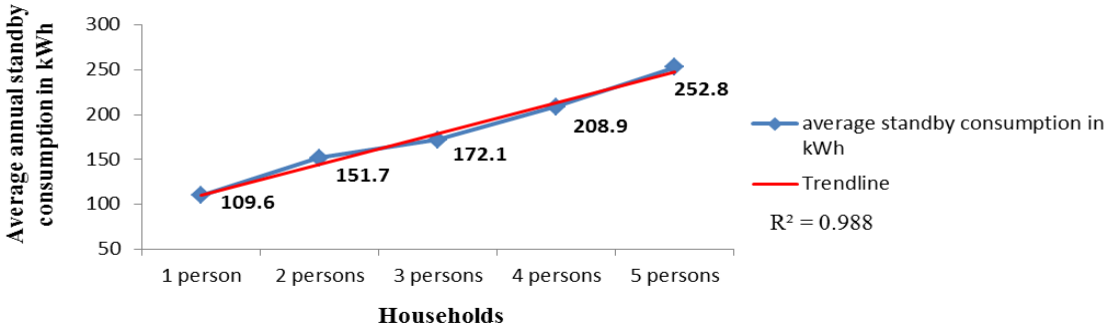


Figure 3.1.10: Relationship between standby consumption and member per household occupants

Low R-square value reveals that there is no relationship between level of education and standby consumption [Figures 3.1.11]. The same results observed from the comparison of level of education and ownership of standby reduction devices [Figure 3.1.12].

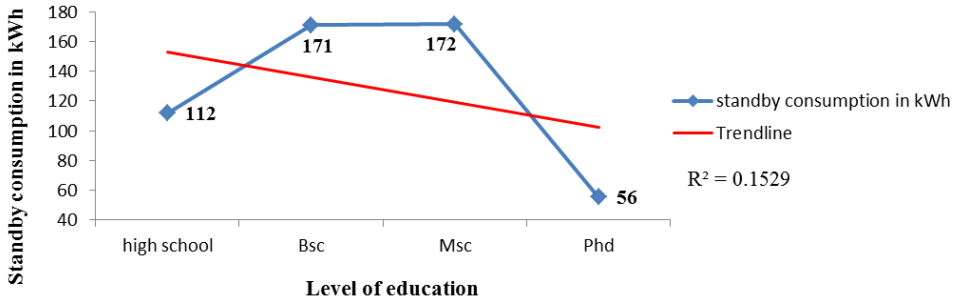


Figure: 3.1.11: Comparison between level of education and standby consumption

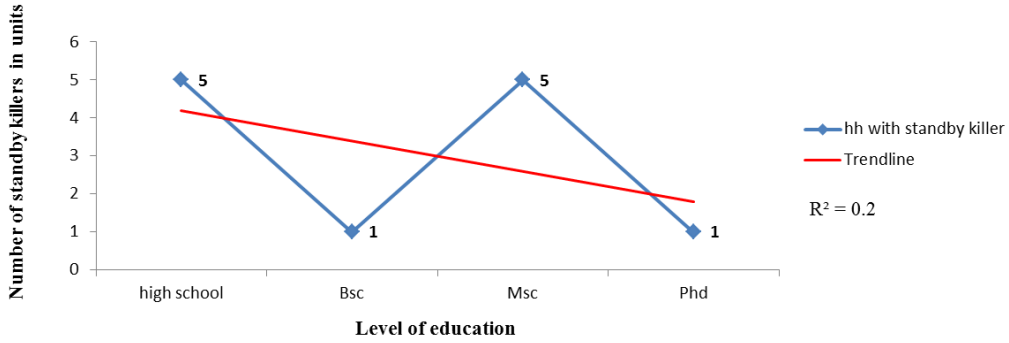


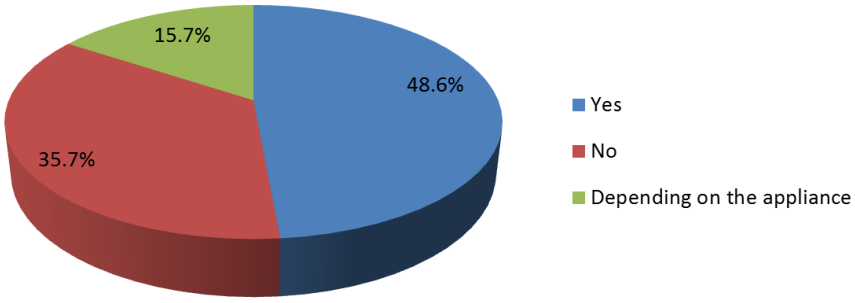
Figure: 3.1.12: Level of education and ownership of standby killer devices

3.1.3 Questionnaire

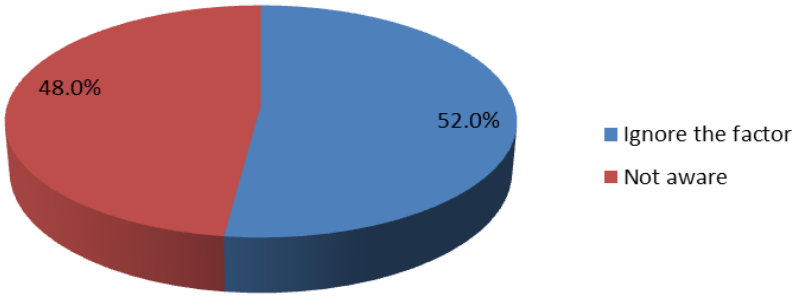
In this section the main results that came from the seventy completed questionnaires will be presented. Firstly, the education level of participants as seen in figure 3.1.4 showed that the majority of the participants in the sample had a relatively high education level, with 92% of the total sample conceived of people with a bachelor or master degree. The questionnaire consisted of six major sections: General Information; Housing; Market-Retailer; Appliances; and Standby Reduction Devices. Results will be presented in Appendix VI.

Part 1: Behavior

1. When you buy an electric appliance, are you interested in its energy performance?

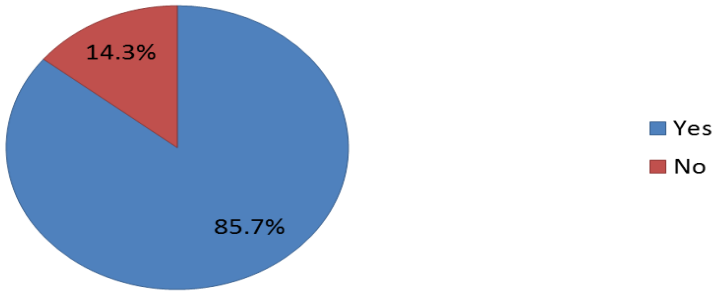


2. If not is it because you:

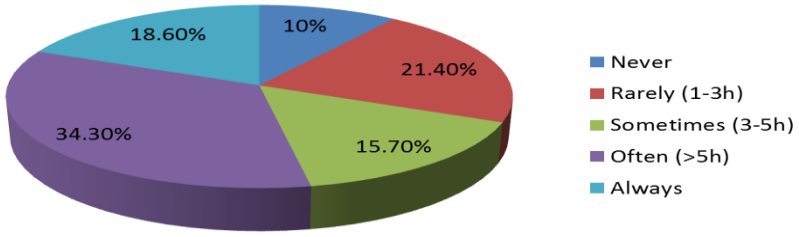


From the standpoint of consumer behavior, it can be noticed that 35% of the participants were not interested in the energy performance of their appliances. Almost half of this percentage reported that they were not aware of the fact that electrical appliances consume standby energy.

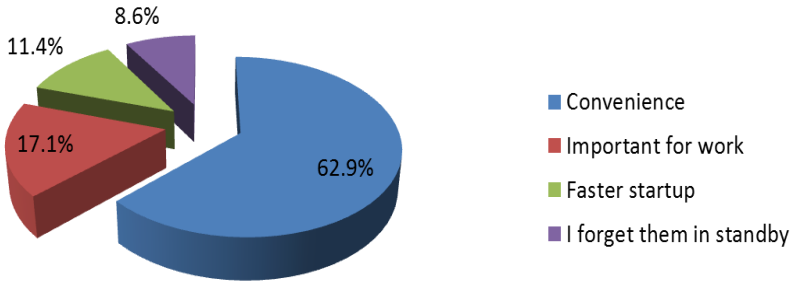
3. Have you ever heard the term standby consumption?



4. Do you leave the household appliances in standby mode?

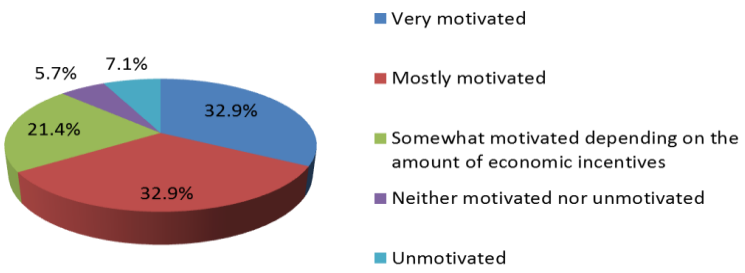


5. Name a reason for having an appliance in standby mode?



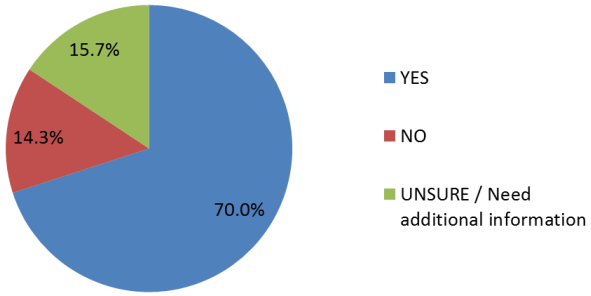
Even though the majority of the study's sample (86%) had heard the term standby consumption, more than 50% had their appliances in standby mode for many hours per day (>5h) [see question 4], and did not consider the energy performance of appliances when they had to purchase them. As shown in question 5, convenience is the main reason for leaving an appliance in standby mode (63%).

6. If there were more incentives from the state (e.g. economic benefits in exchange for getting rid of old products), do you believe that you would be more motivated to exchange the old products for new ones?



As question 6 shows, 85% of the participants feel that economic incentives from the state will be a positive motivating factor in order to replace an old appliance with a new efficient one. The amount of the incentive plays an important role for the decision making for 20% of the sample.

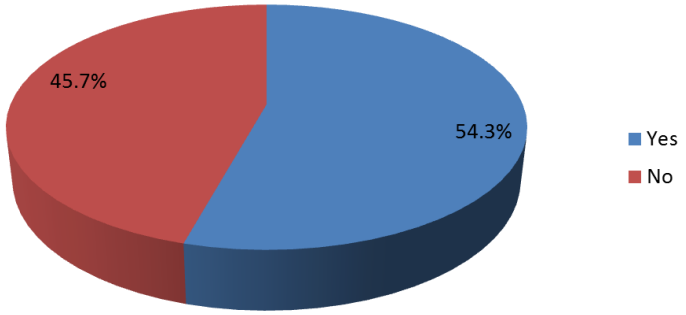
7. Are you willing to completely switch off all your appliances knowing that you can reduce the energy use and spend less money; even though that means that you will have to change your habits?



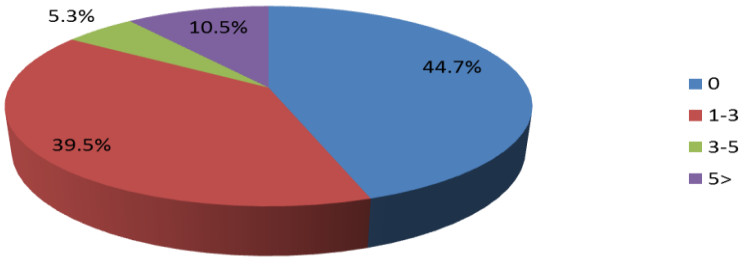
On the other hand, raising awareness showed that 56% are willing to change their habits in favor of saving energy. Willingness, however, does not correspond to the actual behavioral change, i.e. the number of participants that will actually change their habits in order to save energy.

Part 2: Standby reduction devices

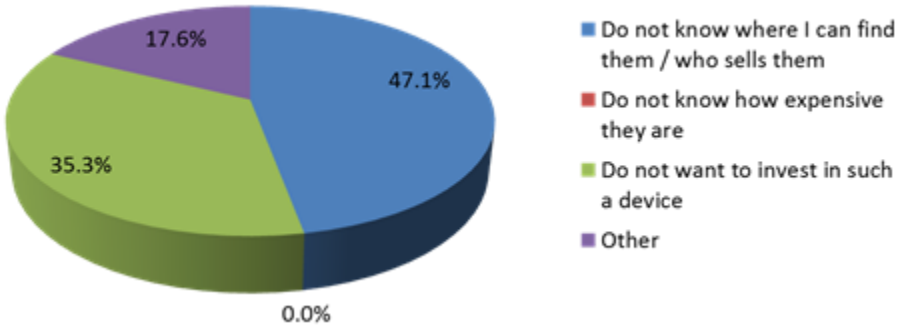
1. Do you know about the existence of devices that are sockets with a switched off button, called standby killers that can minimize the standby energy of your appliances to almost zero?



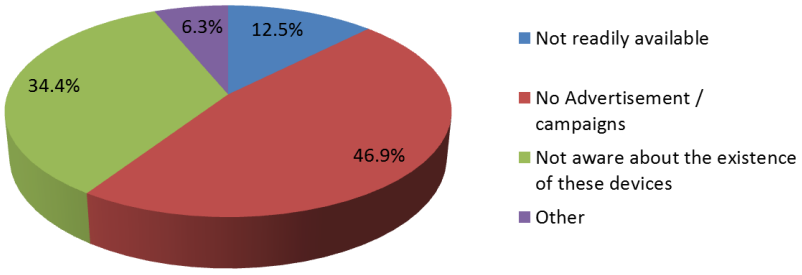
- **A) IF your answer in question 1 was YES, what is the number of standby reduction devices that you have in your household?**



- **B) IF your answer in question 1 was YES but you have no such a device, give an explanation for why not**



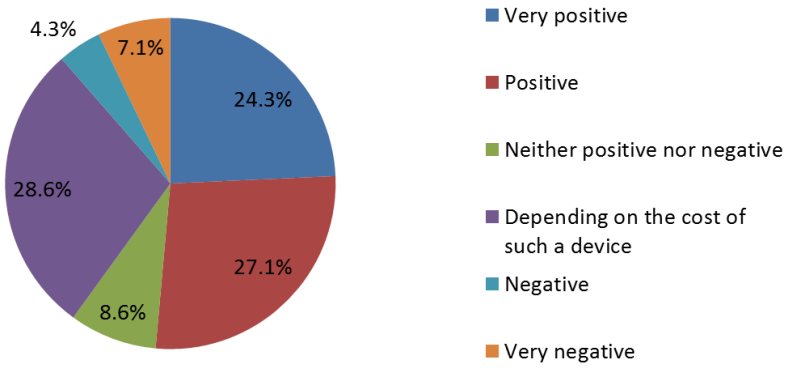
- **C) IF your answer in question 1 was NOT, name the reasons that you are not informed about these devices**



Regarding the existence of standby reduction devices in the market, 54% of the study's sample was found to be aware of them. Even though the penetration rate of these devices into the Dutch households was 114%, this rate does not reflect reality. Only 30% had a standby reduction device in use, and from this percentage only 12% has more than one such a device in their households.

This penetration rate comes from a small number of houses with a very high number of devices (10% of sample had more than five standby killers[26]). In addition, the investment in such a device, but also the lack of a market provider, led to 82% not using a standby reduction device.

2. Knowing that you have the possibility to switch of all your appliances with a remote control and not make any compromises in your comfort, are you willing to invest in a standby device?



More than half of the participants (51%) were positive in investing in a standby reduction device if there was a remote control and would not have to compromise their comfort. The uncertainty about the cost of such a device elicited doubt in 29% of the sample concerning the upfront investment cost. With the presentation of investment costs[27] and the lifetime savings generated from these devices, 78% were positive about investing in a standby killer.

3.1.4 Stock turnover and age of purchased electrical appliances

Table 3.1 shows the stock turnover of appliances as well as the year in which each type of appliance was purchased. Entertainment equipment has lower stock turnover in comparison with large appliances and cooking equipment. Exceptions were set top boxes, stereo hifi, electric keyboards and DVD recorders, but that can be explained by two factors. The first factor is the price of these devices, which is higher compared to the average price of other electrical appliances. The second factor is the fact that newest devices have the same functions as older ones and so there is no reason to be replaced earlier (e.g. decoder, stereo hifi). On the other hand, large appliances, such as washing machines and dishwashers, had the highest stock turnover of 8.8 and 8.5 years respectively. Due to the fact that these appliances were purchased in recent years, the replacement period will take place close to year 2020.

[26] E.g. household number 38 had 14 standby killer devices
[27] After the period these measurements took place, there was a reduction of 50% of the investment costs for the purchase of two standby killer devices

Type of appliance	Average purchase year of appliances	Stock turnover of appliances in years		
		Minimum	Average	Maximum
Television	2008	0.0	5.3	13.0
Set top box	2010	5.0	7.0	9.0
Radio	2007	3.0	6.6	13.0
Pc speaker	2008	1.0	4.6	8.0
Printer scanner	2010	2.0	5.0	9.0
Game console	2010	2.0	4.3	9.0
Microwave	2009	0.0	5.0	9.0
Laptop	2008	0.0	3.0	8.0
Desktop	2008	0.0	3.1	10.0
Stereo hifi	2006	0.0	6.6	13.0
Pc monitor	2009	0.0	3.7	8.0
Decoder	2009	0.0	6.2	10.0
Electric toothbrush	2010	1.0	1.9	4.0
Alarm clock	2010	3.0	4.0	5.0
DVD player	2008	1.0	4.8	8.0
External hardrive	2009	2.0	5.3	8.0
DVD recorder	2008	3.0	7.3	10.0
Amplifier	2007	2.0	3.5	5.0
Coffee machine	2010	1.0	4.7	8.0
Hand vacuum cleaner	2002	2.0	5.0	8.0
Dishwasher	2010	8.0	8.5	9.0
Washing machine	2011	8.0	8.8	10.0
Aquarium	2011	9.0	9.0	9.0
Electric keyboard	2007	5.0	8.0	13.0

Table 3.1: Purchase and years of replacement of measured electrical appliances

3.1.5 Household ownership - Penetration rate: Survey of electrical appliances in Dutch households

A) Ownership level of electrical appliances

As mentioned in section 2.4.1 (table 2.2), all electrical appliances were categorized into six major groups. The total number of appliances was 411 and their quantity of ownership, on average, was 34 electrical appliances per household. Figure 3.2.1 presents the ownership levels per category of household, compared with the average. An important outcome that can be extracted from this figure concerns the ownership differences among categories. Between a family house and a single house the difference is on average thirteen appliances, meaning that the number of members of each household add to the appliance ownership of that household. This can be observed also in

a student house with a high number of appliances. In addition, the new lifestyle[28] trends and the way of living in the modern society add appliances even in the case of single occupants[29].

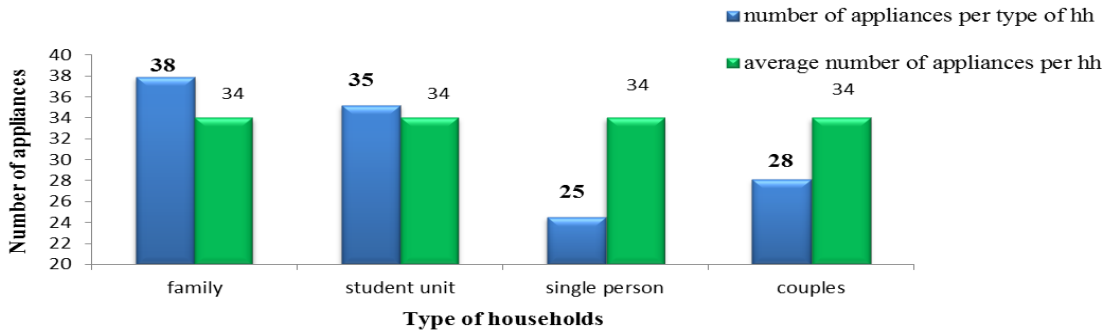


Figure 3.2.1: Comparison between the ownership levels of different types of households and the average value

In figure 3.2.2 the breakdown of appliances in the 44 Dutch households is presented. Entertainment equipment and ICT appliances have almost the same level (~43%). Large appliances, lighting, cooking and miscellaneous equipment together occupy a 14%.

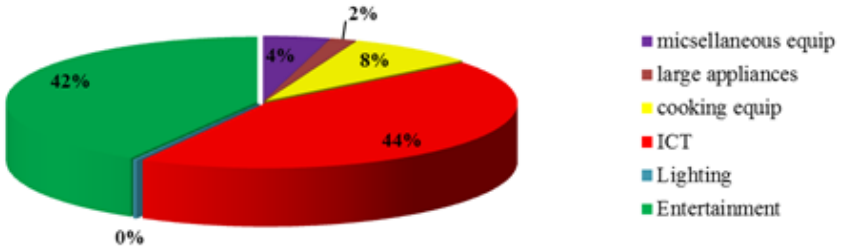


Figure 3.2.2: Breakdown of the different categories of appliances in Dutch households

As shown in figure 3.2.2, there are similarities among different categories of appliances (mostly ICT & entertainment equipment). However, when the focus is on standby consumption and on how each category contributed to that, differences can be observed. This can be seen in figure 3.2.3. Entertainment and ICT equipment contributed 91% to

[28] According to Spaargearen [2003], a lifestyle is defined as a set of social practices that an individual embraces, together with the storytelling that goes along with it.
[29] Energy Efficient Strategies, 2006

the total standby consumption. Large appliances[30] and lighting were excluded from standby measurements. The 2% of miscellaneous equipment is mostly from chargers of electric toothbrushes and hand vacuum cleaners. As for the 7% of cooking equipment it was mostly from microwaves and coffee machines.

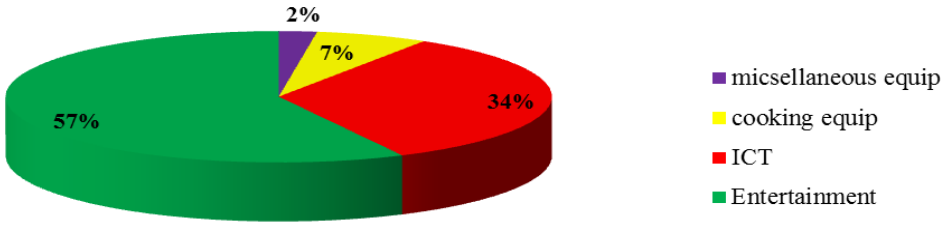


Figure 3.2.3: The percentage of standby power consumption in the total amount of appliances in Dutch households

B) Penetration rate of electrical appliances

The penetration rate of large appliances such as refrigerators and washing machines was expected to be almost 100%, due to the fact that they are necessary for any household. Dishwashers and dryers follow with 43%. From entertainment equipment, home audio and televisions have the highest penetration rate, 92% and 125% respectively. DVD recorders and set top boxes are still low, probably due to their price. Laptops are preferred compared to a desktop PC, due to the higher mobility and flexibility that they offer. Electric toothbrushes are growing with a 36% penetration rate. All penetration rates can be found below in the figure 3.2.4.

[30] Even though air conditioning and other heating cooling systems were excluded from measurements, they may contribute to the total standby consumption.

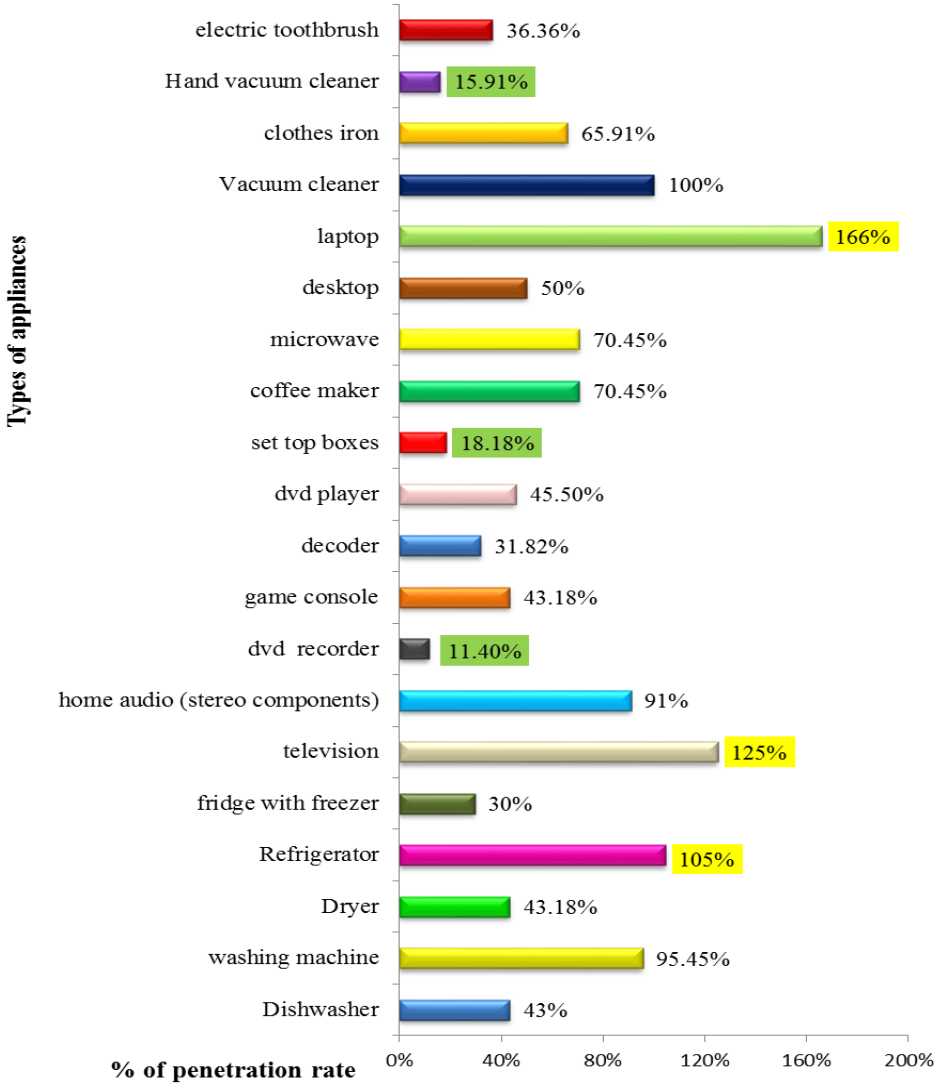


Figure 3.2.4: Penetration rates of electrical appliances in Dutch households in 2012

3.1.6 Distribution of standby power between different types of electrical appliances

Standby consumption in a Dutch household was divided unequally between appliances. As showed in figure 3.2.3, ICT and entertainment equipment contributed the most in standby consumption. The total number of appliances and the average standby consumption per type of appliance in Watt is presented in table 3.2. Even though new appliances penetration rate is less than traditional appliances, their high value in standby consumption contributed the most in the total standby consumption of the household. Set top boxes, stereos, decoders and DVD players, all products coming from entertainment

equipment, consumed the highest values of standby energy but also have a high replacement rate (figure 3.2.4). It should be noted that there were devices that consumed more standby energy than expected, such as electric toothbrushes which have higher standby consumption compared with other appliances such as laptops and game consoles.

Class	N. of measurements	Average standby in Watt
televisions	56	1.62
Set top box	8	8.00
radio	8	1.54
pc speaker	17	4.29
printer scanner	16	2.16
battery charger	1	0.62
game console	19	0.98
microwave	24	1.48
laptop	78	1.01
desktop	21	3.48
stereo hifi	25	6.88
pc monitor	19	0.72
amplifier	4	3.22
electric toothbrush	14	1.04
alarm clock	2	1.74
DVD player - recorder	*23*	*7.97*
Decoder	12	9.10
dishwasher	2	1.79
vacuum cleaner	3	2.88
external hardrive	8	2.56
washing machine	5	0.51
electric keyboard	4	2.78
aquarium	1	3.30
projector	1	2.28
blu-ray player	1	0.10
tablet	2	0.58
subwoofer	1	0.75
coffee machine	9	1.12
light	1	1.32
steam cooker	1	0.64
vinyl player	1	0.80
TOTAL	**387**	**77.26**

Table 3.2: Total number of appliance and the average standby consumption in watt

3.1.7 Identification of Electrical appliances under and below Ecodesign Directive's values

A comparison of standby power among appliances in both the residential and the commercial sector took place in order to investigate which appliances are already compliant with the Ecodesign Directive's requirements for year 2013. A high number of all types of products were consuming on average more than 0.5W (Ecodesign Directive requirement for 2013). Devices that are the newest in the market such as blu-ray players, consumed less than 0.5W. The figure 3.2.5 shows that only 14% of the residential appliances comply with Ecodesign regulation values for 2013, whereas for commercial appliances this level rises to 68%. This suggests that manufactures of most products adopted the limitations proposed by the regulation. Televisions available in the market totally comply with the regulation. The big difference between residential and commercial sector can party explained by the old existing stock in the households. The replacement period can be an important factor that will define when the efficient appliances from the market will be introduced in households.

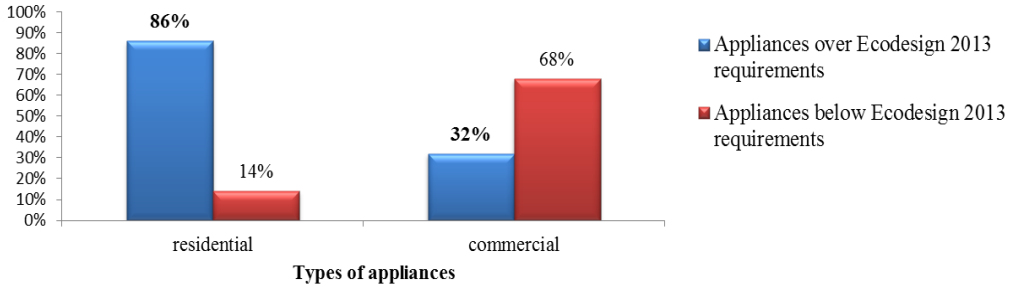


Figure: 3.2.5: Comparison between commercial and residential appliances with Ecodesign 2013 requirements

3.1.8 Standby consumption: Fraction to the total electricity consumption

Total standby power in households ranged from 6.39-55.94W, with an average of 24.53W. As mentioned in the methodology, the data from electricity bills and electric meters would give an estimation of the fraction to total electricity consumption. From the sample, only 14 of total 44 households provided this data (32% of the sample). This corresponded to 2.56%-27.94% of the homes annual electricity use. The average value is 7.8% [table 3.3]. It is known that the average energy consumption in a Dutch household for 2012 is 3350kWh [CBS, 2012c[31]]. The 7.8% represents 261.3kWh in terms of energy consumption.

[31] CBS, 2012c, Kerncijfers wijken en buurten 2004-2010.

Dutch Households	Annual electricity consumption in kWh	Annual actual standby consumption in kWh	Fraction % of standby energy in the total annual electricity
1	1035	149.21	14.42
2	3314	146.72	4.43
3	2751	129.16	4.70
4	1316	107.43	8.16
5	5167	389.4	7.54
6	2091	154.94	7.41
7	3770	159.63	4.23
8	2991	223.66	7.48
9	1608	97.35	6.05
10	2050	320.71	15.64
11	3450	257.49	7.46
12	3280	415.9	12.68
13	660	184.42	27.94
14	2607	66.78	2.56
Total	36090	2802.8	**7.8**

Table 3.3: Fraction of standby in the total electricity consumption in Dutch household for 2012

3.1.9 Standby consumption: Energy savings – Economic benefits – CO_2 reduction potential per household

- **Energy savings per household, in kWh**

For the standby killer case, the maximum energy savings potential will be already achieved in 2012 if standby killers are implemented in all electrical appliances of the households. In this case, the reduction of standby energy consumption is 100% **(**261.3kWh). For the Ecodesign and BAT cases, the percentage of standby reduction for 2012 is 0%. This is because both Ecodesign and BAT require stock turnover. As figure 3.6 presents, reduction is achieved only after replacement of the existing. For the Directive and BAT, stock turnover and hence the energy savings begin from 2013. Both cases, reach their maximum savings in 2023, reducing standby electricity consumption per household by an average of 77% and 80% respectively [figure 3.6]. Appendix VII shows a detailed set of results for all three cases analyzed in this section.

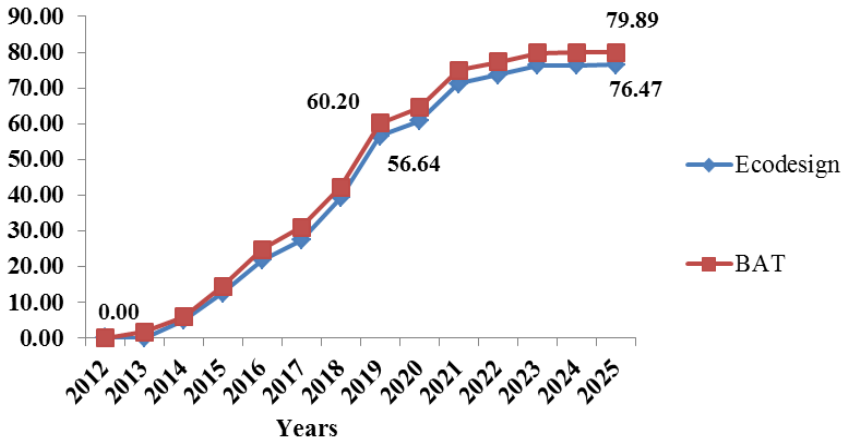


Figure 3.6: Percentage of energy savings between Ecodesign and BAT

For the Ecodesign Directive case it should be noted that figure 3.6 presented a maximum theoretical potential, considering that all types of electrical appliances were included in the regulation. Nevertheless, up until March 2012 many types of appliances were not covered by the regulation. In figure 3.7, a comparison between the business as usual case (considering the devices covered by the regulation up until March 2012 with no further inclusion of new types of products until 2025) and the case of maximum potential (all types of household appliances covered by the regulation from 2012 and on) is presented. The limited coverage of the types of appliances by the regulation has a large effect on the energy savings potential reached by the Ecodesign case. The business as usual case leads to 17% savings until 2025.

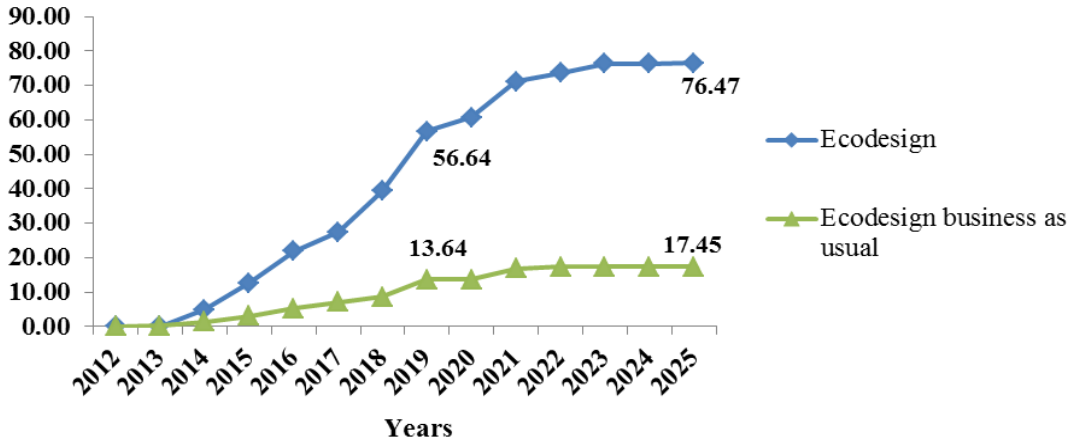


Figure 3.7: Comparison between Ecodesign case of maximum energy savings potential and business as usual case in the Netherlands for period 2012-2025

- **Energy savings Economic benefits – CO2 reduction potential per household**

In figures 3.8, 3.9 and 3.10, the energy savings, economic benefits and CO_2 savings for the total number of households in the Netherlands for the period 2013-2025 coming from equations in section 2.6, will be showed, respectively. Thus, in the end of the chapter, in table 3.4 an overview of these results can be found.

As figure 3.8 shows, standby energy savings with the use of standby killers achieve the highest values compared with Ecodesign and BAT case. These savings gradually start growing for BAT and Ecodesign Directive.

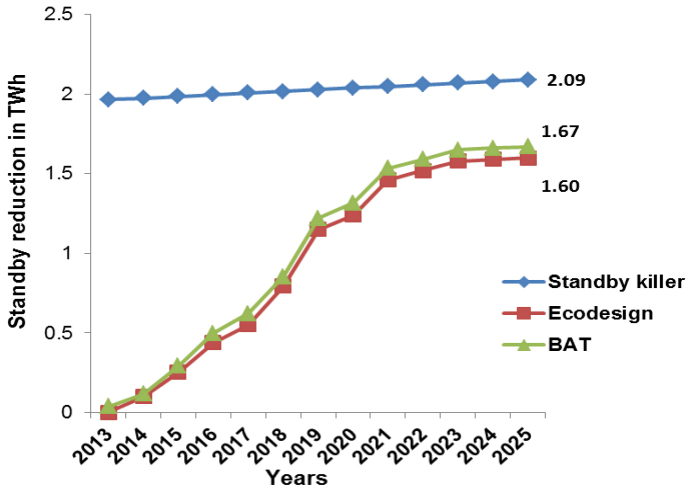


Figure: 3.8: Comparison of standby energy reduction of total households in the Netherlands for the period 2013-2025

In relevance with economic benefits, the higher values are associated with the use of standby reduction devices. For Ecodesign Directive and BAT cases there are no significant economic benefits for year 2013 [figures: 3.9].

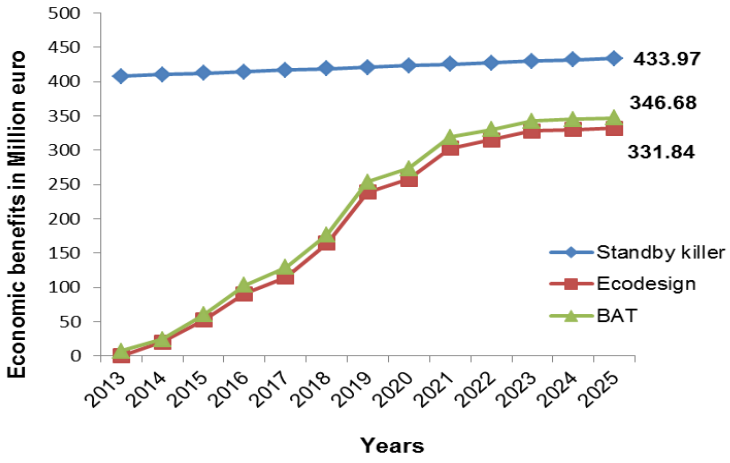


Figure 3.9 Comparison of economic benefits of total households in the Netherlands for the period 2013-2025

Further to previous findings, the standby reduction devices achieve the highest CO_2 reduction followed by BAT and Ecodesign Directive [figure 3.9].

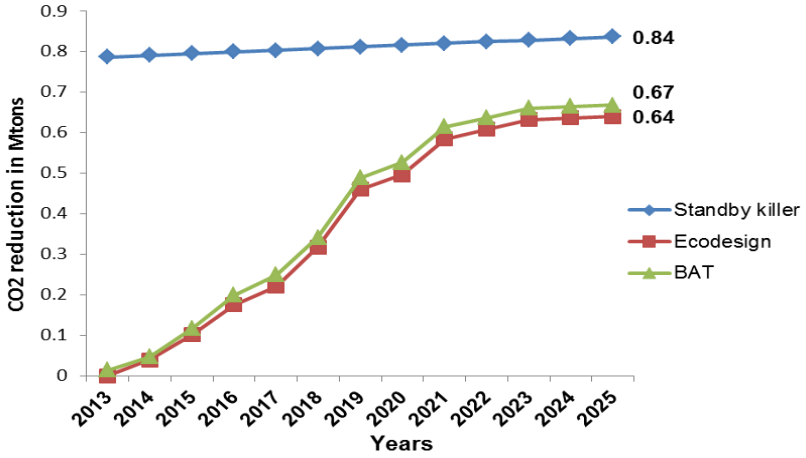


Figure 3.10: Comparison of CO2 savings of total households in the Netherlands for period 2013-2025

Overview of the results

	Standby killer	Ecodesign Directive	BAT
Annual energy savings per hh, in kWh	261.3	0.04	4.74
Annual energy savings of total hh in the NL for 2013, in TWh	1.96	0.0003	0.04
Energy savings in the NL for period 2013-2025, in TWh	28.3	12.3	13.1
Annual economic benefits per hh in the NL, in €/hh	54.2	0.01	0.98
Annual economic benefits in the NL for the year 2013 in Million€:	408	0.06	7.4
Total economic benefits for period 2013-2025 in the NL, in billion€:	5.47	2.55	2.71

	Standby killer	Ecodesign Directive	BAT
Annual CO_2 savings per household, in Kg CO_2	104.5	0.016	1.896
Annual CO_2 savings of total hh in the NL in 2013, in Million tons CO_2	0.78	0.000	0.014
Total CO_2 savings of total hh in the NL for period 2013-2025 in M tons CO_2	10.54	4.91	5.22

Table 3.4: Overview of energy, CO_2 savings & economic benefits for the Netherlands

4. Comparison of results with literature review

In this chapter the study's results will be compared and analyzed with the findings of literature studies.

4.1 Analysis of household characteristics

As shown in figure 3.1.10, the higher the number of residents per household, the greater the total level of standby consumption. Shuma-Iwisi (2006) came with the same conclusion with respect to South African houses. The focus was on standby power and household characteristics from 30 households in the regions of Johannesburg, in South Africa.

Jeeninga's report in 2007, proposed a trend according to which a decrease in the average number of persons per household in the Netherlands leads to an increase in energy use. This tendency was not observed in the findings for Dutch households in which the opposite observation occurred [3.1.10]. Further, in the present study, the Dutch households showed a difference of 13 appliances between families and single units [figure 3.2.1], although the number of appliance showed a growth in comparison with previous decades.

Another finding of this study has to do with the household income, according to which there was no relationship between monthly income of the household and the average standby consumption [figure 3.1.7]. These findings are opposed to the INEPSO project 2011. In 2011, the INEPSO project focused on lowering Belgian household energy consumption by promoting behavioral and lifestyle changes. In that research, it was stated that up to a certain income level, the energy use rises exponentially and then it tends to moderate. Their calculation focused on GDP per capita and not per monthly

income. The relation between income and energy use is more complex and needs to be taken into account in combination with other determinants[32].
Further, a higher household income correlates with lower environmental concern [INEPSO project, 2011]. In 2012, a study conducted by McLoughlin et al. in Ireland aimed to investigate the relationship between occupant characteristics such as income, age, social class, types of dwelling and electricity consumption patterns in the house. Their methodology was based on statistical/regression models as well as bottom up models, in order to identify the relationships between occupant characteristics and electricity use. The sample size consisted of 3941 households. McLoughlin (2012) showed that higher professionals consume more electricity than the middle or lower classes, reflecting a possible income effect. The effect of income on standby consumption was also studied by Sahin et al, in 2012 and the authors determined that as the household income increases the standby consumption also increases.

Based on previous studies, INEPSO project (2011) indicated that older people are less aware of environmental problems and residential energy use rises with age [O'Neill & Chen, 2002]. Electricity consumption and standby consumption for younger residents was lower when compared to the other two age categories 36-55 and 56 plus [McLoughlin 2012]. This does not come into agreement with the findings of this study [figure 3.1.9], in which there was no relationship between these characteristics and standby consumption.

In the result section, it was mentioned that there was no correlation between standby consumption and level of education [Figure 3.1.11]. The opposing findings came from the INEPSO project in Belgium. In that project it was concluded that highly educated, socially and environmentally friendly conscious people consume less energy in comparison with less educated people. Bertiaux et al (2008) analyzed via surveys how the supply of environmental information and customized advice provided in 1000 Belgian consumers was reflected in behavioral changes. Bertiaux [2008] also confirmed the above statement for Belgium participants, claiming that the higher the education level the higher the knowledge and awareness for environmental problems. From the questionnaire survey it was found that Dutch participants were also highly aware about the problem of standby losses in electrical appliances (86%). Nevertheless, there is no evidence that their awareness also represents their willingness to take action (see also section 4.3).

[32] Price and income elasticities shift over time because of new technology and new preferences that emerge and determine behavior.

4.2 Analysis of the penetration rate of electrical appliances

In 2008, Elburg et al published a report under the title Basisdocument: "Elektrische apparatuur in Nederlandse huishoudens", in which they presented scenarios for the period 2010-2020 regarding the penetration rate of common electrical appliances in Dutch households[33]. The research consisted of a model with multiple scenarios by using data from the period 1980-2005. The data were collected by various institutes, such as CBS, VHK and BEK[34]. Taking into account that this study only focuses on penetration rate in 2012, a comparison between both cases took place for this year. The data is presented by category of appliances.

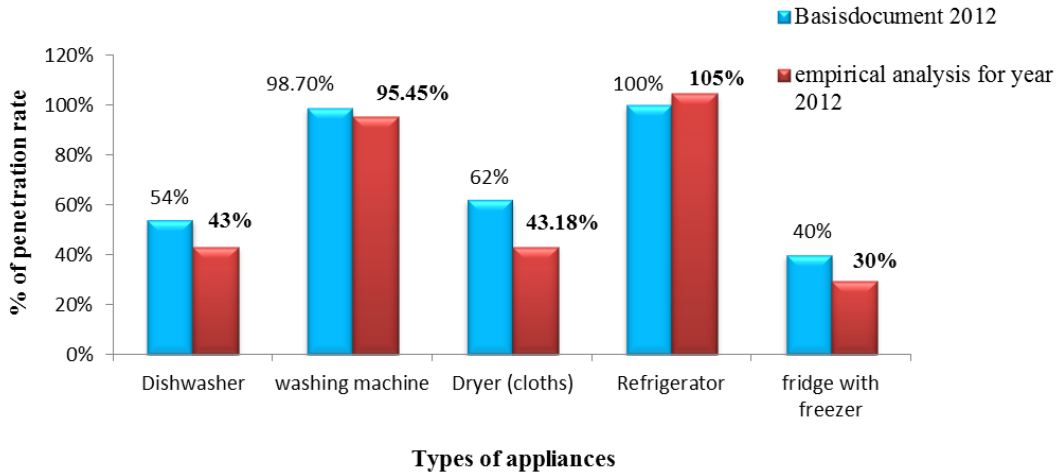


Figure 4.1: Penetration rate of large appliances in Dutch households for the year 2012

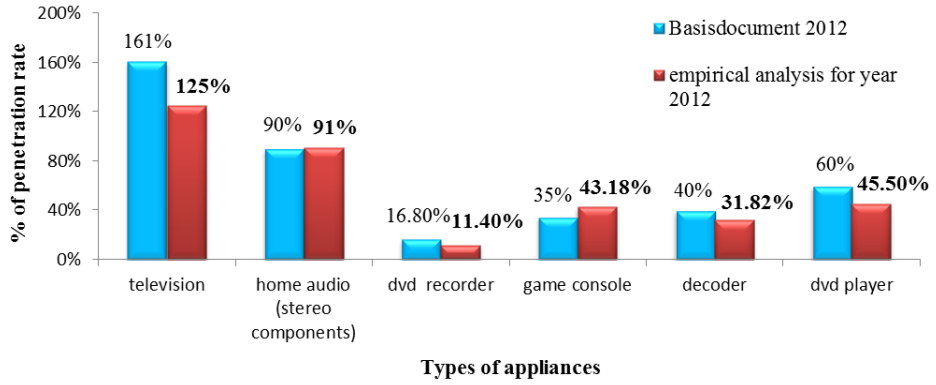


Figure 4.2: Penetration rate of entertainment equipment in Dutch households for the year 2012

[33] Appliance penetration rate is defined as the incidence of occurrence of an appliance within a given geographical area.
[34] BEK: Basisonderzoek, Elektriciteitsverbruik Kleinverbruikers, CBS: Centraal Bureau voor de Statistiek, VHK: Van Holsteijn en Kemna

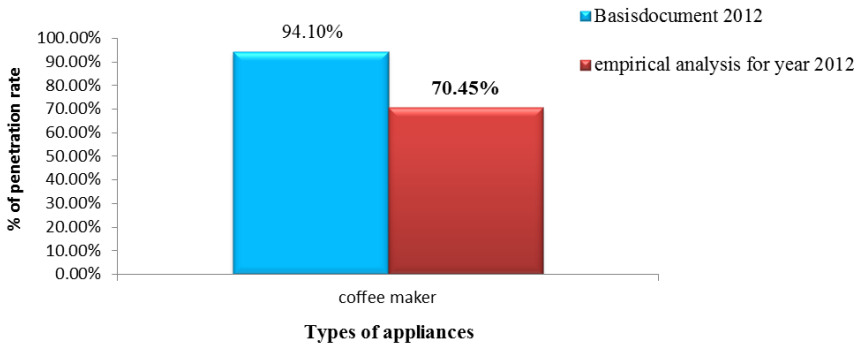


Figure 4.3: Penetration rate of cooking equipment in Dutch households for the year 2012

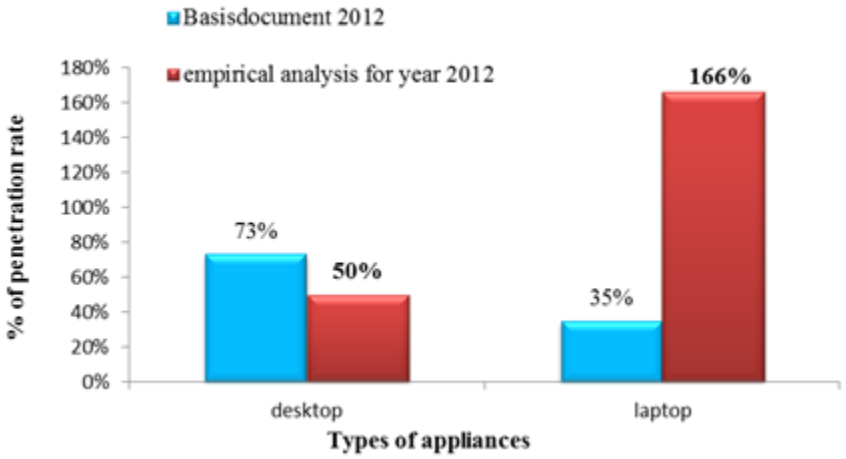


Figure 4.4: Penetration rate of ICT appliances in Dutch households for the year 2012

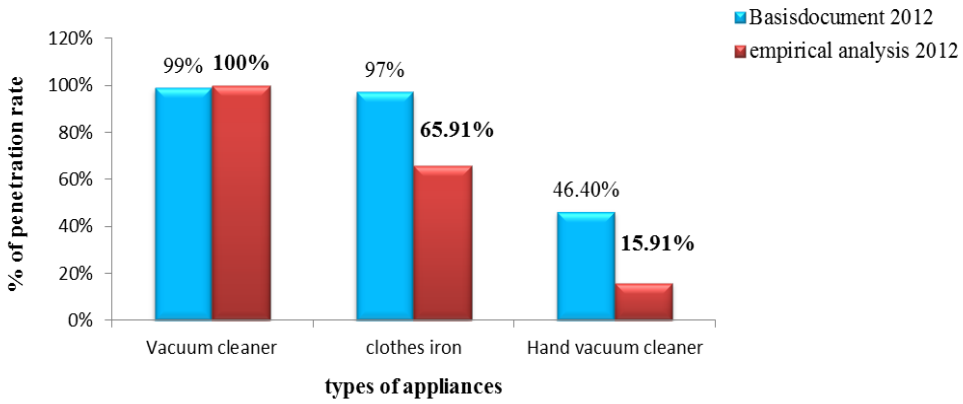


Figure 4.5: Penetration rate of miscellaneous cooking equipment in Dutch households for the year 2012

As shown in figure 4.1, the findings of both studies show some correlation in specific types of appliances, such as the large appliances. An exception appears with respect to clothing dryers, for which the Basisdocument predicted higher penetration rate that was not verified in the current study. Penetration rates for home audio are similar. A large difference comes from comparing rates between televisions and DVD players. This can be explained by the fact that nowadays there is a shift in other devices for entertainment, such as laptops. Laptops can be used as a multi-purpose device. This assumption supports the findings presented in figure 4.4, where the largest difference between the current results and the Basisdocument is found. This report revealed a high penetration rate for laptops that also leads to the dwindling of the typical desktop PC. Regarding miscellaneous equipment, vacuum cleaners have similar rates but not iron clothing, hand vacuums and coffee machines. The explanation of these differences can be found in participant's habits and different characteristics.

Shuma-Iwisi (2006) has reported the penetration rate of electrical appliances across 30 African households. In figure 4.6, a comparison between the penetration rates of electrical appliances in Dutch and South African households is showed. It can be observed similarities in decoders, printer scanner and PC monitors. The higher deviations occurred in cellphones (>2 appliances/person), television, stereo hifi and DVD player. Some of these deviations (such as television cellphones) and converges should be investigated in the different culture and life styles of both countries.

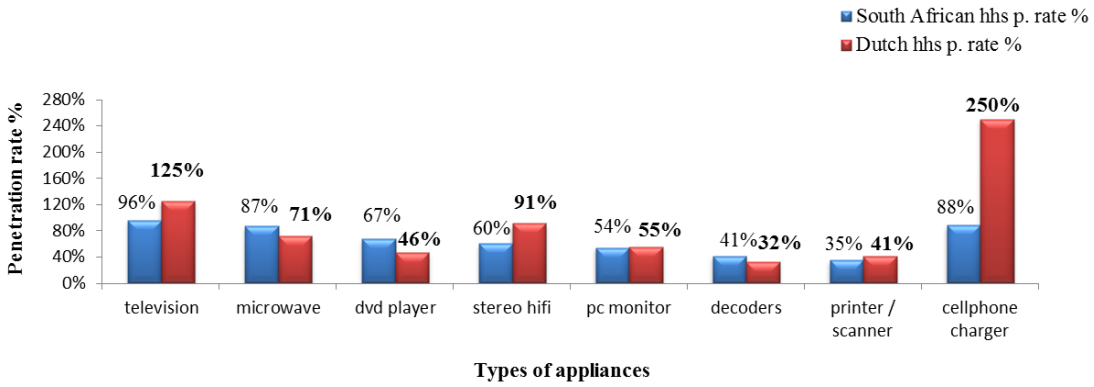


Figure 4.6: Comparison of penetration rates between South African and Dutch households

The Remodece project (2008) measured the ownership level of electrical appliances in European countries. Measurement campaigns were performed in at least 100 households per country, including 1300 households and more than 12000 appliances in total. A comparison of the penetration rates between the participating EU countries and the Netherlands occurred [figure 4.7]. The penetration rates converge mainly in appliances such as television, microwave, decoder and washing machines. The higher deviation appears in laptops and desktops. This can be explained by the 4-5 years of difference between the two studies. During this period a shift from desktop PC to the more economical and practical laptops have been made. Figure 4.8 shows the decline in sales of desktop PCs for period 2009-2012.

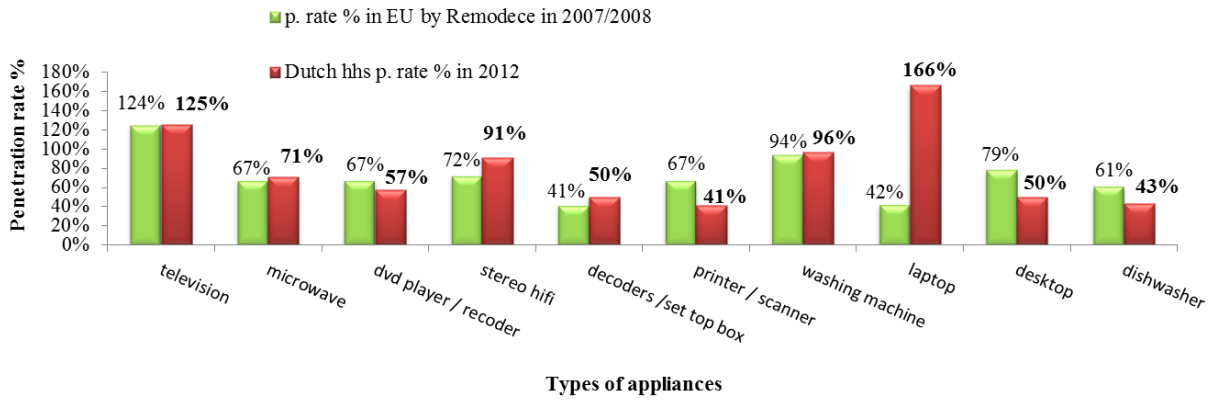


Figure 4.7: Comparison between penetration rate EU and Dutch households

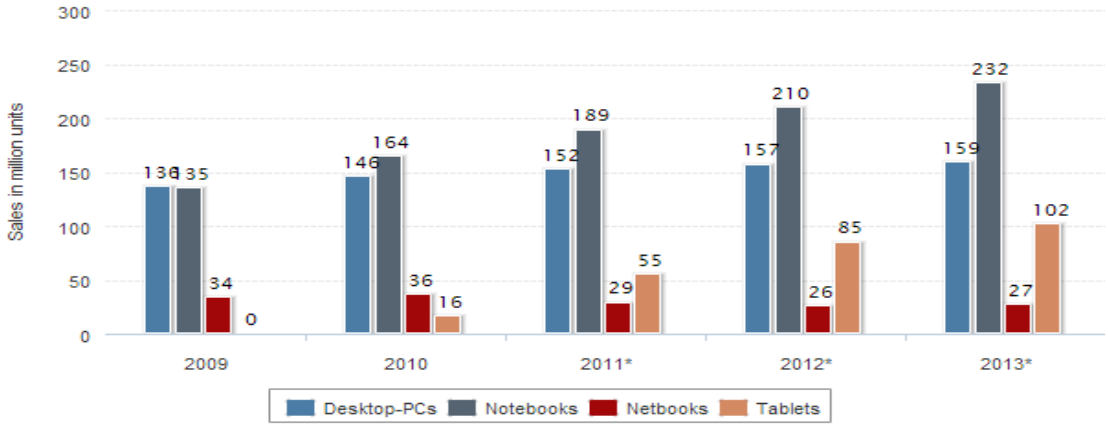


Figure 4.8: Forecast for global sales of tablets, laptops and desktop pcs from 2009-2013. Figure derived from Morgan Stanley, Statistics 2012

Figure 4.9 presents the average number of appliances per household. Australia has the higher amount of electrical appliances purchased with 67 appliances. USA and UK follow with 41 and 44 respectively. New Zealand comes last followed by the Netherlands with 34 appliances per household.

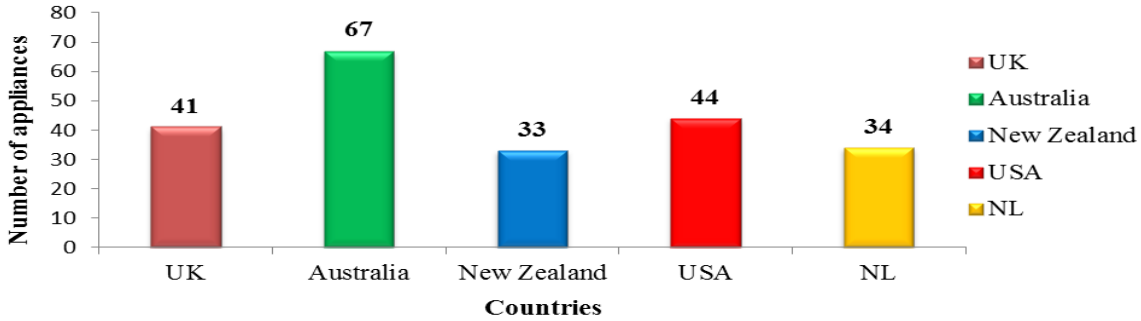


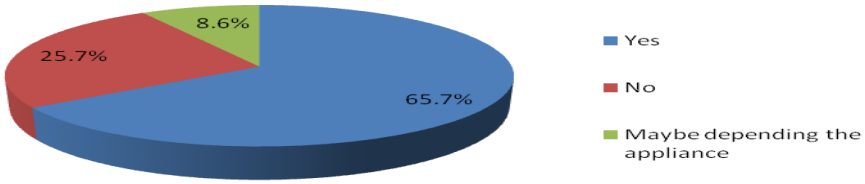
Figure 4.9: Comparison of number of appliances per households between countries

4.3 Consumer behavior analysis via questionnaire

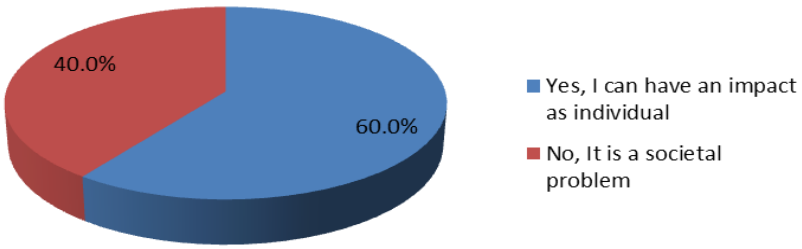
1. Have you ever heard the term standby consumption?

The majority of participants in this study were aware of the term standby consumption (86%). Bertiaux (2008) found similar results from his research with Belgian participants (81%). In that survey the question was formulated as follows: "*According to you, does a television that is turned off from a remote control consume electricity? (Yes, no, does not know*)". Even though in the Dutch survey the question was broader (see section results/ questionnaire) it can still be concluding that both countries are well informed about the term.

2. If you do not receive any economic benefits from your actions (for instance when your landlord pays the electricity bills), would you still change your behavior for other reasons?



3. Aware of the negative impact of the old appliances and their energy consumption in standby mode, do you feel that you can – as an individual - have an impact on the entire society?

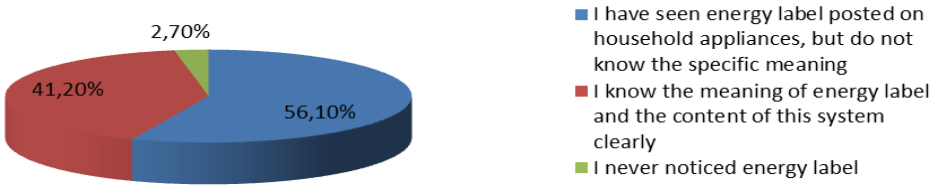


Question 2 and 3 provide information as to why many campaigns aiming to induce behavior changes in consumers often fail. This can be explained by the consumer's social dilemma: On one hand, consumers are aware of environmental problems and are in favor of tackling them. On the contrary, it is believed that without any economic benefit they will maintain their current behavior [INEPSO project, 2011]. More than 25% of the participants refused to change their habits without obtaining any economic benefit, even though being aware of their actions' negative impact. In addition, 40% of the participants consider it as a societal problem, not able to be solved by individual actions.

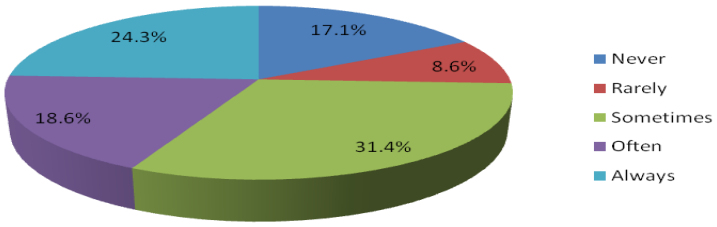
4. Grade your capability of recognizing energy labels on your electric appliances

Liuyang et. al., (2011) presented a research with suggestions for improving energy label in China but also consumer awareness in relevance with the recognition of energy labels in electrical appliances. A comparison between both studies in relevance with consumer awareness is presented in figures below.

a) Chinese results by Liuyang Zhan, 2011



b) NL results:



It can be noticed that, neither in China nor in the Netherlands, a significant part of the sample was able to recognize the meaning of energy labels on electrical appliances (56% & 38% respectively).

4.4 Comparison of appliance standby consumption per household

In this section the results coming from the literature review in relevance with standby consumption will be analyzed. The results obtained from household measurements indicate a wide variation of standby consumption which can be partly explained the different types of methodology used.

Standby consumption measurements have been conducted in many countries around the world. The most recent studies conducted in countries such as USA, UK, Argentina, Turkey, Hungary, Belgium, Korea, Denmark, Australia and New Zealand, in the period 2006-2012. The results obtained from household measurements indicate a wide variation of standby consumption.

In USA, the average standby consumption in 75 Californian houses was found equal to 13% of the houses annual electricity use in 2006 [Meier & Nordman, 2008]. In the same study an average of 44 appliances per household measured from a data pool of 2000 appliances. The average standby power was 54W/hh and the average annual electricity consumption was 7350kWh/yr.

In UK, DEFRA[35] measured the standby consumption of 251 households (225 for 1 month and 26 for a whole year) in 2012. A common British household had 41 appliances and an annual electricity consumption of 3638kWh/yr. The share estimated to be 12.5%.

In Argentina during 2007, Tanides et al, showed that standby consumption in 15 households was 7.7% of the total electricity consumption with an average standby power of 23W.
In Turkey, whole house measurements in 201 households during 2012 showed that the average household standby power and standby electricity consumption were 27W and 134kWh/year respectively [Sahin et al, 2012]. This level of consumption corresponded to 5% of average household electricity consumption. The number of appliances measures was 1421, including lighting. The average annual electricity consumption was 2728kWh/yr.

In Hungary during 2007, measurements of the energy savings potential in 30 households were conducted with the use of standby killer devices [Valentova]. The study estimated that standby consumption represented 8.2% of total electricity consumption in the households.

In 2007, Clement et al. conducted bottom up measurements in 10 Belgium households. Their measurements showed a variation in standby power from 7W to 134W, with an average of 40W. The standby consumption was on average 274kWh/year, representing 8% of the annual electricity consumption of an average household. In addition, they

[35] DEFRA: the Department for Environment, Food and Rural Affairs

calculated the minimum and maximum values of large appliances. Operation times were known but not the age of the appliances.

During 2011 KERI, the Korean Electrotechnology Research Institute conducted a research for investigating standby consumption. Their research showed that in, in 2011, the nationwide annual standby energy was reduced to 45% as compared to the levels of 2003. The average standby energy in 2011 was 209kWh, representing 6.1% of the annual electricity consumption.

In Denmark, during 2009, Gudbjerg measured standby energy in 30 Danish households in Denmark for a whole year. Standby consumption corresponded to 9% of the total electricity consumption. The average standby power found to be 67W.

In Australia, Energy Efficient Strategies conducted a survey report in order to investigate the standby losses in 120 households during 2006. According to the report, standby losses were 92W. Moreover, 11% of the total electricity consumption was lost due to the standby losses. Each Australian house had on average 67 appliances.

A standby consumption research took place in New Zealand, during the same year [Cogan et al, 2006]. From a large database of appliances it was calculated that standby power and standby consumption were 92W and 10.7% respectively. The ownership level was 33 appliances for each household.

A recent study conducted by Remodece project measured the standby consumption in electrical appliances in European countries[36] during 2008. The time interval for the measurements was 10 minutes per appliances for a period of two weeks. The lifetime of appliances was not taken into account. According to the measurements, the average standby consumption was about 27W or 179kWh per household, annually. This represented 6.6% of the total annual energy per household. The total electricity consumption was 2700kWh/yr.

In order to investigate the variation of standby consumption between recent and previous studies, the data collected by Meier and Lebot in 2002 will be used. Meier and Lebot in 2002 compiled standby consumption results from in different countries. Argentina had the lowest standby consumption, representing a share of 3% of the total electricity consumption and Australia had the highest with 12%. Standby power use among these countries varied between 7-86W respectively.

In this study standby power of 44 households in the Netherlands was investigated and 418 appliances were measured. The average standby power use was 25W and the average annual electricity consumption was 3350kWh. Standby calculated to be 260kWh which represents a fraction of 7.8% of total electricity consumption of the Netherlands. Tables 4.1, and 4.2, show an overview of the above results.

[36] The participating countries were: Romania, Portugal, Norway, Italy, Hungary, Greece, France, Denmark, Germany, Belgium, Czech Republic, and Bulgaria

There is high variation between countries with a minimum value of 2W in Korea and a maximum of 92W in Australia [table 4.1]. Netherlands has less consumption from all countries except Korea, but when the focus goes on the fraction of the total electricity use then Korea, Turkey and Argentina have less than the Netherlands. Nevertheless the share of 7.8% is still less than the average in the European Union (11% REMODECE project).

Country (reference)	Year of survey	N. of appliances measured	N. of hhs	Average Standby use per hh (W)	Fraction of the total el. use (%)
USA (Meier & Nordman)	2008	2000	75	112	13%
UK(DEFRA & DECC)	2011		251		12.5%
Turkey (Sahin et al)	2012	1421	201	27	5%
Belgium (Clement et al)	2007	80	10	40	8%
Korea (KERI)	2011	2000	105	2	6.1%
Denmark (Gudbjerg et al)	2009		30	67	9%
Hungary (Valentova)	2007		95	30	8.2%
Argentina (Tanides et al)	2007		15	23	7.7
New Zealand (Cogan et al)	2006	11890	400	58	
EU[37] (REMODECE project)	2008	11459	1300	27	11%
Australia (Energy efficient strategies)	2006	8000	120	92	10.7%
Netherlands (THIS STUDY)	2012	418	44	25	7.8%

Table 4.1: Estimates of standby power use between different studies for period 2006-2012

From the comparison between studies in different time periods, a reduction of standby consumption in the total electricity use for the Netherlands for the last 15 years can be observed, even though the ownership of appliances rose. The standby consumption was reduced in Australia as well. On the other hand, USA shows a significant increase of 8% for the period 1996-2008 and the same occurred for Argentina with a double standby consumption in less than decade [table 4.2].

Country (reference)	Year of survey	Average standby use per hh (W)	Fraction of the total electricity use (%)
Argentina (Tanides et. al.)	2000	7	3%
France (Sidler)	2000	38	7%
Netherlands (Siderius)	1995	37	10%
Switzerland (Meyer & Schaltergger)	1999	19	3%
Australia(Harringtion & Kleverlaan)	2000	86	12%
USA (Rainer et al)	1996	50	5%

Table 4.2: Bottom up estimates of standby power use, Source: Meier & Lebot 2002

[37] The participating countries were: Romania, Portugal, Norway, Italy, Hungary, Greece, France, Denmark, Germany, Belgium, Czech Republic and Bulgaria

4.5 Sensitivity Analysis

In this section the sensitivity analysis of this study will be presented. It was identified for variables that can affect the analysis. The reason to perform a sensitivity analysis is to understand how the results of this study are affected by uncertainties.

These sensitivity variables are:

- Standby time period (in hours): +5/- 20%
- Energy logger measurement errors: +/- 10%
- Household stock growth rate: +/- 20%
- Growth rate: +/- 20%
- Price of electricity: +/- 20%
- CO_2 intensity: +/- 20%

There was methodological difficulty concerning the uncertainty of standby hours. The upper limit to standby hours is 8760h which are the total hours per year. Since the sensitivity of standby hours was done per appliance basis and certain appliances already were remaining at standby mode for the whole year, it was not possible to perform sensitivity +20% cause then the values would exceed the upper limit of 8760hours. This leads to inconsistencies in upper limit sensitivity analysis since the hours increase varies across appliances. On average the increase could go to 5% and that is what is presented in figure 4.10.

- **Standby time period (in hours) and energy logger errors**

Since the relationship between energy savings, CO_2 reduction and economic benefits is linear, only standby reduction devices were presented, but the same sensitivity applies to them as well.

There is sensitivity in both cases of standby hours and logger errors. If the upper limit of the logger error is taken, the final results display an increase of 15%. This shows an uncertainty in the final results of -10% +15% [figure 4.11]. The same relationship can be seeing in the standby hours but with different values.

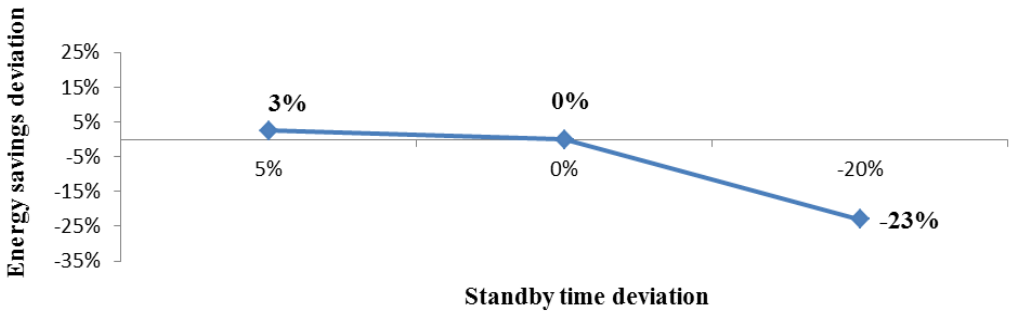


Figure 4.10: Energy savings sensitivity with standby time as a variable

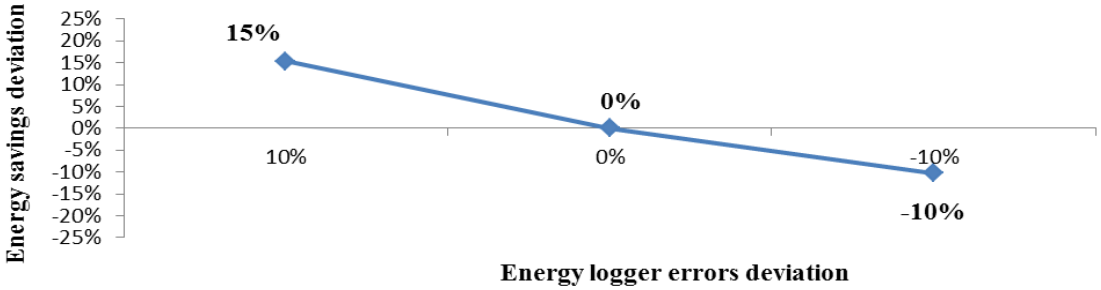


Figure 4.11: Energy savings sensitivity with energy logger as a variable

It was considered a sensitivity analysis on growth rate projection. But since the housing stock is already really large any changes in the growth rate did not affect the final results.

- **Price of electricity and CO_2 intensity:**

The price of electricity as well as the CO_2 emission factor does not affect the energy use due to standby. Thus any changes in these factors are only going to affect the emission savings and economic benefits respectively. Any change in CO_2 intensity or electricity price is going to cause the same relative difference to the emission reduction and economic benefits respectively as shown in figures 4.12 and 4.13.

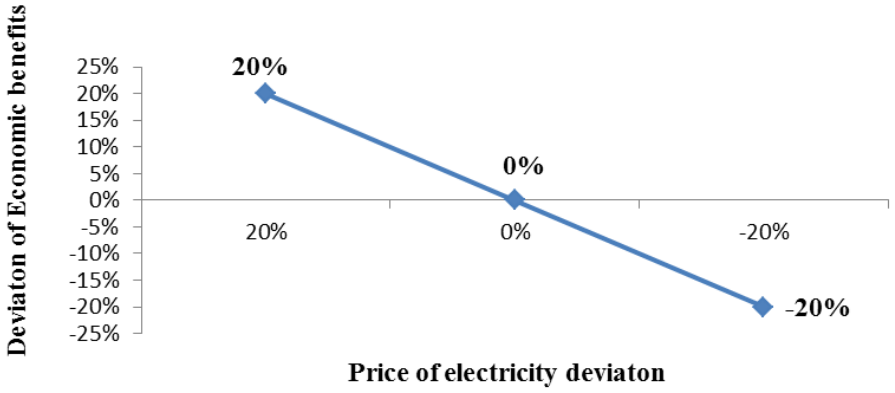


Figure 4.12: Economic benefit sensitivity with price of electricity as a variable

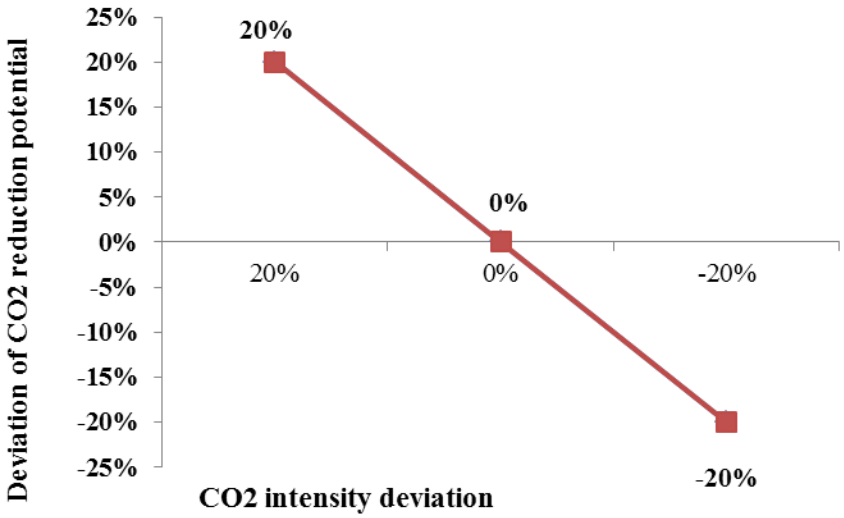


Figure 4.13: CO_2 reduction sensitivity with CO_2 intensity as a variable

5. Conclusions

A study of forty-four households in the Netherlands cannot provide definitive evidence of the magnitude of standby power consumption. However, due to sample dispersion and large database of appliances, it can provide some new insights to the amplitude of the problem as well as to the opportunities to reduce it.

For the year 2012, the penetration rate of electrical appliances in the Netherlands corresponds to 34 appliances per household. This rate is higher than the penetration rates obtained in previous years. The difference can be attributed to changes in lifestyle trends and acquisition of comforts that have made their appearance in recent years. The highest penetration rates were found in Entertainment and ICT equipment, the values of which were 42% and 44% respectively over the total sample. In terms of standby consumption, the Entertainment equipment came first, as it accounted for 57% of the total standby consumption, while 34% was accounted for ICT. Regarding individual appliances, laptops and televisions had the highest penetration rates, with values corresponding to 166% and 125%, respectively. On the other hand, the lowest penetration rates were found in hand vacuum cleaners and DVD recorders, with the first obtaining a penetration rate of 15.9% and the second a rate of 11.4%. An important conclusion from these measurements is that, even though many appliances have low penetration rates, their contribution to the total standby energy remains high. The highest levels of total standby energy were found in set top boxes, stereo hifi and decoders, the real standby power of which was found to 8W, 6.8W and 9.1W, respectively.

Measurements examine the possible correlations between household characteristics and standby consumption. The higher the income, the higher the ownership level of appliances per household. Thus, as would be expected, an increase in the number of residents per household was also related to an increase in the consumption of standby power. Between a single and a four persons house there is an increase in standby consumption by a factor of two. On the other hand, education level and age of occupants did not show any relationship with standby consumption.

Regarding standby consumption, the total standby power in Dutch households ranged from 6.39W-55.94W, with an average of 24.53W. This level corresponded to an average value of 7.8% of total electricity use. Nevertheless, compared with previous decades, there is a reduction in the overall proportion of standby consumption – 10% in 1995 – even though the number of appliances per household grew. In general, the 7.8% of the Netherlands is lower as compared to other countries such as UK, USA and Australia that have an average of 12.5%, 13% and 11% respectively. Since the choice of bottom up measurement as method of calculation for specific types of household appliances was selected, standby consumption is expected to represent a higher share of electricity consumption in reality.

The study concludes that for Dutch households, the theoretical savings (energy and CO_2) and the economic benefits from the use of standby reduction devices are significant. The use of these devices for the year 2012, show a reduction of 1.95TWh or 7.8% of the annual electricity consumption. For the other two cases there are not any energy savings for 2012, because both cases are depended on the stock turnover and there are not high replacement rates of appliances for this year. In Ecodesign and BAT cases the savings will grow gradually from 2013 and they will achieve a maximum potential of 77% and 80% respectively in 2023 (see figure 3.6, Appendix VII). Specifically for Ecodesign, the maximum theoretical potential will be achieved if all types of household appliances will be covered in the next years. In any other case, the savings will remain low (17.5% in 2025) and make the regulation ineffective comparing with the other two cases (standby killer, BAT).

The same findings occurred for CO_2 reduction with 105Kg CO_2 saved with the use of standby reduction devices for 2012 and almost zero for Ecodesign and BAT cases. For the period 2012-2025 the reduction with standby killer, Ecodesign and BAT reaches the amount of 10.5, 4.9 and 5.2million tons CO_2, respectively.

Concerning monetary terms, the annual economic savings in the Netherlands for the year 2012 with the use of standby killers reached the 54€ per household. In addition to previous statements, no economic benefits achieved from the other cases in year 2012.

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It can be observed that there are pitfalls in achieving the expected theoretical potential from the above aforementioned cases. For the BAT case, even though is slightly more effective than Ecodesign Directive, the investment costs for the replacement of existing stock affects consumers and have negative impact on their purchase decisions. High

purchase costs may reduce consumers' willingness to take part in the replacing process. That can be a reason that many appliances, such as set top boxes, stereo hifi and decoders, are an important source of standby consumption. It is clear that replacement rate plays a vital role in substitution of old with new efficient appliances and that's why economic incentives from the state can make BAT appliances more attractive to consumers.

Regarding the effectiveness of the Ecodesign Directive case, a major drawback is that not all types of appliances are included in the procedure. Appliances that consume significant amounts of energy and have high penetration rates in households (for instance, imaging and sound equipment) are still uncovered. Further, the requirements proposed by Ecodesign Directive seems to be already outdated, which potentially reduces the Directives' effectiveness and relevance. There are already new appliances on the market with levels below the 0.5W maximum limits set, such as blu-ray players and televisions which consume just 0.1W in standby mode. In addition, measurements reveal that appliances with the same primary functions but from different manufacturers, differ in standby power consumption. These variations could be due to differences in design philosophies and/or materials used that results in different efficiencies. This parameter underlines the possibility that many technological improvements can still be implemented. Moreover, as most of the products covered in households have long life cycles, especially large appliances and ICT equipment, an important proportion of the total appliance stock will not be required to comply with the regulation's limits. While 86% of residential appliances are above regulation requirements, compared to only 32% in the commercial sector, it can be concluded that the theoretical potential of the Ecodesign Directive will not reach its maximum potential. As mentioned also in BAT case, the replacement rate is a very important factor and results showed that many years needed until the existing stock is being completely replaced by new appliances. This is the reason why savings appear not earlier than 2014, and reach their maximum theoretical potential in 2023.

A solution with short term benefits and low investment costs could be the adoption of standby reduction devices. Even though standby power consumption for individual appliances is low, it has been realized that using standby killer devices is economically feasible for households and can achieve significant savings. The above make standby killers the ideal proposal to tackle the problem of standby power losses. Nevertheless, there are factors that may prevent a larger penetration of standby killer devices into the market. The major barrier is the low consumer awareness, and more specifically the lack of information about standby power consumption and the availability of standby reduction devices in the market.

With regard to informational barriers, empirical analysis of the consumer questionnaire shows that even though 86% of consumers have heard of the term standby consumption, only 22% unplug their electrical appliances. Moreover, 63% replied that convenience and comfort is the main reason for leaving their appliances in standby mode and 35% were not interested in appliances' energy performance. As for the standby killers, 54% of the

sample have heard about the existence of these devices but only 12% own more than one, in their households.

For the above reasons, there is the need for behavioral changes from the consumers' perspective. Rising informational awareness showed that 56% are willing to change their habits in favor of saving energy. 85% of the participants feel that economic incentives from the state will be a positive motivating factor to replace an old appliance with a new more efficient one. With the presentation of investment costs and the lifetime savings generated from these devices, 78% were positive about investing in a standby killer. From the study's empirical analysis, participants who had their appliances measured appeared to be more willing to change their behavior compared with the ones who only answered the questionnaire and did not receive the follow-up recommendations. This reveals the necessity of the individualization of solutions, related to consumer's needs. Willingness, however, does not necessarily correspond to the actual behavioral change. The conversion rate between consumers' awareness and action needs to be further investigated.

Summarizing, the present study highlights the need for reducing standby power use in a variety of common electrical appliances. It also investigates the magnitude of standby power in Dutch households. It reveals that consumer behavior in terms of purchase choices and use of products can have a significant impact on standby reduction. The minimum values of measured standby power suggests that it is technically feasible to reduce standby power to less than 0.5Watt with the use of more stringent design limits. Even though Ecodesign Directive is a policy tool that already achieved energy savings in a number of products still the theoretical potential remains low due to incomplete coverage of appliances under the regulation and the high replacement rates of the household appliances. For these reasons the implementation of standby reduction devices is the most promising solution with the benefits directly visible in the savings of existing stock. The introduction of awareness campaigns tailored to the individual consumer that aim to promote the benefits of using standby killer devices can have a substantial influence and enhance the reduction of the aggregate standby consumption for the Netherlands.

6. Recommendations and Limitations

Recommendations

Related to standby consumption, there are two conflicting trends. The first states that standby energy use will decrease over time for individual types of appliances due to technological improvements and the contribution of policy regulation. The second trend states that standby consumption may rise in the next years. The main reasons are (1) Efficiency improvements of specific types of appliances such as laptops may be outweighed by the increase of the number of these appliances purchased and owned per

household (for instance, the penetration rate of TVs is 125%). (2) New types of appliances that consume standby power increasingly appear in the market (for instance, set-top boxes) (3) Appliances with high penetration rate that are still uncovered by Ecodesign Directive, such as laptop/desktop PCs and (4) Traditional appliances coming with new features that consume standby energy (for instance, new digital washing machines) can increase the overall standby consumption and reduce the savings potential brought by regulation.

The enhancement of Ecodesign Directive, by means of faster implementation procedures, strengthened standby limits and increased coverage of the types of electrical appliances that are still under consideration, is an important factor to take into consideration. This may obviate the penetration of less energy efficient products in the market and reduce the overall standby consumption in the near future.

Incentives coming in the form of reduced pricing for highly efficient appliances or for the replacement of an old appliance with the newest in the market may stimulate consumer willingness to invest in more efficient products. Further, additional information should be provided by manufacturers about the standby power use as well as clearer instructions for consumers, to maximize the efficiency of their products in use mode. This information should be enlisted on the products and easy to be reached by consumers.

Consumers can be part of the equation not only when they are aware of the magnitude of the standby losses, but also when being informed about the benefits to be gained. Energy savings and the economic benefits that are derived from them, have a direct influence on consumer environmental behavior. This can be acquired through appropriate information and training on efficient use of appliances. The more the information is tailored to individual consumer problems and preferences, the more the possibilities for this information to be used effectively. As consumers seek for advice relating to their own energy consumption, general campaigns are not as effective as personal advice from an energy consultant, who can easily visualize standby losses with a measuring device.

Limitations

The survey was implemented successfully for 44 households in 12 regions of the Netherlands. The following can be stated as methodological limitations of the survey.

- Inaccessibility in measuring all types of appliances in stores and households. This was due to the bulky nature of the energy logger and subsequent difficulty in its use in cramped spaces.
- Absence of data from consumer's electricity bills and electric meters. Only 32% of the participants (14 households) provided their electricity bills.
- Absence of the measurement procedure of large appliances such as refrigerators, and lighting equipment due to difficulties to be measured in standby mode.
- Due to sort period measurements per household (~5-10minutes per appliance) variation in standby consumption was not fully captured.

- Approximate appliance usage time and stock turnover based on consumer estimations and recalled behavioral patterns.
- Uncertainty in future stock projection about growth rate and the price of electricity.

In order to investigate with higher detail the magnitude of standby power use there is a need for additional steps and procedures. Firstly, a higher number of houses should be measured in order to cover all the different types of households. The characteristics of the dwelling may also affect standby consumption and should be factored into the equation. Even the smallest appliance contributes to the total consumption; standby measurements should report all the household appliances, not only the major ones. Energy loggers should be plugged in twenty-four hours a day, the whole year for monitoring daily and seasonal fluctuations. During different time periods per day and per season, consumers have different needs and preferences. For instance, during summer air conditioning consumption increases and central heating is minimized. In order to have more accurate results these changes need to be investigated. Moreover, data from a greater sample of new appliances sold in the market could be used for a more realistic approach to calculate the stock turnover.

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Appendices

Appendix I – Questionnaire

HOYSEHOLD QUESTIONAIRE

I General information

1. Name:

2. Age:

3. What is your level of education?

4. What is your monthly income?

- 500 or less
- 500 – 1000
- 1000 – 2500
- 2500 – 4000
- 4000 – 5500
- 5500 – 7000

5. In which City and Street do you live?

II Housing

1. Do you live in the house with your parents or on your own?
2. How many people are living in the house?
3. Is the house a family home, an apartment (non-shared kitchen and bathroom) or a student-unit (with shared kitchen and bathroom)?
4. Are the utility bills included in the rent, or do you pay them yourself?
5. When paid yourself: With how many people do you share the utility bills?
6. How many years have you been living in the house?

III Appliances

1. When you buy an electric appliance, are you interested in its energy performance?
    - Yes

- No
- Depends on the appliance

2. If not, is it because you:
    - Choose to ignore this factor?
    - You are not aware of it?
3. Do you believe that Media and Companies promote energy efficiency
    - Strongly Agree
    - Agree
    - Depend on the product
    - Disagree
    - Strongly disagree

IV Behavior

1. Have you ever heard the term standby consumption?
    - Yes
    - No
2. Do you leave the household appliances in standby mode?
    - Never
    - Rarely
    - Sometimes
    - Often
    - Always
3. Name a reason for having an appliance in standby mode
    - Convenience
    - Important for work
    - Faster startup
    - I forget them in standby
4. Did you know that an appliance consumes energy even when it is turned off?
    - Yes
    - No
5. Are you willing to completely switch off all your appliances knowing that you can reduce the energy use and spend less money; even though that means that you will have to change your habits?

- Yes
- No
- Maybe depending the appliance

6. Studies show that if all appliances are switched off, 1 month utilities can be saved on a yearly basis. For what amount on a yearly basis would you choose to never use the standby mode again?
    - 1 Month utilities
    - Between 1 Month and 3 Months utilities
    - I am not interested in saving money
7. If you are not having any economic benefits from your actions (for instance when your landlord pays the electricity bills) would you still change your behavior for other reasons?
    - Yes
    - No
    - Maybe, depending on the appliance
8. If YES or MAYBE, name a reason?
    - Environmental
    - Ethical
    - Other
9. If there were more incentives from the government (e.g. economic benefits in exchange for getting rid of old products), do you believe that you would be more motivated to exchange the old products for new ones?
    - Very motivated
    - Mostly motivated
    - Somewhat motivated depending on the amount of economic incentives
    - Neither motivated nor unmotivated
    - Unmotivated
10. Aware of the negative impact of the old appliances and their energy consumption in standby mode, do you feel that you can – as an individual - have an impact on the entire society?
    - Yes, I can have an impact as individual
    - No, It is a societal problem

V Market-Retailer

1. Grade how often a retailer/salesman referred to the energy efficiency of an appliance you wanted to buy.
   - Never
   - Rarely
   - Sometimes
   - Often
   - Always
2. Grade your own interest in the energy use of an appliance when you buy it
   - Never
   - Rarely
   - Sometimes
   - Often
   - Always
3. Please name the most important factor for you when you choose to buy an appliance?
   - Performance
   - Brand
   - Price
   - Value for money (combination performance/price)
4. Grade your capability of recognizing energy labels on your electric appliance?
   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

VI Standby reduction devices

1. Do you know about the existence of devices that are sockets with a switched off button, called standby killer that can minimize the standby energy of your appliances to almost zero?
   - Yes, I do
   - No, I don't
2. (IF YES) What is the number of standby devices that you have in your household?
   - 0
   - 1-3
   - 3-5
   - 5 or more

IF NOT what do you think the reasons are that you are not informed about these devices?

- Not readily available
- No Advertisement / campaigns
- No interest about the existence of these devices
- Other

IF your answer is YES but you have NO such a device, give an explanation why not

- Do not know where I can find them / who sells them
- Do not know how expensive they are
- Do not want to invest in such a device
- Other

3. Knowing that you have the possibility to switch of all your appliances with a remote control and not make any compromises in your comfort, are you willing to invest in a standby device?
   - Very positive
   - Positive
   - Neither positive nor negative
   - Depending on the cost of such a device
   - Negative
   - Very negative
4. Knowing that with an additional cost of 80e (2 devices) and a lifetime of at least 5 years you can reduce your energy bill and save money, are you willing to invest in a standby device?
   - Very positive
   - Positive
   - Neither positive nor negative
   - Negative
   - Very negative

Are you willing to change your way of thinking after knowing the amount of energy you can save with more efficient products?

- YES
- NO
- UNSURE / Need additional information

Appendix II - Questionnaire analysis

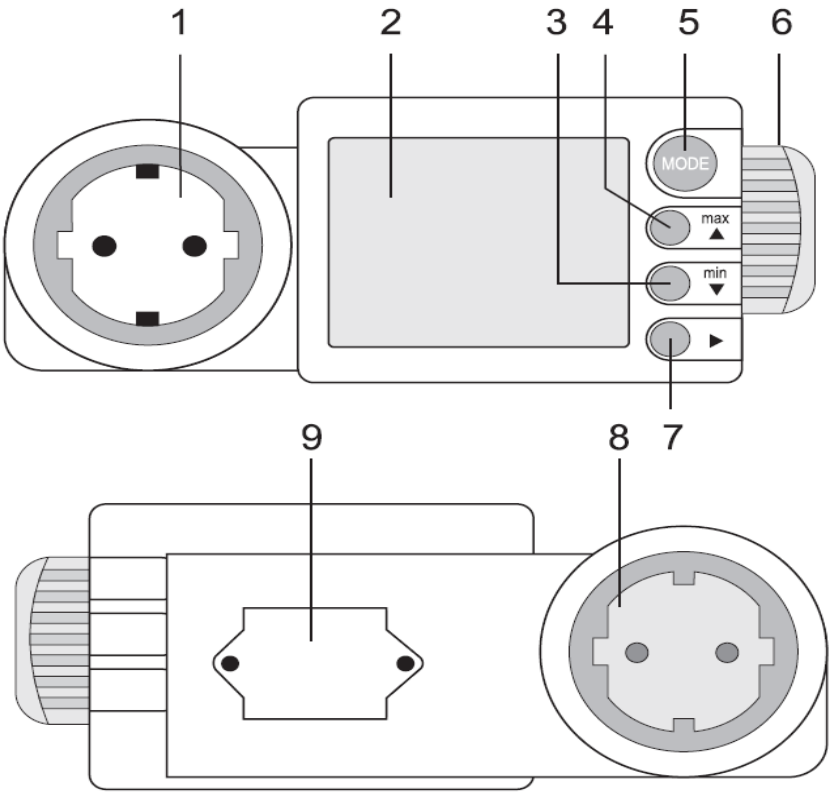
		N	%
Age	>20	1	1.4%
	20-30	38	54.3%
	31-40	10	14.3%
	41-50	6	8.6%
	50>	15	21.4%
	Total	***70***	***100.0%***
Income	500 or less	3	4.3%
	500 – 1000	3	4.3%
	1000 – 2500	23	32.9%
	2500 – 4000	22	31.4%
	4000 – 5500	14	20.0%
	5500 – 7000	5	7.1%
	7000 -8500	0	0.0%
	8500 or more	0	0.0%
	Total	***70***	***100.0%***
Education	High School	3	4.3%
	Bachelor	32	45.7%
	Msc	32	45.7%
	Phd	3	4.3%
	Total	***70***	***100.0%***
Number of people in the house?	1	13	18.6%
	2	21	30.0%
	3	21	30.0%
	4	11	15.7%
	5	3	4.3%
	6>	1	1.4%
	Total	***70***	***100.0%***
When you buy an electric appliance, are you interested in its energy performance	Yes	34	48.6%
	No	25	35.7%
	Depending on the appliance	11	15.7%
	Total	***70***	***100.0%***
If not, is it because you:	Ignore the fctor	13	52.0%
	Not aware	12	48.0%
	Total	***25***	***100.0%***
Media and Companies promote energy efficiency	Strongly Agree	9	12.9%
	Agree	20	28.6%
	Neither agree nor disagree	21	30.0%
	Disagree	12	17.1%
	Strongly disagree	8	11.4%
	Total	***70***	***100.0%***
Have you ever heard the term standby consumption	Yes	60	85.7%
	No	10	14.3%
	Total	***70***	***100.0%***
Do you leave the household appliances in standby mode	Never	7	10.0%
	Rarely	15	21.4%
	Sometimes	11	15.7%
	Often	24	34.3%
	Always	13	18.6%
	Total	***70***	***100.0%***

Name a reason for having an appliance in standby mode	Convenience	44	62.9%
	Important for work	12	17.1%
	Faster startup	8	11.4%
	I forget them in standby	6	8.6%
	Total	***70***	***100.0%***
Did you know that an appliance consumes energy even when it is turned off	Yes	49	70.0%
	No	21	30.0%
	Total	***70***	***100.0%***
Are you willing to completely switch off all your appliances knowing that you can reduce the energy use and spend less money; even though that means that you will have to change your habits	Yes	39	55.7%
	No	11	15.7%
	Maybe depending the appliance	20	28.6%
	Total	***70***	***100.0%***
Studies show that if all appliances are switched off, 1 month utilities can be saved on a yearly basis. For what amount on a yearly basis would you choose to never use the standby mode again	1 Month utilities	51	72.9%
	Between 1 Month and 3 Months utilities	13	18.6%
	I am not interested in saving money	6	8.6%
	Total	***70***	***100.0%***
If you are not having any economic benefits from your actions (for instance when your landlord pays the electricity bills) would you still change your behavior for other reasons?	Yes	46	65.7%
	No	18	25.7%
	Maybe depending the appliance	6	8.6%
	Total	***70***	***100.0%***
If YES or MAYBE, name a reason	Environmental	37	71.2%
	Ethical	12	23.1%
	Other	3	5.8%
	Total	***52***	***100.0%***

		N	*%*
If there were more incentives from the government (e.g. economic benefits in exchange for getting rid of old products), do you believe that you would be more motivated to exchange the old products for new ones	Very motivated	23	32.9%
	Mostly motivated	23	32.9%
	Somewhat motivated depending on the amount of economic incentives	15	21.4%
	Neither motivated nor unmotivated	4	5.7%
	Unmotivated	5	7.1%
	Total	***70***	***100.0%***
Aware of the negative impact of the old appliances and their energy consumption in standby mode, do you feel that you can – as an individual - have an impact on the entire society	Yes, I can have an impact as individual	42	60.0%
	No, I a societal problem	28	40.0%
	Total	***70***	***100.0%***
Grade how often a retailer/salesman referred to the energy efficiency of an appliance you wanted to buy	Never	22	31.4%
	Rarely	12	17.1%
	Sometimes	28	40.0%
	Often	6	8.6%
	Always	2	2.9%
	Total	***70***	***100.0%***
Grade your own interest in the energy use of an appliance when you buy it	Never	12	17.1%
	Rarely	4	5.7%
	Sometimes	28	40.0%
	Often	15	21.4%
	Always	11	15.7%
	Total	***70***	***100.0%***
Please name the most important factor for you when you choose to buy an appliance	Performance	12	17.1%
	Brand	3	4.3%
	Price	7	10.0%
	Value for money	48	68.6%
	Total	***70***	***100.0%***
Grade your capability of recognizing energy labels on your electric appliance	Never	12	17.1%
	Rarely	6	8.6%
	Sometimes	22	31.4%
	Often	13	18.6%
	Always	17	24.3%
	Total	***70***	***100.0%***

		N	%
Do you know about the existence of devices that are sockets with a switched off button, called standby killer that can minimize the standby energy of your appliances to almost zero?	Yes	38	54.3%
	No	32	45.7%
	Total	***70***	***100.0%***
IF YES) What is the number of standby devices that you have in your household	0	17	44.7%
	1-3	15	39.5%
	3-5	2	5.3%
	5>	4	10.5%
	Total	***38***	***100.0%***
IF NOT name the reasons that you are not informed about these devices	Not readily available	4	12.5%
	No Advertisement / campaigns	15	46.9%
	Not aware about the existence of these devices	11	34.4%
	Other	2	6.3%
	Total	***32***	***100.0%***
IF your answer is YES but you have no such a device, give an explanation why not	Do not know where I can find them / who sells them	8	47.1%
	Do not know how expensive they are	0	0.0%
	Do not want to invest in such a device	6	35.3%
	Other	3	17.6%
	Total	***17***	***100.0%***
Knowing that you have the possibility to switch of all your appliances with a remote control and not make any compromises in your comfort, are you willing to invest in a standby device	Very positive	17	24.3%
	Positive	19	27.1%
	Neither positive nor negative	6	8.6%
	Depending on the cost of such a device	20	28.6%
	Negative	3	4.3%
	Very negative	5	7.1%
	Total	***70***	***100.0%***
Knowing that with an additional cost of 80e (2 devices) and a lifetime of at least 5 years you can reduce your energy bill and save money, are you willing to invest in a standby device	Very positive	24	34.3%
	Positive	31	44.3%
	Neither positive nor negative	4	5.7%
	Negative	4	5.7%
	Very negative	7	10.0%
	Total	***70***	***100.0%***
		N	***%***
Are you willing to change your way of thinking after knowing the amount of energy you can save with more efficient products	YES	49	70.0%
	NO	10	14.3%
	UNSURE / Need additional information	11	15.7%
	Total	***70***	***100.0%***

Appendix III – User manual of Voltcraft energy logger 4000



Operating elements

1. Protection main socket
2. Display (LCD)
3. Min key with up function
4. Max key down up function
5. Mode key to switch displays
6. Lateral SD card slot
7. Selection key for settings and data transfer
8. Protection key socket
9. Rear compartment for buffer battery

Data Transmission

An optional SD card with the following characteristics is required for reading out:

- Memory size at least 512 MB, max 2GB
- Storage format FAT 32
- Not write-protected
- Minimum 5 MB free storage capacity
- Energy data previously saved on the card must be deleted

Proceed as follows to start data transmission

- Pull the plastic cover on the SD card shaft until out to the side
- Insert the optional SD card in the slot as illustrated. The chamfered corner points downwards
- Push the card shaft unit (6) into the machine.
- The SD card symbol is displayed. If the symbol cannot be seen check whether the card is fully inserted.
- Press the Continue arrow (7) in order to start the data transmission. A flashing arrow signalizes data transmission and the memory information runs from 0 to 99%
- The data is transferred to the card. Depending on the use of various SD cards and the size of the stored data, this can lead to a longer data transfer sequence, although the machine already shows that the storage has been completely accomplished. For this reason, you should leave the SD card several seconds in the energy logger, even after the display indicates that the transfer has been completed. Then the SD card can be removed. Close the cover of the SD card drive.

Technical data

Operating voltage	230 V/AC 50/60 Hz
Max. power/current	3500 W/15 A
Performance measurement display	0.1 -3500 W
Display energy use	0.000 - 9999 kWh
Display	three lines with 4 positions each
Tariff range	0,000 - 9,999
Accuracy	5 - 3500 W (± 1% + 1 count)
	2 -5 W (± 5% + 1 count)
	< 2 W (±15% + 1 count)
Buffer battery	3 V, CR1620
Ambient conditions	10 - 50 °C/max. 90%rH (not condensing)
	Operating altitude: max. 2000 m (above MSL)
Weight	ca. 240 g
Dimensions (LxWxH)	164 x 82 x 83 (mm)

The measurements

You get the energy logger in a box, with a booklet, a small CD with software and an SD card. I want all of it back that means: the energy logger in the original plastic cover, in the plastic bubble wrap, the booklet, the CD in its original plastic cover, the SD card and all of it in the original box! You will not be graded before I have everything back.

Read the operating instructions. They are provided with the energy logger.

Install the energy logger software on your computer. If you have problems reading the small CD, the software is also available on Blackboard.

You will measure one appliance at a time. To perform this measurement:

1. Start the provided excel sheet, and fill out all the appliance data. Make sure that the equipment description (type, manufacturer, model number, production year) are correct, and describe the appliance uniquely.

2. Clear the memory of the energy logger before the measurement (push "mode" button until screen shows ---------; see operating instructions)

3. Use the mode-button to see the time and date screen on the energy logger.

The measurement of an appliance is done in a cycle. E.g. for a television: unplugged, plugged but not turned on at all, on standby mode, playing, turned off, unplugged. Each of the different modes must be measured for at least 10 minutes. So measuring the television cycle indicated takes at least half an hour.

During the cycle, you must write down the time at which you change from one mode to the other. This timestamp must be written down as it appears on the energy logger. These notes must either directly be taken in the provided excel-sheet, or later be transferred carefully to this excel sheet.

4. Take the measurement and make the list of timestamps.

After each measurement:

5. Transfer the data files from the energy logger to the SD card. (see operating instructions)

6. Transfer the data files from the SD card to a suitably named **empty** folder on your computer. The folder must not contain other data files.

7. Start the energy logger viewer, click file -> new to start a new document, and click tools-> add logger to open your data files. Of course you choose the folder that you put the data files into. Now you see a graph of your measurements.

8. Click Tools-> Export Logger Data to export the data to a comma separated value (.csv) file, in the same folder. Name the file applianceX.csv; where X

runs from 1 to the number of appliances you will measure (at least 10). Do not rename the .bin files (this makes them unusable).

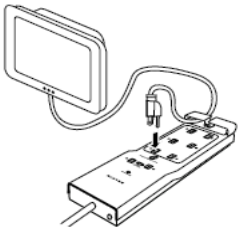
9. Delete the files on the SD card.
10. Clear the memory of the energy logger (see operating instructions).
11. The files that you have now (2 .bin files and 1 .csv file) must be saved.

Now you are ready to start measuring the next appliance.

Appendix IV - User manual Belkin converse switch

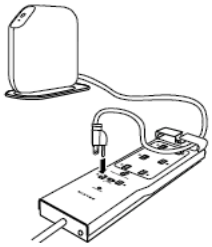
1 Plug in any of your devices that do not require constant, round-the-clock power into one of the Conserve Switch Surge Protector's Remote-Switched Outlets. Recommended devices include:

- Computers
- Monitors
- Printers
- Computer Speakers
- External Hard Drives
- Paper Shredders
- Lamps

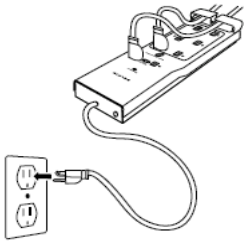


2 Plug in any of your devices that require constant, round-the-clock power into one of the Conserve Switch Surge Protector's Always-On Outlets. Recommended devices include:

- Wireless Routers
- Modems
- Cordless Phones

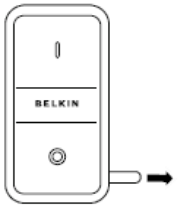


3 Plug your Conserve Switch's power cord into a wall outlet.



4 **Remove the clear battery tab** from the back of the remote switch. The remote is now ready to use.

NOTE: Mounting screws are not included; see the "Wireless Remote Switch with Wall-Mount" section later in this user guide.



INDICATOR LIGHTS

- The "Always-On Outlets" light should be on if power is present. If this light goes out at any time, it means the circuit breaker has tripped and should be reset.
- The "Not Grounded" light should not be on. If this light turns on, you may have a ground-wiring problem in your home and you should contact an electrician to properly ground the outlet. Connecting a Belkin Surge Protector to an improperly grounded outlet will void all Belkin warranties. If your home is properly grounded and the "Not Grounded" light is on, please contact Belkin for your free replacement.
- The "Remote-Switched Outlets" light shows the state of the Remote-Switched Outlets. When the light is on, the Remote-Switched Outlets are powered; if the light is off, the Remote-Switched Outlets are not powered.

HOW TO USE YOUR CONSERVE REMOTE SWITCH

1 Firmly press and release the "I" button to turn ON the Remote-Switched Outlets. As you press the button, a green light flashes on the remote switch to indicate that the remote is working. Your devices are now powered and ready for use.

2 Turn on and use your devices as usual.

3 When you are finished using your devices, turn off each device as you normally would.

4 When your devices are turned off, firmly press and release the "O" button to turn OFF the Remote-Switched Outlets. As you press the button, a green light flashes on the remote switch to indicate that you have eliminated power to Conserve Switch's Remote-Switched Outlets. Devices plugged into the Always-On Outlets will remain powered.

5 When ready to use your equipment again, repeat Steps 1–5.

NOTE: A green LED on the wireless remote switch will illuminate when the switch is pressed. This indicates that the signal was sent and that the battery is OK. If you do not see the light, it is time to replace the battery. To replace the battery, see the Troubleshooting section.

Appendix V - List of BAT electrical appliances

Provided by store

Television	Inches	Model	Standby in watt	Type	Year
LG	42	42LM3400	0.3	3D LED	2012
SAMSUNG	37	37ES6100	0.3	3D LED	2012
SAMSUNG	46	UE46ES6100	0.3	3D LED	2012
PHILIPS	46	46PFL5606	0.15	LED	2012
SONY	40	KDL40HX750	0.25	3D LED	2012
LG	42	42PA4500	0.3	PLASMA	2011
PHILIPS	32	32PDL7906	0.2	3D LED	2012
LG	32	32LS3500	0.19	LED	2011
PHILIPS	32	PFL5507	0.01	3D LED	2012
PHILIPS	37	37PFL9606H	0.1	3D LED	2012
LG	47	47LM860	0.1	3D LED	2012
PHILIPS	40	40PFL8606	0.2	3D LED	2012
PHILIPS	58	58PFL9955H/12	0.15	LED	2012

Measured in store

Television	Inches	Model	Standby in watt	Type	Year
F&U	24	FLED24963	0.27	LED	2011
SAMSUNG	24	P2370HD	0.64	LCD	2011
TOMSON	24	24FS5246C	0.21	LED	2011
LG	26	26CS460	0.16	LCD	2012
GRUNDIG	26	VLC4114C	0.16	LCD	2012
LG	32	32CS460	0.16	LCD	2012
SAMSUNG	32	LE32C530F1	0.15	LCD	2011
SAMSUNG	32	LE32D400E1	0.24	LCD	2012
TOSHIBA	32	32XV733DG	0.10	LCD	2011
SAMSUNG	40	LE40D503F7	0.15	LED	2012
SAMSUNG	40	SMARTTV	0.56	LED	2012
SONY	40	KDL40BX400A	0.13	LCD	2011

Washing M.	Label	Model	Standby in watt	Year
WHIRLPOOL	A++	AWOE 91200	0.081	2012
BOSCH	A++	WIP 20321	0.075	2011
ARISTON	A+++	AQ112D 697	2.001	2012
ARISTON	A+++	WML 803BEU	0.30	2012

Stereo hifi	Model	Standby in watt	Year
SONY	MHCEX700	4.05	2011

Pc Monitor	Inches	Model	Standby in watt	Type	Year
F & U	22	FDH2288W	0.33	LED	2012
SAMSUNG	22	UE22D500EB	0.20	LED	2011

Microwave	Model	Standby in watt	Year
TOYOTOMI	MM720CMF	0.053	2012
BEKO	MWB 2310 EX	1.102	2012

Home cinema	Model	Standby in watt	Year
PANASONIC	SA PT580	0.09	2011
JVC	XV-THU1	0.72	2011

Fryer	Model	Standby in watt	Year
TEFAL	FR4009	0.16	2012

Dryer	Label	Model	Standby in watt	Year
WHIRLPOOL	A++++	AZA 9781	0.037	2012

DVD player	Model	Standby in watt	Year
PANASONIC	P380	1.94	2011
PHILIPS	DVD3360ME	5.5	2011
LG	DVX642	3.5	2011

Blu-ray player	Model	Standby in watt	Year
LG	HR550	1.20	2012
SAMSUNG	BD-P1500	0.52	2012
SONY	BDPS 350	0.16	2012

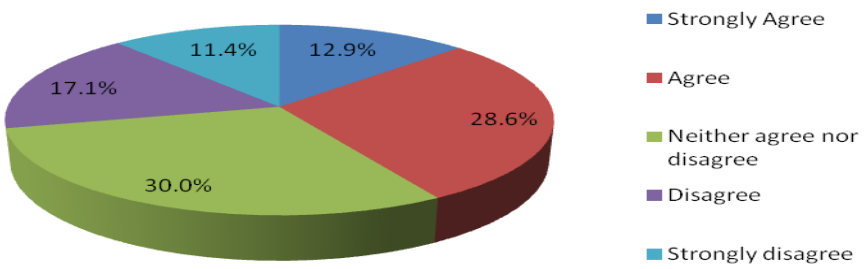
Alarm clock	Model	Standby in watt	Year
TOMSON	CR3081	1.17	2011
PHILIPS	AJ3121	1.23	2012

Coffee maker	Model	Standby in watt	Year
BOSCH	TASSIMO TAS	0.59	2011
KRUPS	Z XN70065	1.66	2012

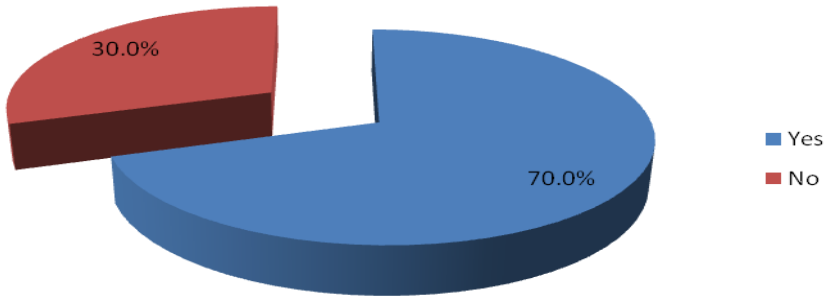
Appendix VI – Aggregated questionnaire answers

Behavior

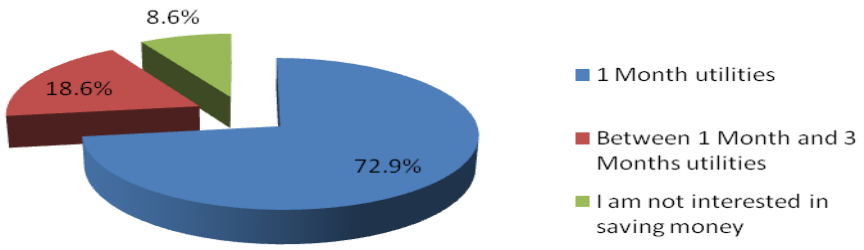
1. Do media and companies promote energy efficiency?



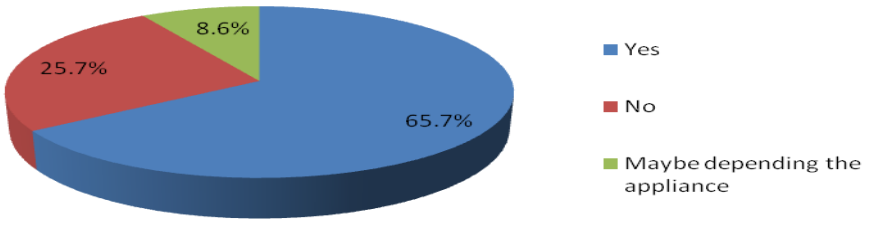
2. Did you know that an appliance consumes energy even when it is turned off?



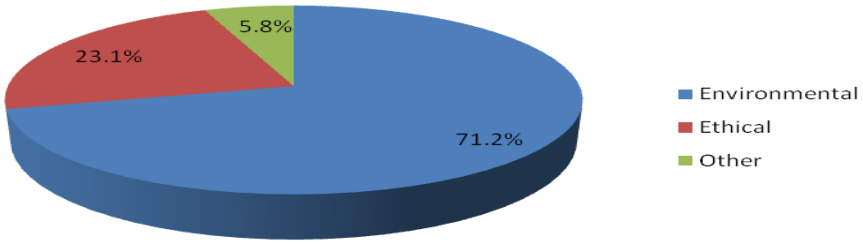
3. Studies show that if all appliances are switched off, 1 month of utilities can be saved on a yearly basis. For what amount, on a yearly basis, would you choose to never use the standby mode again?



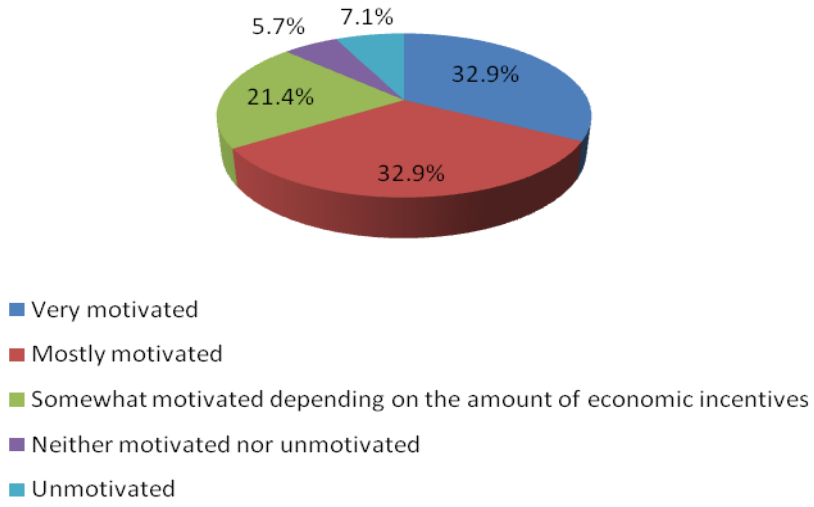
4. If you do not receive any economic benefits from your actions (for instance when your landlord pays the electricity bills), would you still change your behavior for other reasons?



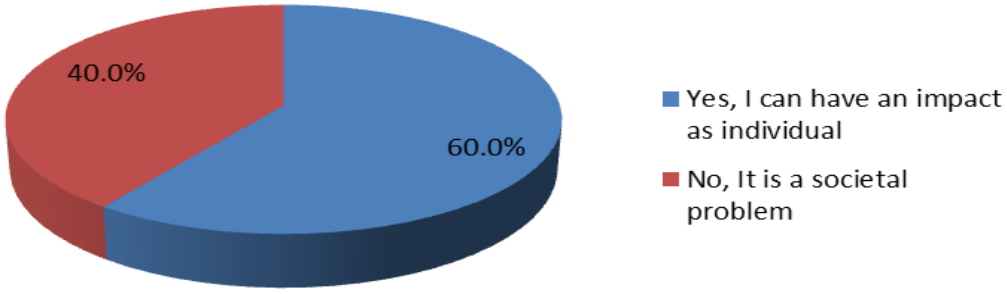
5. If you answer in question 7 was YES or MAYBE, please name a reason



6. If there were more incentives from the government (e.g. economic benefits in exchange for getting rid of old products), do you believe that you would be more motivated to exchange the old products for new ones?

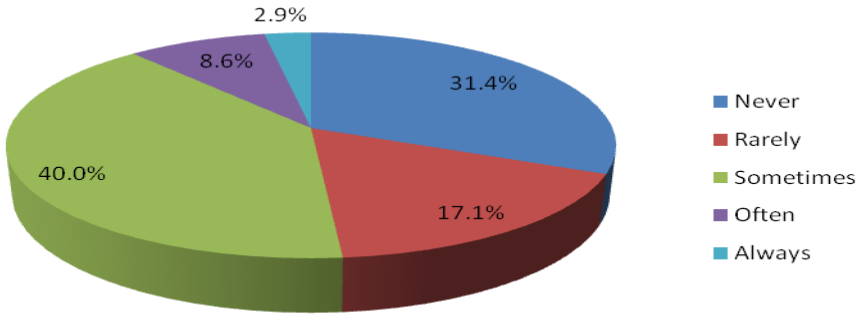


7. Aware of the negative impact of the old appliances and their energy consumption in standby mode, do you feel that you can – as an individual - have an impact on the entire society?

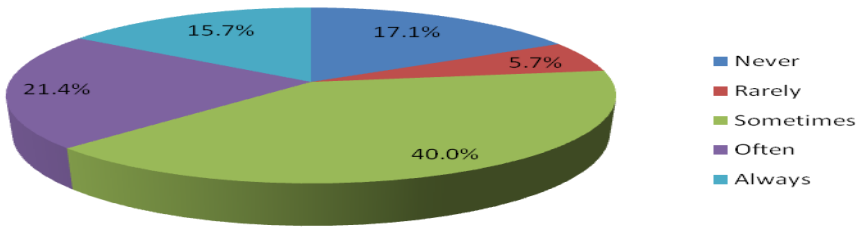


Market-retailer

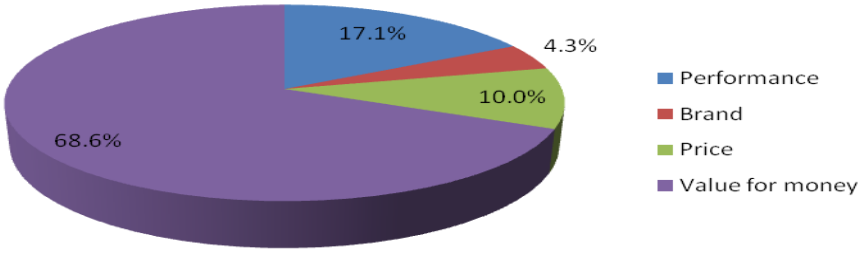
1. Grade how often a retailer/salesman referred to the energy efficiency of an appliance you wanted to buy



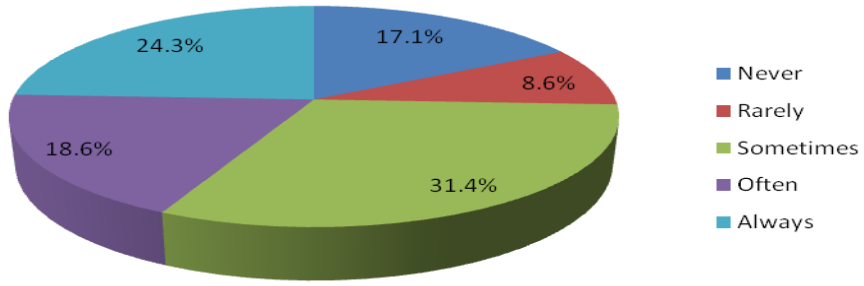
2. Grade your own interest in the energy use of an appliance when you buy it



3. Please name the most important factor for you when you choose to buy an appliance



4. Grade your capability of recognizing energy labels on your electric appliance



Appendix VII - Percentage of standby reduction of Ecodesign & BAT case in Dutch households, for period 2012-2025 in comparison with 2012 values

A)

N. Dutch Households	Years ECODESIGN case													
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	0.00	0.00	0.00	2.61	26.36	26.36	31.90	58.71	58.71	70.94	70.94	70.94	70.94	72.94
2	0.00	0.00	0.00	6.29	7.44	7.44	39.13	39.13	39.13	55.73	55.73	55.73	55.73	55.73
3	0.00	0.00	0.00	0.00	0.92	1.33	1.33	71.33	71.33	71.33	71.33	71.33	71.33	71.33
4	0.00	0.00	7.53	8.68	9.32	22.22	32.44	32.44	32.44	73.04	73.04	73.04	73.04	73.04
5	0.00	0.00	0.00	1.05	1.05	1.05	1.05	1.05	6.18	6.18	6.18	31.67	31.67	31.67
6	0.00	0.78	0.78	64.23	64.23	75.19	83.94	83.94	83.94	83.94	83.94	83.94	83.94	83.94
7	0.00	0.00	2.43	2.43	46.21	46.21	70.52	70.52	70.52	70.52	75.34	75.34	75.34	75.34
8	0.00	3.47	39.72	39.72	39.72	39.72	44.54	82.53	82.53	82.53	82.53	82.53	82.53	82.53
9	0.00	8.13	8.13	11.29	11.35	13.81	13.81	86.31	86.31	90.66	90.66	90.66	90.66	90.66
10	0.00	3.27	3.27	3.27	44.63	45.52	45.52	81.37	82.02	82.02	82.02	82.02	82.02	82.02
11	0.00	3.90	27.17	35.34	37.60	37.78	37.78	37.78	37.78	50.73	50.73	50.73	50.73	50.73
12	0.00	0.00	0.00	1.60	1.60	1.60	48.32	48.32	48.32	85.54	85.54	85.54	85.54	85.54
13	0.00	0.00	15.47	44.42	46.87	62.93	78.76	78.76	78.76	78.76	78.76	78.76	78.76	78.76
14	0.00	1.70	5.52	5.52	18.46	23.29	31.34	70.40	70.40	70.40	70.40	70.40	70.40	70.40
16	0.00	0.00	0.00	13.19	13.19	19.20	27.09	27.09	66.28	72.86	88.87	88.87	88.87	88.87
17	0.00	8.98	8.98	23.14	23.14	44.98	44.98	46.17	46.17	65.95	65.95	65.95	70.30	70.30
18	0.00	0.00	0.00	12.13	29.79	29.79	50.68	50.68	50.68	64.98	64.98	64.98	64.98	64.98
19	0.00	15.20	15.20	15.20	26.69	41.33	41.33	41.33	41.33	41.33	41.33	41.33	41.33	41.33
20	0.00	0.00	0.00	0.00	2.71	6.27	19.45	49.55	49.55	81.07	81.07	81.07	81.07	81.07
21	0.00	0.00	3.51	12.29	15.03	15.59	26.06	32.43	32.43	70.35	85.23	85.23	85.23	85.23
22	0.00	0.00	0.00	0.41	1.96	5.04	46.23	54.78	54.78	77.93	77.93	77.93	77.93	77.93
23	0.00	1.79	1.79	3.19	12.26	41.59	53.52	53.52	58.91	82.24	82.24	82.24	82.24	82.24
24	0.00	0.00	3.28	4.64	10.05	24.51	47.42	47.42	47.42	78.45	78.45	78.45	78.45	78.45
25	0.00	8.09	8.09	42.59	43.27	43.27	87.12	87.12	87.12	87.12	87.12	87.12	87.12	87.12
26	0.00	0.00	6.01	11.86	14.75	14.75	50.08	75.32	75.32	75.32	75.32	75.32	75.32	75.32
27	0.00	0.00	1.37	1.37	2.40	3.45	3.45	10.21	10.21	10.21	10.21	88.95	88.95	88.95
28	0.00	0.21	4.01	4.72	4.72	10.27	30.41	30.41	30.41	84.39	84.39	84.39	84.39	84.39
29	0.00	5.04	5.04	5.04	46.26	49.09	49.09	49.09	49.09	85.33	85.33	85.33	85.33	85.33
30	0.00	0.00	1.07	3.44	4.06	4.06	23.02	70.57	70.57	70.57	86.94	86.94	86.94	86.94
31	0.00	0.00	0.00	40.83	87.74	87.74	87.74	87.74	87.74	87.74	87.74	87.74	87.74	87.74
32	0.00	0.00	0.00	0.00	0.00	1.72	32.59	77.79	77.79	77.79	77.79	77.79	77.79	77.79
33	0.00	0.00	0.00	0.00	3.04	3.04	9.38	92.30	92.30	92.30	92.30	92.30	92.30	92.30
34	0.00	0.00	0.77	1.79	61.84	61.84	61.84	61.84	61.84	89.35	89.35	89.35	89.35	89.35
35	0.00	0.00	0.00	14.49	20.83	60.35	60.35	60.35	60.35	60.35	60.35	60.35	60.35	60.35
36	0.00	0.00	0.00	0.00	15.57	22.50	36.63	54.68	80.83	80.83	80.83	80.83	80.83	80.83
37	0.00	0.00	0.00	0.00	8.66	8.66	8.66	70.33	70.33	70.33	70.33	70.33	70.33	70.33
38	0.00	0.00	32.49	32.49	43.27	43.27	43.27	81.29	81.29	82.21	82.21	83.36	83.36	83.36
39	0.00	3.84	3.84	20.92	34.38	34.38	34.38	45.73	45.73	45.73	61.55	64.17	64.17	64.17
40	0.00	0.00	1.18	1.18	1.18	10.84	38.28	81.64	81.64	81.64	81.64	81.64	81.64	81.64
41	0.00	0.00	0.00	38.88	38.88	38.88	38.88	38.88	49.00	61.98	62.76	62.76	62.76	62.76
42	0.00	0.00	0.00	0.00	2.47	29.02	29.02	37.40	37.40	37.40	77.57	80.00	80.00	80.00
43	0.00	0.00	0.00	0.00	1.50	1.50	1.57	1.57	94.25	94.25	94.25	94.25	94.25	94.25
44	0.00	1.21	7.28	15.80	15.80	21.13	47.92	75.82	75.82	80.10	80.10	80.10	80.10	80.10
Average percentage	**0.00**	**0.02**	**4.97**	**12.70**	**21.89**	**27.50**	**39.32**	**56.64**	**60.81**	**71.22**	**73.75**	**76.32**	**76.42**	**76.47**

B)

N. Dutch Households	Years BAT case													
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	0.00	0.00	0.00	3.48	27.05	27.05	36.48	65.69	66.03	82.52	82.52	82.52	82.52	82.52
2	0.00	0.00	0.00	7.21	15.60	15.60	31.13	31.13	31.13	36.57	36.57	36.57	36.57	36.57
3	0.00	0.00	0.00	0.00	5.22	9.94	9.94	93.56	93.56	93.56	93.56	93.56	93.56	93.56
4	0.00	0.00	11.44	15.08	15.08	20.38	28.06	28.06	28.06	68.55	68.55	68.55	68.55	68.55
5	0.00	0.00	0.00	1.68	1.68	1.68	1.68	1.68	7.64	7.64	8.39	33.88	33.88	33.88
6	0.00	0.89	0.89	51.78	51.78	64.10	77.05	77.05	77.05	77.05	77.05	77.05	77.05	77.05
7	0.00	0.00	4.85	4.85	46.02	46.02	71.39	71.39	71.39	71.39	76.21	76.21	76.21	76.21
8	0.00	2.08	42.35	42.35	42.35	42.35	50.00	89.35	89.35	89.35	89.35	89.35	89.35	89.35
9	0.00	8.56	8.56	13.49	14.08	17.55	17.55	86.62	86.62	91.80	91.80	91.80	91.80	91.80
10	0.00	5.08	5.08	5.08	49.77	53.21	53.21	85.76	90.63	90.63	90.63	90.63	90.63	90.63
11	0.00	6.42	39.77	52.77	56.63	56.84	56.56	56.56	56.56	75.91	75.91	75.91	75.91	75.91
12	0.00	0.00	0.00	5.83	5.83	5.83	54.25	54.25	54.25	92.93	92.93	92.93	92.93	92.93
13	0.00	0.00	19.49	51.85	57.71	69.13	78.58	78.58	78.58	78.58	78.58	78.58	78.58	78.58
14	0.00	2.67	12.06	12.06	28.01	41.47	51.46	86.17	86.17	86.17	86.25	86.25	86.25	86.25
16	0.00	0.00	0.00	13.19	13.19	19.03	26.92	26.92	66.11	71.65	87.67	87.67	87.67	87.67
17	0.00	11.61	11.61	29.19	29.19	47.14	47.14	49.81	49.81	71.31	71.31	71.31	76.63	76.63
18	0.00	0.00	0.00	20.38	42.63	42.63	72.03	72.03	72.03	77.86	77.86	77.86	77.86	77.86
19	0.00	15.94	15.94	15.94	42.23	65.06	65.06	65.06	65.06	76.50	76.50	76.50	76.50	76.50
20	0.00	0.00	0.00	0.00	3.04	7.19	21.36	56.87	56.87	83.57	83.57	83.57	83.57	83.57
21	0.00	0.00	2.76	11.51	15.48	16.52	26.57	33.54	33.54	67.44	81.59	81.59	81.59	81.59
22	0.00	0.00	0.00	0.79	2.74	7.72	40.20	46.14	46.14	66.41	66.41	66.41	66.41	66.41
23	0.00	3.53	3.53	6.56	17.01	43.07	47.87	47.87	55.44	78.77	78.77	78.77	78.77	78.77
24	0.00	0.00	3.63	5.75	12.74	19.81	46.78	46.78	46.78	79.42	79.42	79.42	79.42	79.42
25	0.00	9.08	9.08	46.45	47.37	47.48	88.24	88.24	88.24	88.24	88.24	88.24	88.24	88.24
26	0.00	0.00	2.63	11.67	17.75	17.75	48.59	69.26	69.26	69.26	69.26	69.26	69.26	69.26
27	0.00	0.00	2.84	2.84	5.32	7.84	7.84	15.92	15.92	15.92	16.37	95.11	95.11	95.11
28	0.00	0.37	3.36	6.36	6.36	12.32	31.14	32.02	32.02	84.60	84.60	84.60	84.60	84.60
29	0.00	5.22	5.22	5.22	48.28	53.69	53.69	53.69	53.69	93.05	93.05	93.31	93.31	93.31
30	0.00	0.00	1.88	5.13	6.11	6.11	22.13	68.37	68.37	68.57	86.31	86.31	86.31	86.31
31	0.00	0.00	0.00	41.66	78.93	78.93	78.93	78.93	78.93	78.93	78.93	78.93	78.93	78.93
32	0.00	0.00	0.00	0.30	0.30	4.18	37.22	77.02	77.02	77.02	77.02	77.02	77.02	77.02
33	0.00	0.00	0.00	0.00	4.61	4.61	13.21	94.39	94.39	94.39	94.39	94.39	94.39	94.39
34	0.00	0.00	2.06	2.28	63.99	64.11	64.11	64.11	64.11	93.32	93.32	93.32	93.32	93.32
35	0.00	0.00	0.00	19.72	36.33	89.37	89.37	89.37	89.37	91.24	91.24	91.24	91.24	91.24
36	0.00	0.00	0.00	0.00	16.31	24.83	39.50	59.02	82.24	82.24	82.24	82.24	82.24	82.24
37	0.00	0.00	0.00	0.00	6.33	6.33	6.33	86.01	86.01	86.01	86.01	86.01	86.01	86.01
38	0.00	0.00	31.34	31.34	44.06	44.06	44.06	79.77	79.77	79.77	79.77	80.18	80.18	80.18
39	0.00	4.07	4.07	26.45	29.48	29.62	29.26	42.44	42.44	42.44	50.46	53.64	53.64	53.64
40	0.00	0.00	0.52	0.52	0.52	9.20	31.00	78.94	78.94	78.94	78.94	78.94	78.94	78.94
41	0.00	0.00	0.00	36.87	36.87	36.87	36.87	36.87	49.25	63.79	66.53	66.53	66.53	66.53
42	0.00	0.00	0.00	0.00	3.53	35.08	35.08	47.06	47.06	47.06	82.16	82.16	82.16	82.16
43	0.00	0.00	0.00	0.00	1.30	1.30	1.41	1.41	95.14	95.14	95.14	95.14	95.14	95.14
44	0.00	2.52	10.30	20.16	20.16	19.82	46.93	74.83	75.89	76.39	76.39	76.39	76.39	76.39
Average percentage	**0.00**	**1.81**	**5.94**	**14.60**	**24.86**	**31.00**	**42.24**	**60.20**	**64.58**	**74.93**	**77.25**	**79.76**	**79.89**	**79.89**

Notes:

1. Household number15 was excluded from the tables due to zero standby consumption

C)

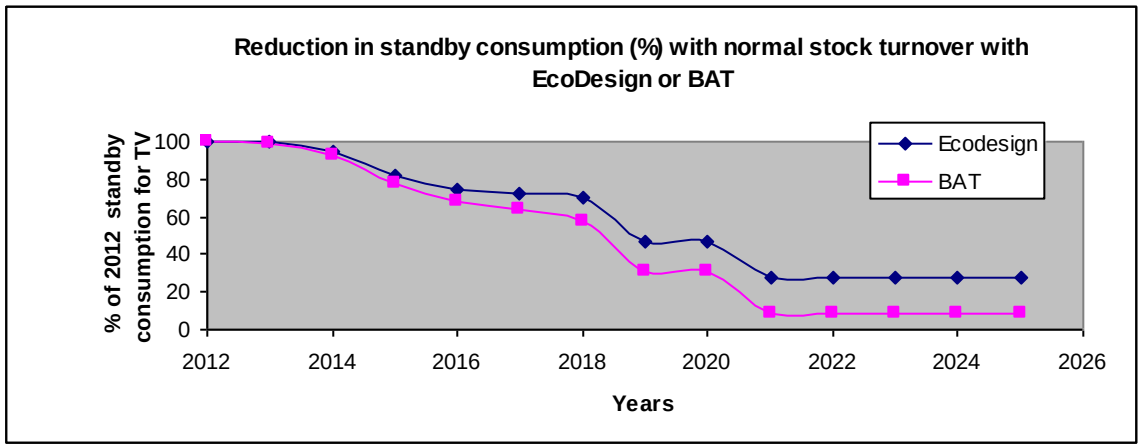
N. Dutch Households	Years ECODESIGN case as usual													
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.22	12.22	12.22	12.22	12.22
2	0.00	0.00	0.00	3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.17	59.17	59.17	59.17	59.17	59.17	59.17
4	0.00	0.00	0.74	0.74	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.78	0.78	0.78	0.78	0.78	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40
7	0.00	0.00	0.00	0.00	43.79	43.79	43.79	43.79	43.79	43.79	43.79	43.79	43.79	43.79
8	0.00	0.00	11.18	11.18	11.18	11.18	11.18	36.98	36.98	36.98	36.98	36.98	36.98	36.98
9	0.00	0.00	0.00	0.00	0.05	2.52	2.52	20.44	20.44	24.79	24.79	24.79	24.79	24.79
10	0.00	0.00	0.00	0.00	0.00	0.89	0.89	0.89	1.55	1.55	1.55	1.55	1.55	1.55
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.94	12.94	12.94	12.94	12.94
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.16	0.16	0.16	0.16
13	0.00	0.00	15.47	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42
14	0.00	0.00	0.00	0.00	12.94	12.94	12.94	12.94	12.94	12.94	12.94	12.94	12.94	12.94
16	0.00	0.00	0.00	0.00	0.00	0.62	0.62	0.62	0.62	7.20	23.21	23.21	23.21	23.21
17	0.00	8.98	8.98	8.98	8.98	8.98	8.98	8.98	8.98	8.98	8.98	8.98	8.98	8.98
18	0.00	0.00	0.00	0.00	17.66	17.66	29.04	29.04	29.04	29.04	29.04	29.04	29.04	29.04
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	2.03	2.03	2.03	2.03	27.22	27.22	27.22	27.22	27.22
21	0.00	0.00	3.51	3.51	3.51	3.51	5.31	5.31	5.31	21.35	27.22	27.22	27.22	27.22
22	0.00	0.00	0.00	0.00	0.42	0.42	0.42	0.42	0.42	5.29	5.29	5.29	5.29	5.29
23	0.00	0.00	0.00	1.39	1.39	2.72	2.72	2.72	2.72	2.72	2.72	2.72	2.72	2.72
24	0.00	0.00	0.00	1.34	1.34	1.34	22.21	22.21	22.21	53.25	53.25	53.25	53.25	53.25
25	0.00	0.12	0.12	34.46	34.46	34.46	34.46	34.46	34.46	34.46	34.46	34.46	34.46	34.46
26	0.00	0.00	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.76	6.76	6.76	6.76	6.76	6.76	6.76
28	0.00	0.00	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00	0.00	1.72	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	1.02	1.02	1.02	1.02	1.02	1.02	28.53	28.53	28.53	28.53	28.53
35	0.00	0.00	0.00	0.00	0.00	39.52	39.52	39.52	39.52	39.52	39.52	39.52	39.52	39.52
36	0.00	0.00	0.00	0.00	14.99	14.99	14.99	33.04	33.04	33.04	33.04	33.04	33.04	33.04
37	0.00	0.00	0.00	0.00	8.66	8.66	8.66	42.01	42.01	42.01	42.01	42.01	42.01	42.01
38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.02	38.02	38.02	38.02	38.02	38.02	38.02
39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.08	0.08
40	0.00	0.00	1.18	1.18	1.18	1.18	1.18	6.40	6.40	6.40	6.40	6.40	6.40	6.40
41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00	0.00	26.55	26.55	34.93	34.93	34.93	34.93	34.93	34.93	34.93
43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44	0.00	1.21	7.28	7.28	7.28	7.28	29.31	29.31	29.31	29.31	29.31	29.31	29.31	29.31
Average percentage	**0.00**	**0.26**	**1.37**	**3.02**	**5.32**	**7.07**	**8.70**	**13.64**	**13.66**	**16.93**	**17.45**	**17.45**	**17.45**	**17.45**

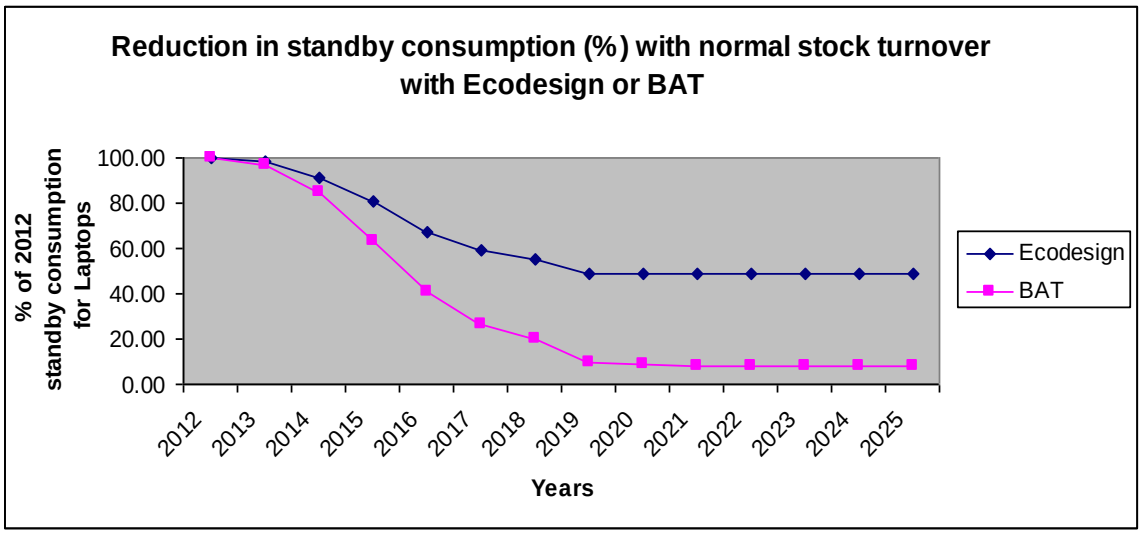
Appendix VIII - Standby consumption: comparison BAT & Ecodesign effectiveness per type of appliance

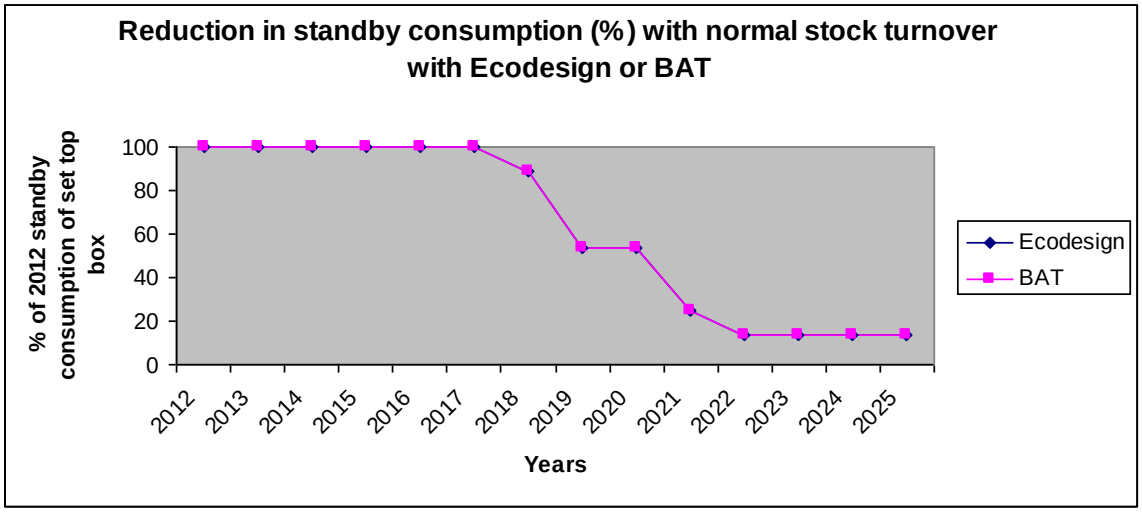
This section presents the comparison between Ecodesign values and BAT, per type of appliances, with respect to standby consumption for the period 2012–2025. An assumption has been made that no consumer behavioral changes will occur during this period. Further, the stock turnover was obtained from the participant's survey and the reference case is year 2012. Table 8.0 presents the full list of the reduction potential per type of appliances. BAT shows a higher potential in 14 types of appliances compared with the 8 types in which Ecodesign prevails. Due to the fact that percentages do not give a clear image of the energy savings, when all types of appliances (418) for the 44 households, where summed up for the period 2012-2025, Ecodesign Directive gave a 0.049 GWh standby consumption which is slightly higher than the 0.047 GWh of BAT.

Reduction of 2012 standby consumption (%) with normal stock turnover for the period 2012 - 2025		
Types of appliances	**Ecodesign**	**BAT**
Television	72.83	91.94
Laptop	51.54	91.87
Set top box	86.57	86.57
Radio	68.88	78.4
Pc speaker	88.86	75.71
Printer scanner	69	93.03
Game console	51.42	84.14
Microwave	74.53	96.55
Desktop	86.78	92.07
Stereo	90.43	79.83
Pc monitor	40.96	81.34
Decoder	89.36	94.68
Electric toothbrush	50.43	32.58
Alarm clock	71.24	29.26
DVD player	83.83	92.84
External hardrive	81.45	38.02
DVD Recorder	95.28	81.78
Amplifier	86.3	91.78
Coffee machine	53.77	64.26
Vacuum cleaner	86.83	86.3
Dishwasher	82.83	90.9
Washing machine	1.51	37.56
Electric keyboard	68.85	34.1

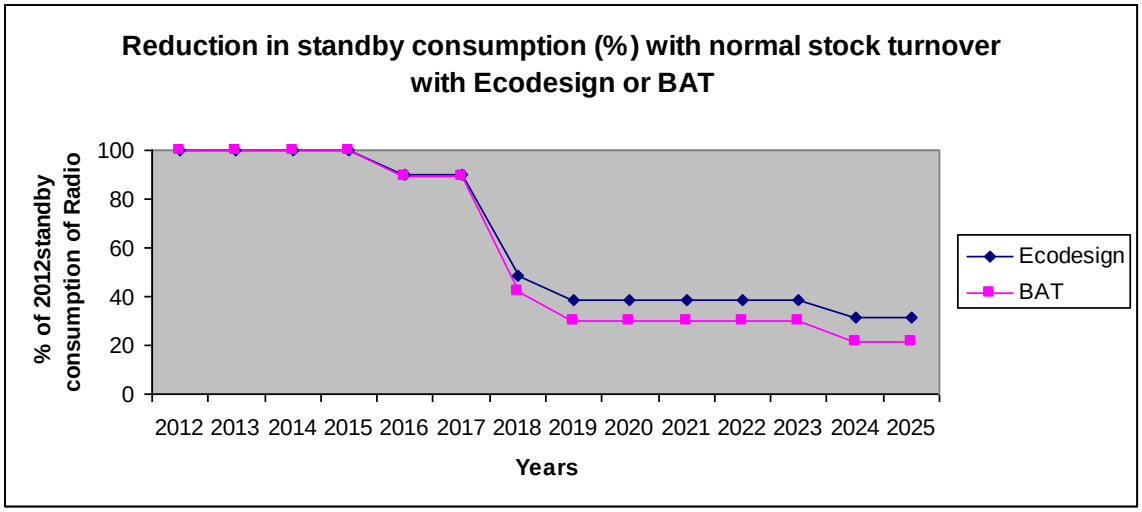
In table 8.0: Reduction of standby consumption (%) per type of appliance for the period 2012-2025

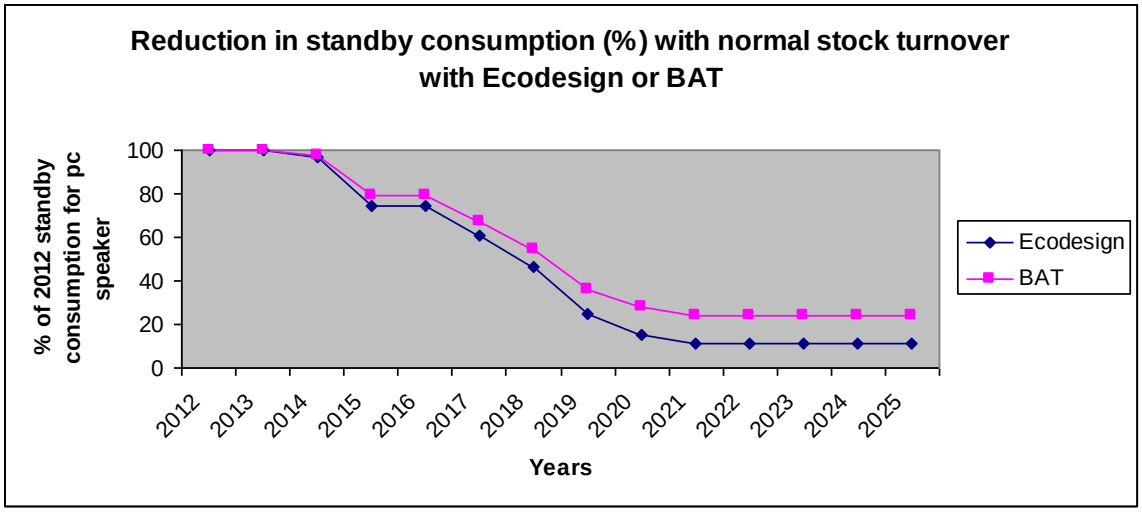


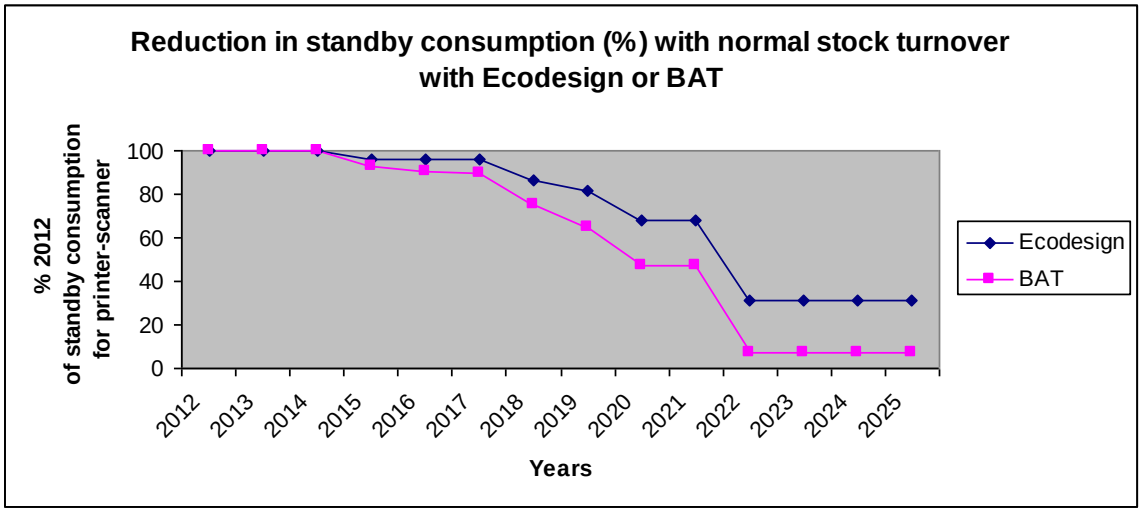


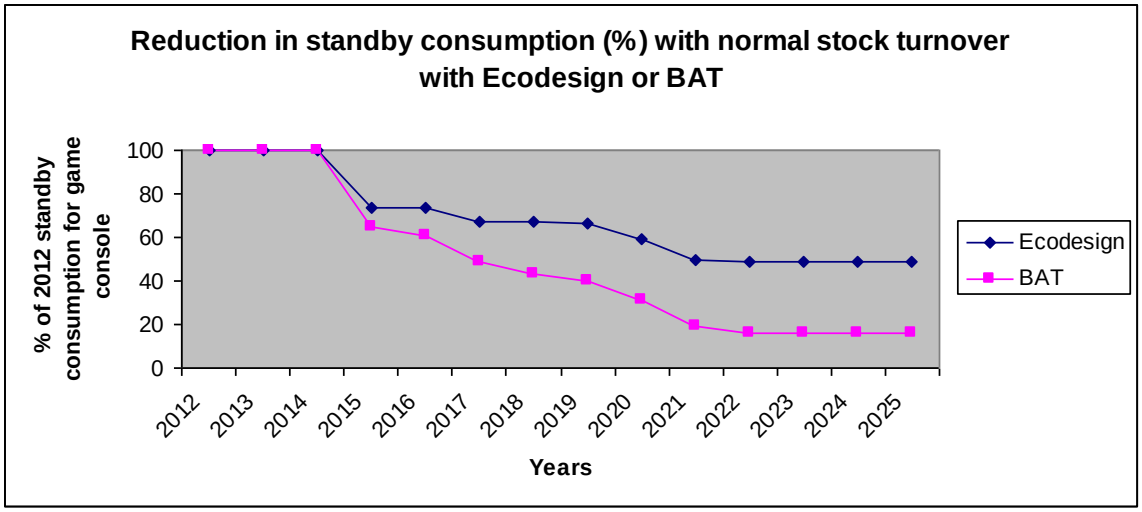


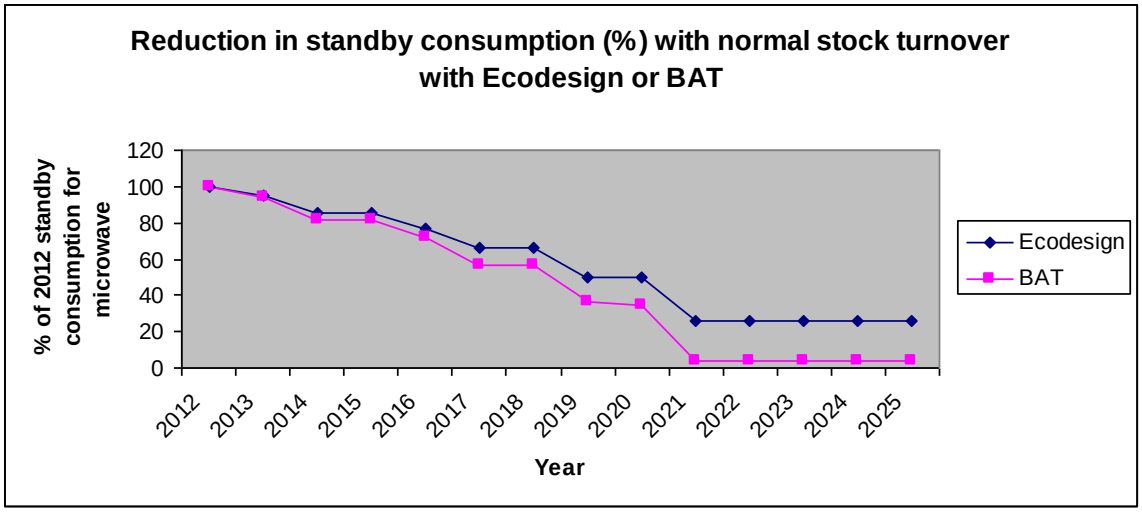
In this figure Ecodesign and BAT gave the same reduction values in standby consumption

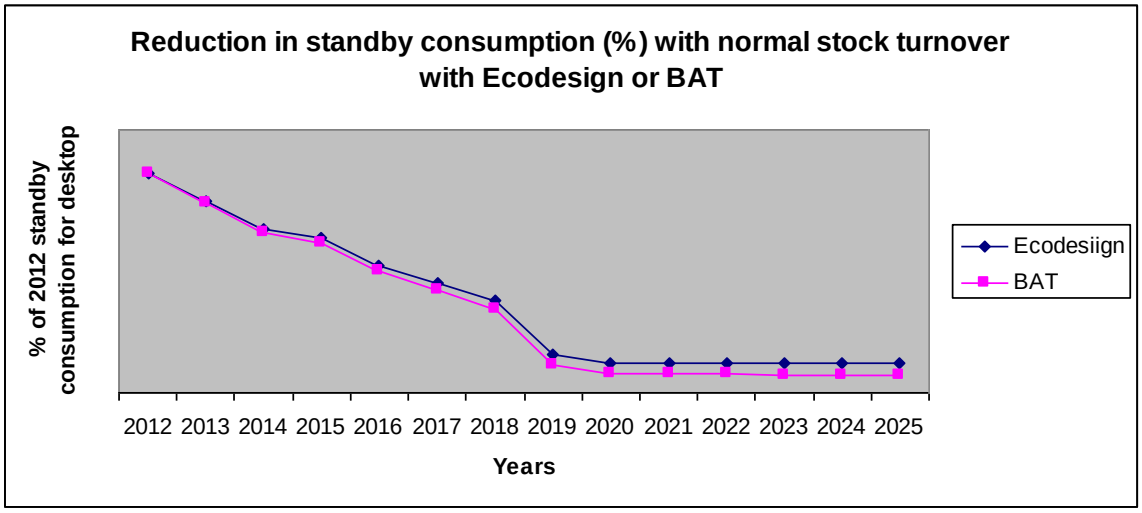

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012standby consumption of Radio
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

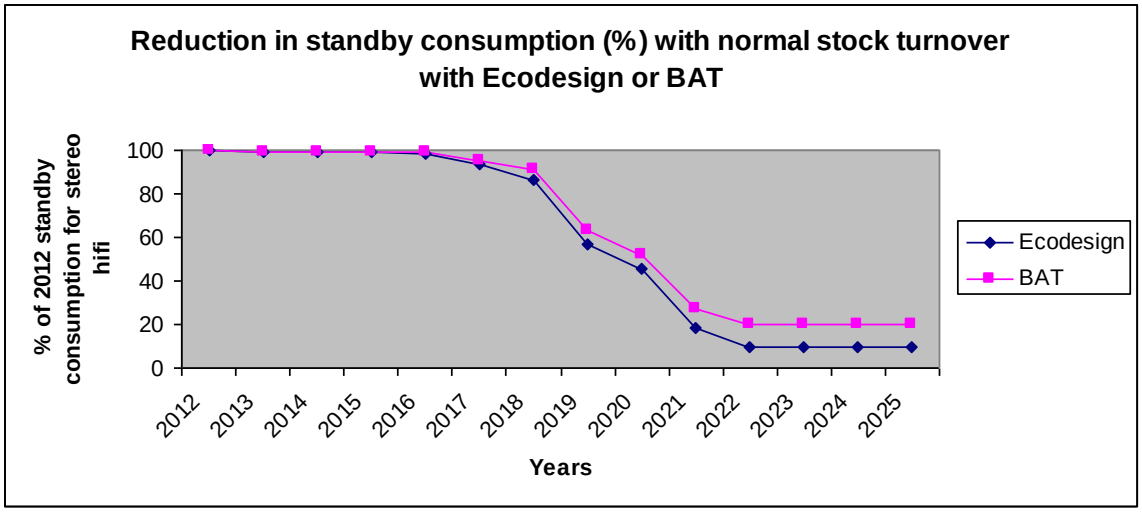

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for pc speaker
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

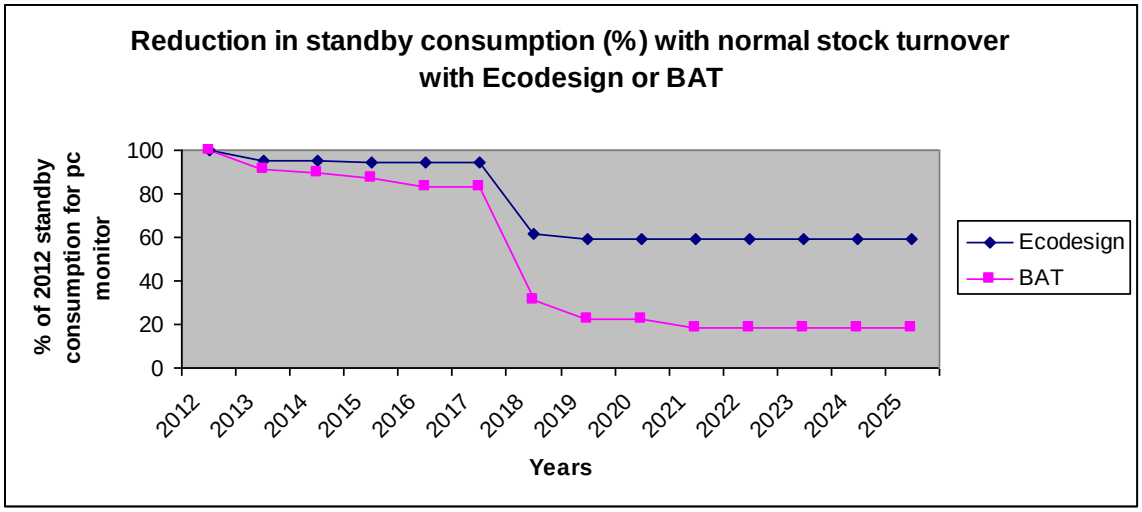

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% 2012 of standby consumption for printer-scanner
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

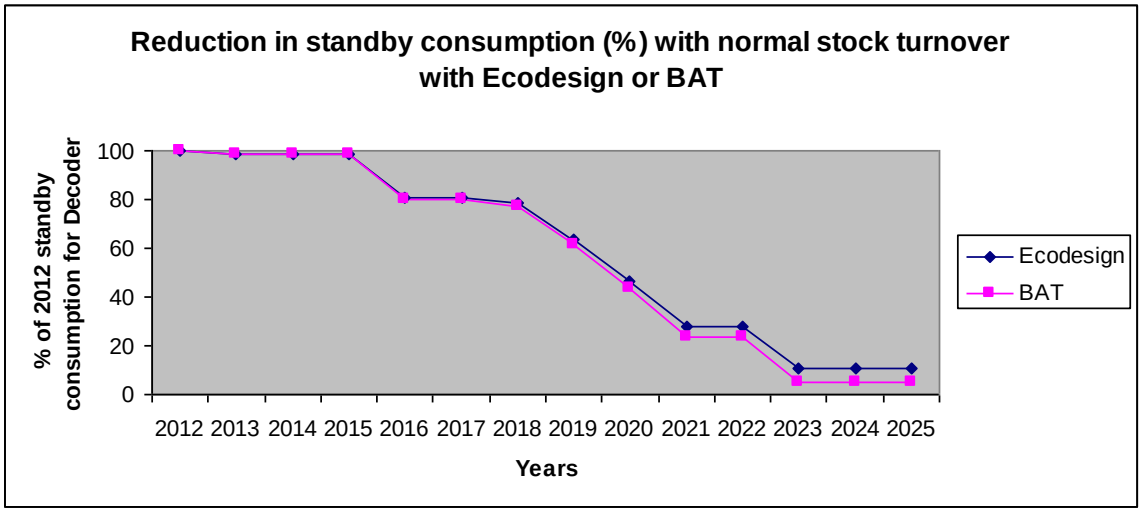

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for game console
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

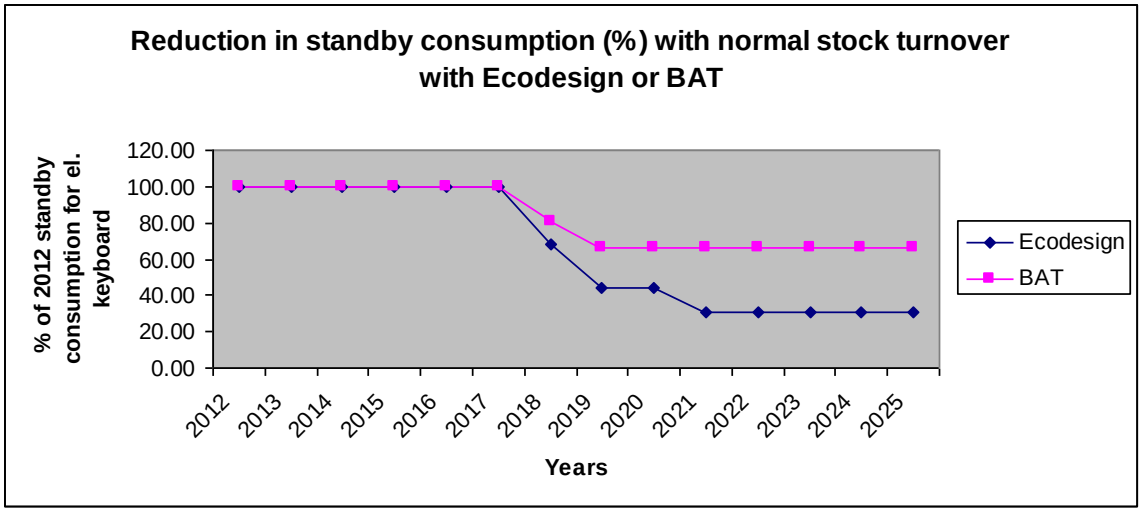

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for microwave
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Year
Ecodesign
BAT

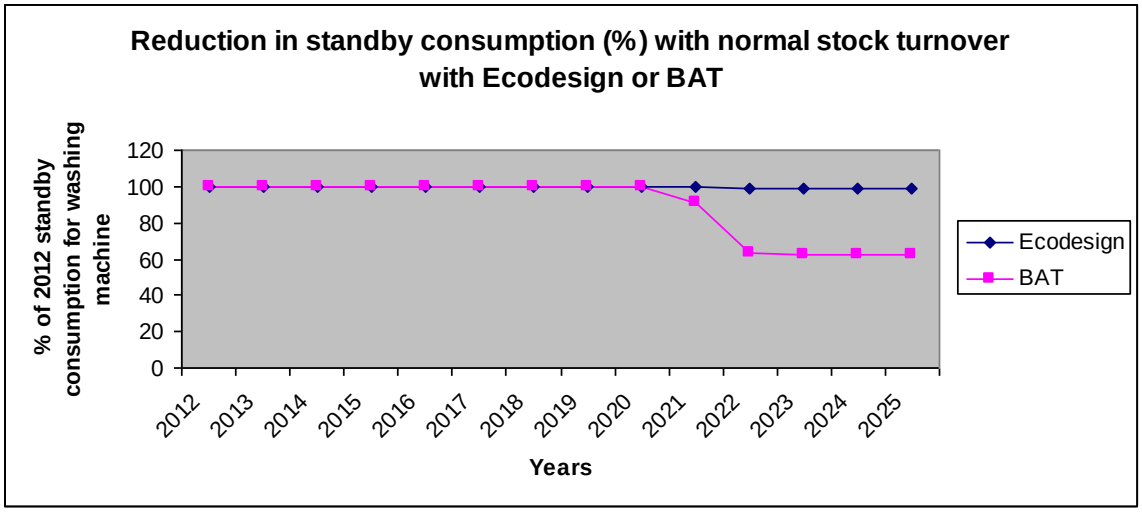

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for desktop
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesiign
BAT

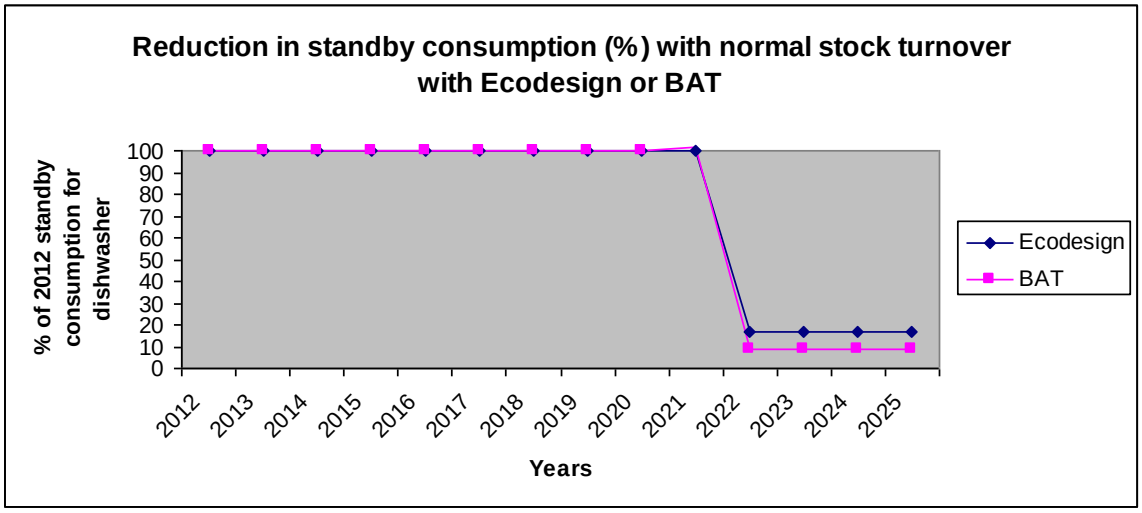

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for stereo hifi
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

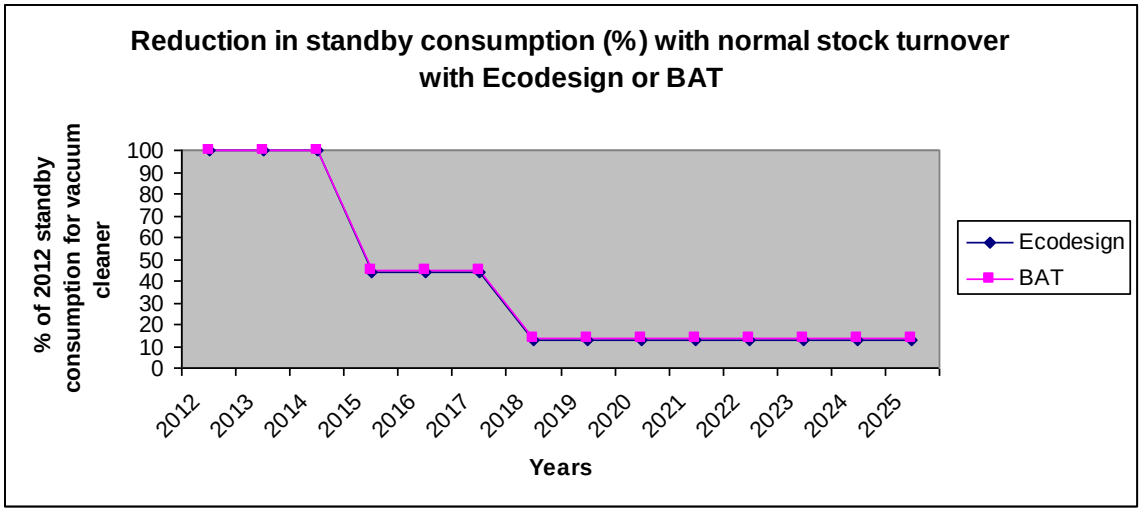

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for pc monitor
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

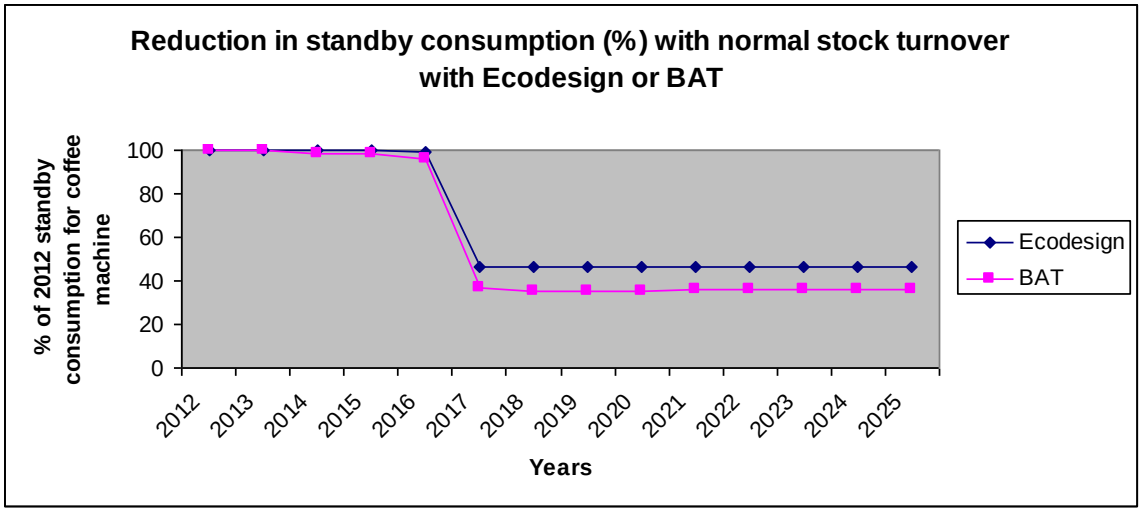

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for Decoder
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

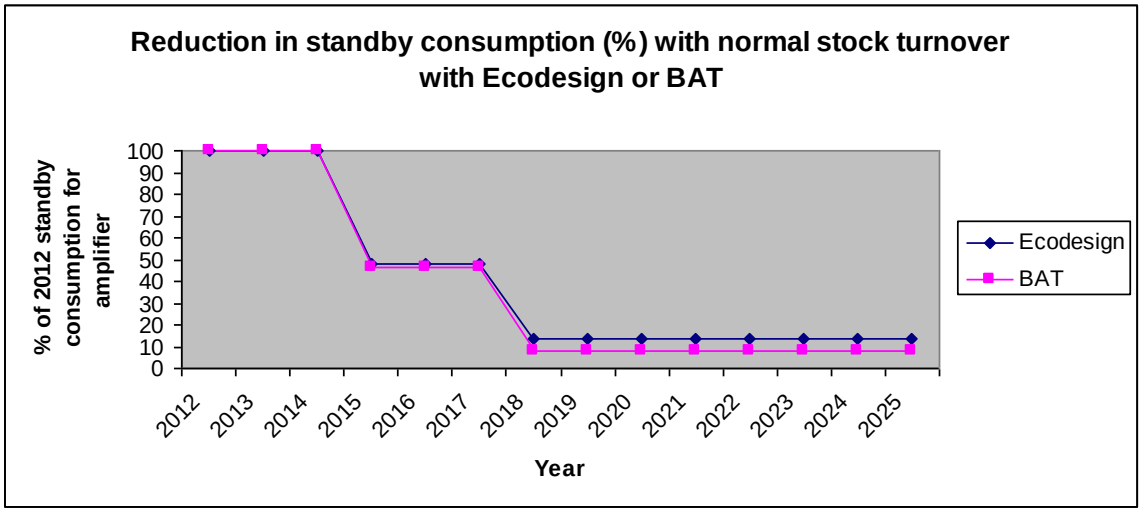

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for el. keyboard
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

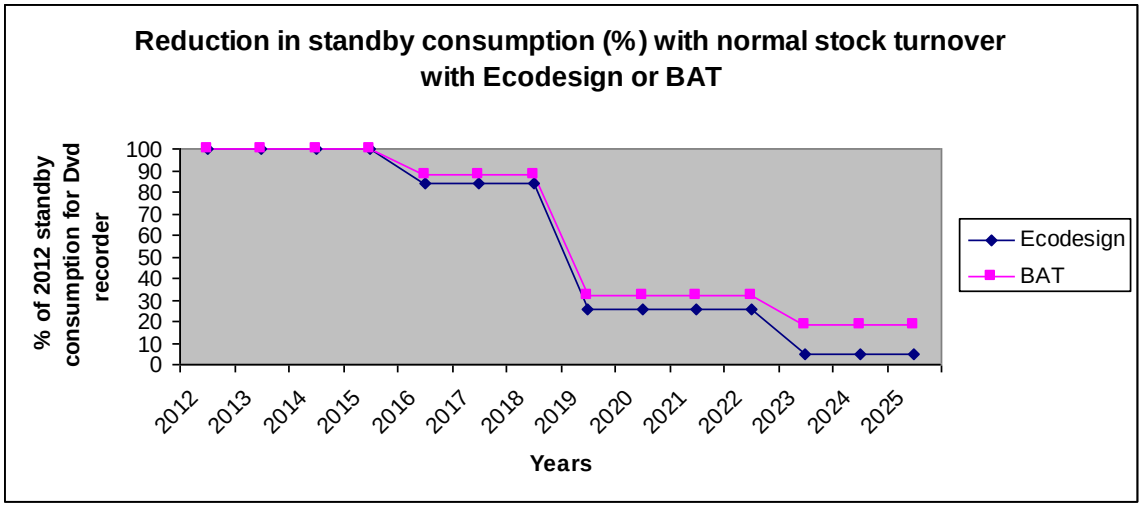

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for washing machine
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

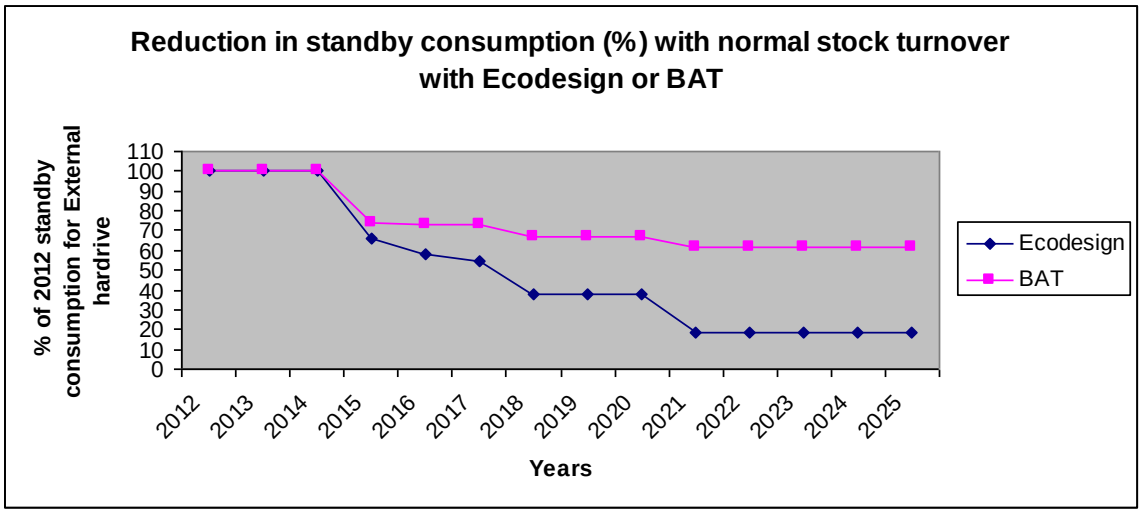

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for dishwasher
100
90
80
70
60
50
40
30
20
10
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

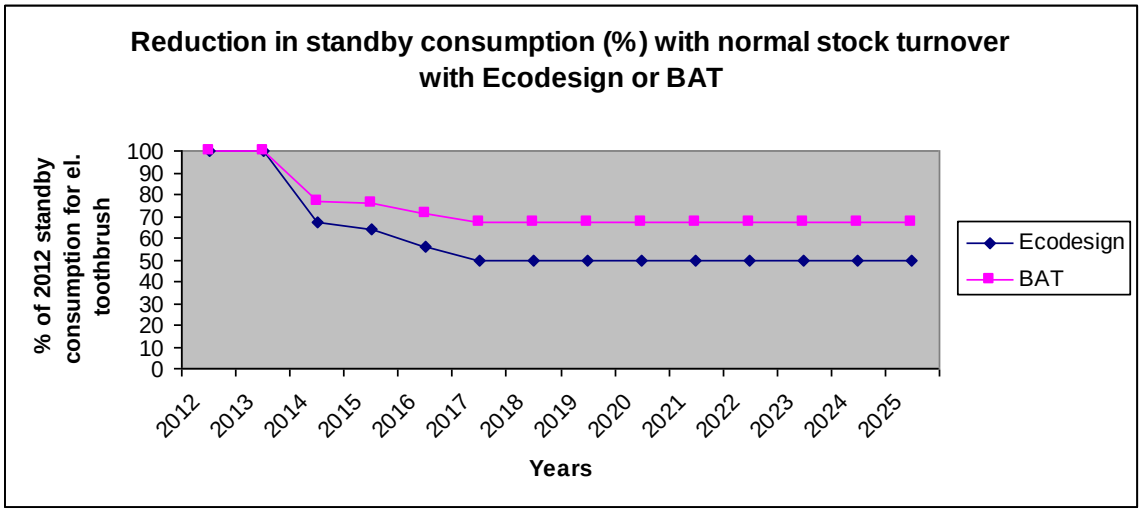

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for vacuum cleaner
100
90
80
70
60
50
40
30
20
10
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

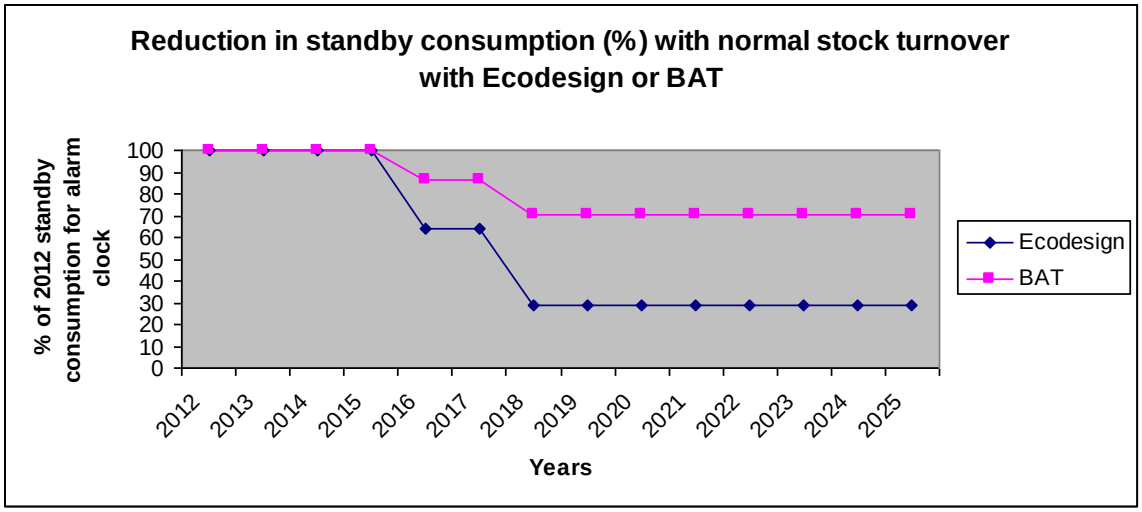

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for coffee machine
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT


Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for amplifier
100
90
80
70
60
50
40
30
20
10
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Year
Ecodesign
BAT

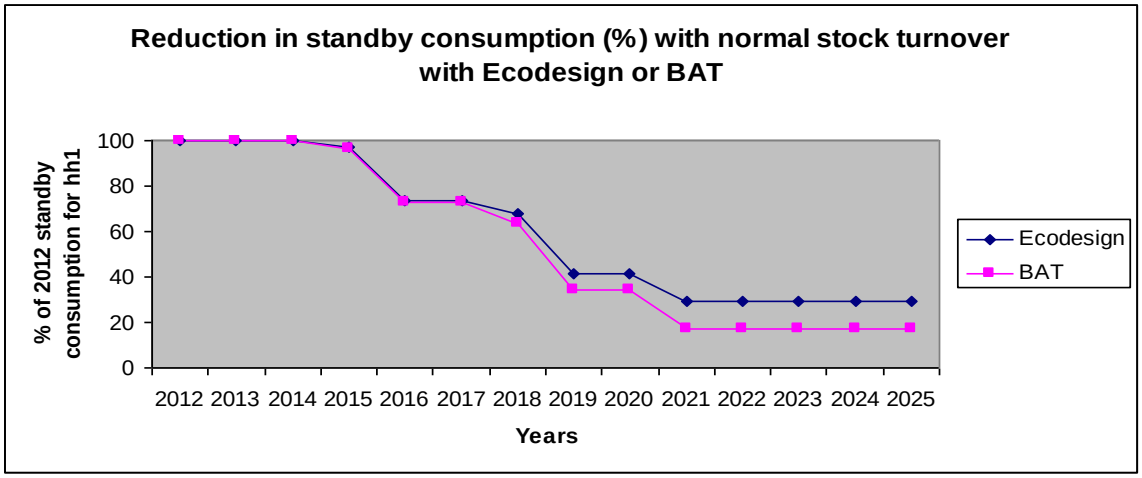

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for Dvd recorder
100
90
80
70
60
50
40
30
20
10
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

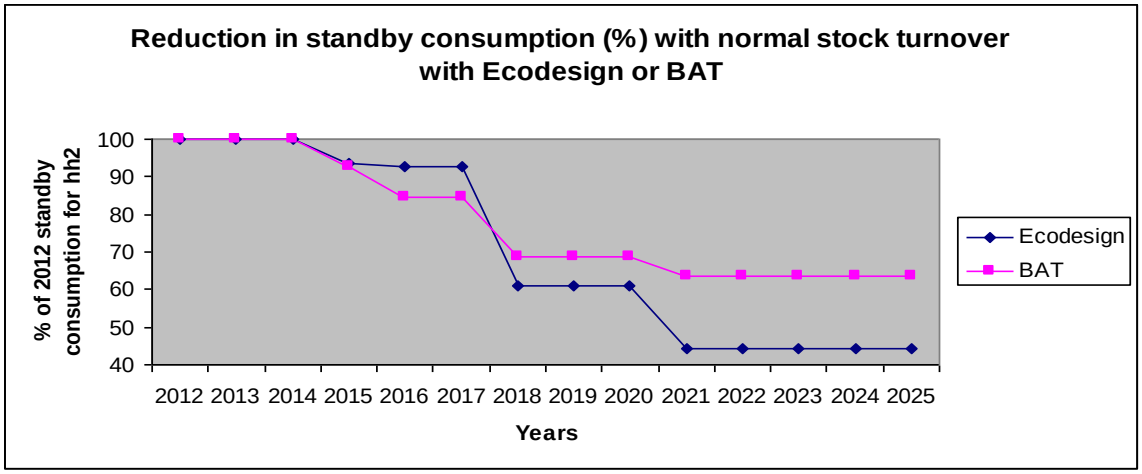

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for External hardrive
110
100
90
80
70
60
50
40
30
20
10
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

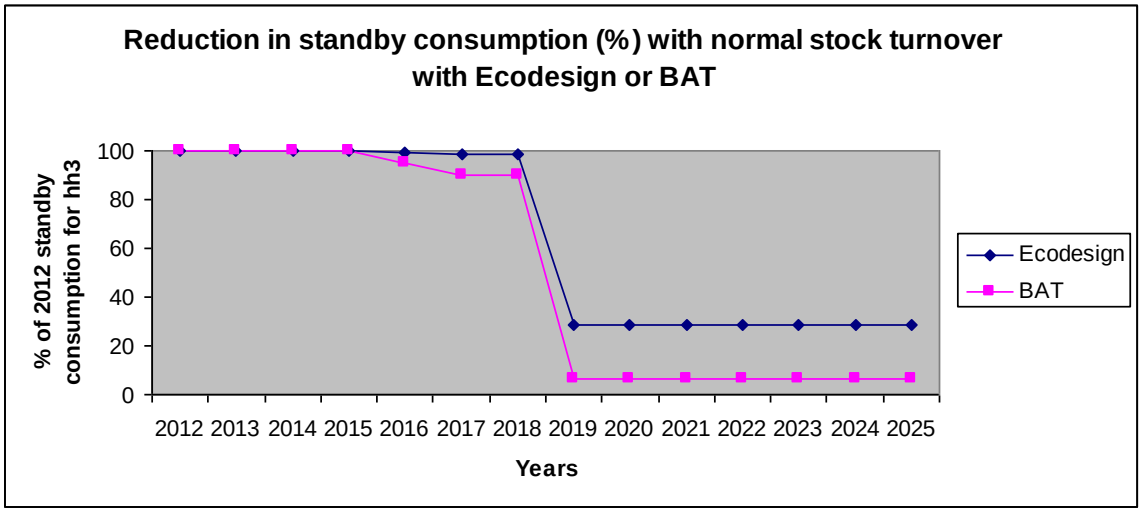

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for el. toothbrush
100
90
80
70
60
50
40
30
20
10
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

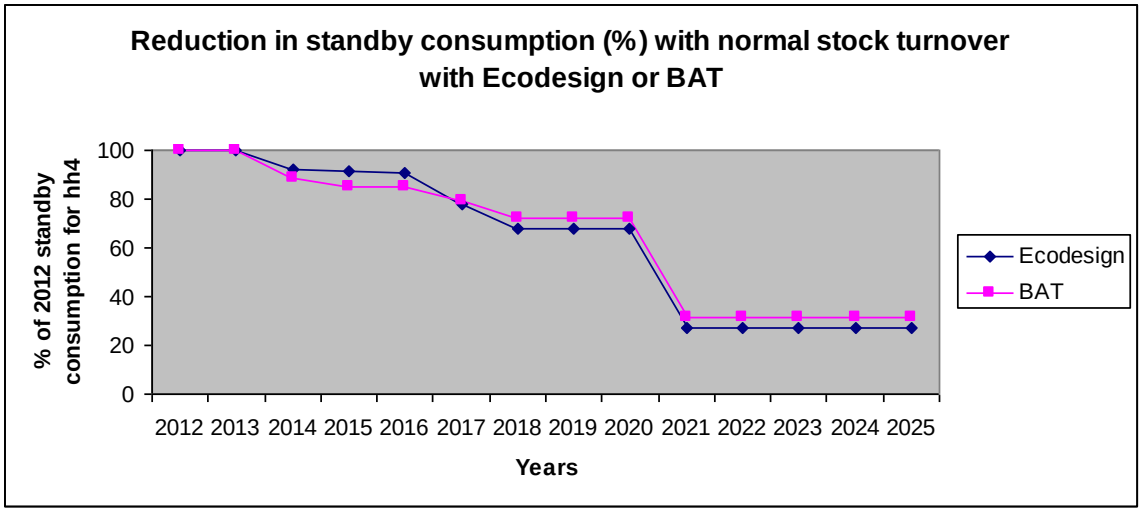

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for alarm clock
100
90
80
70
60
50
40
30
20
10
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

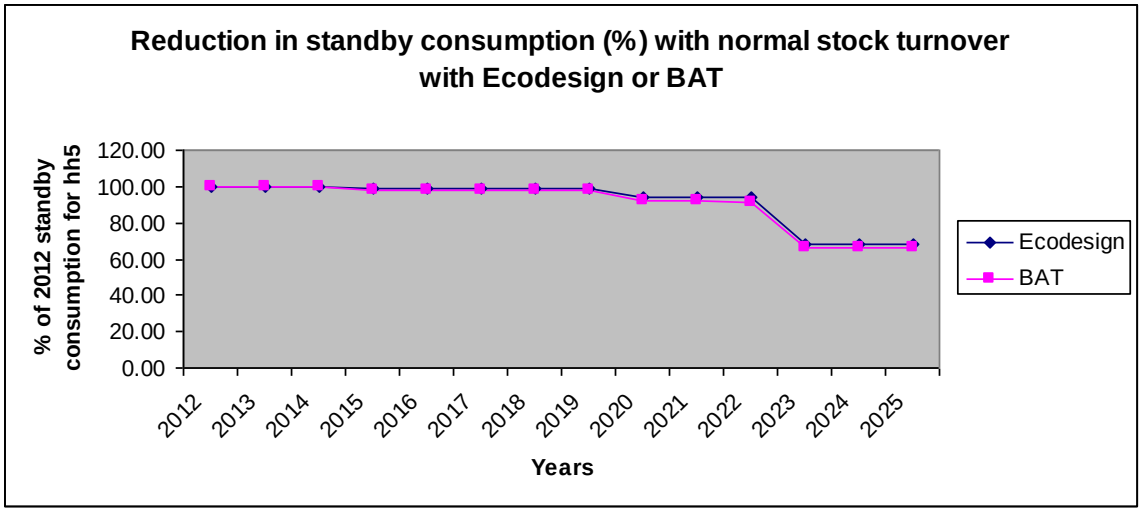
Appendix IX – Standby consumption: comparison BAT & Ecodesign effectiveness per household

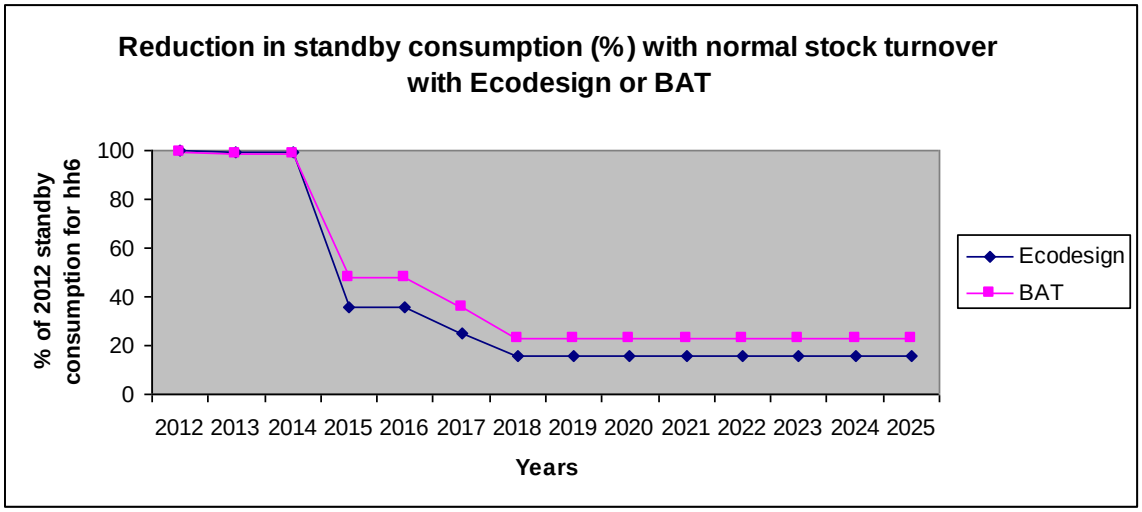


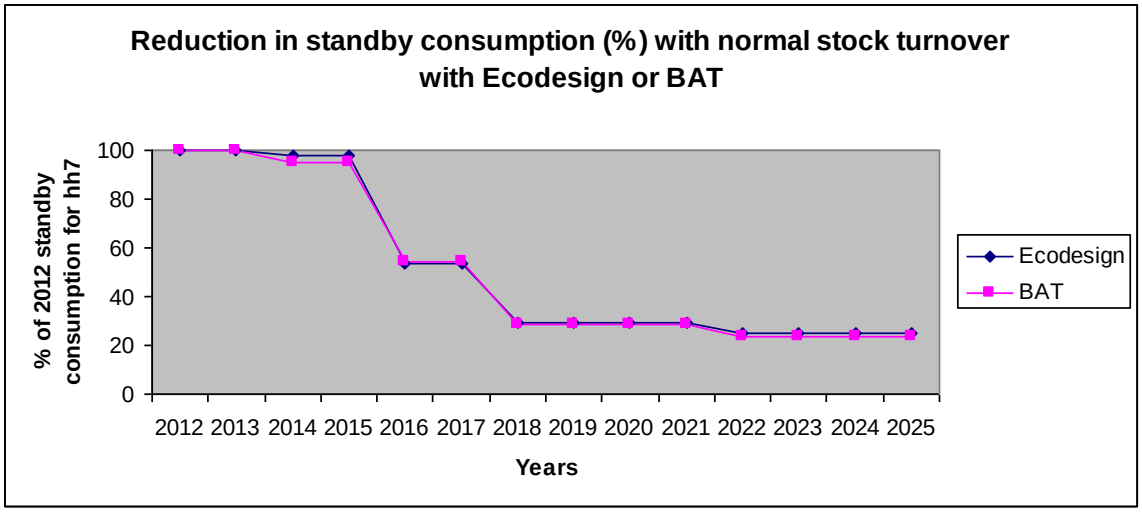


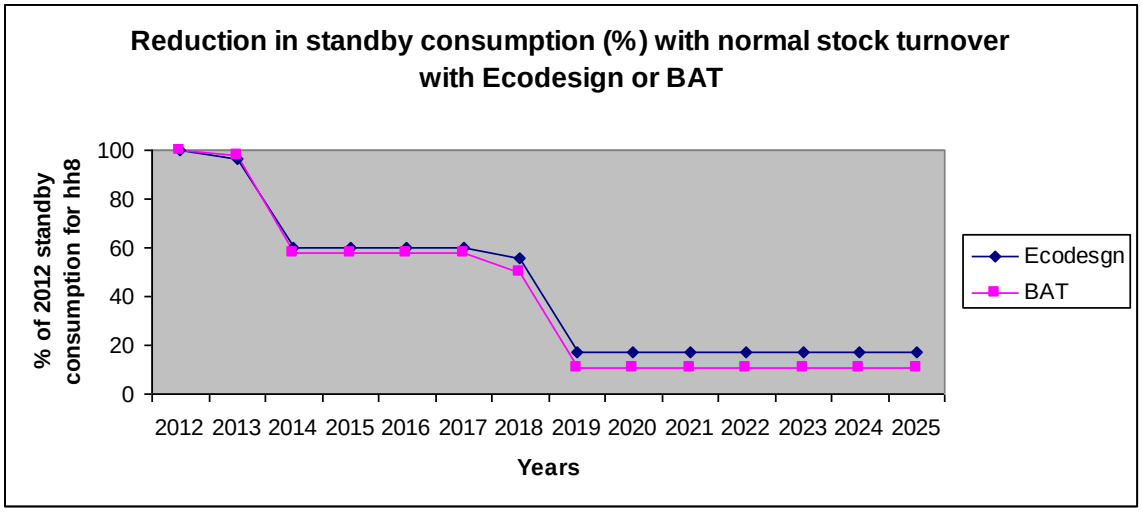


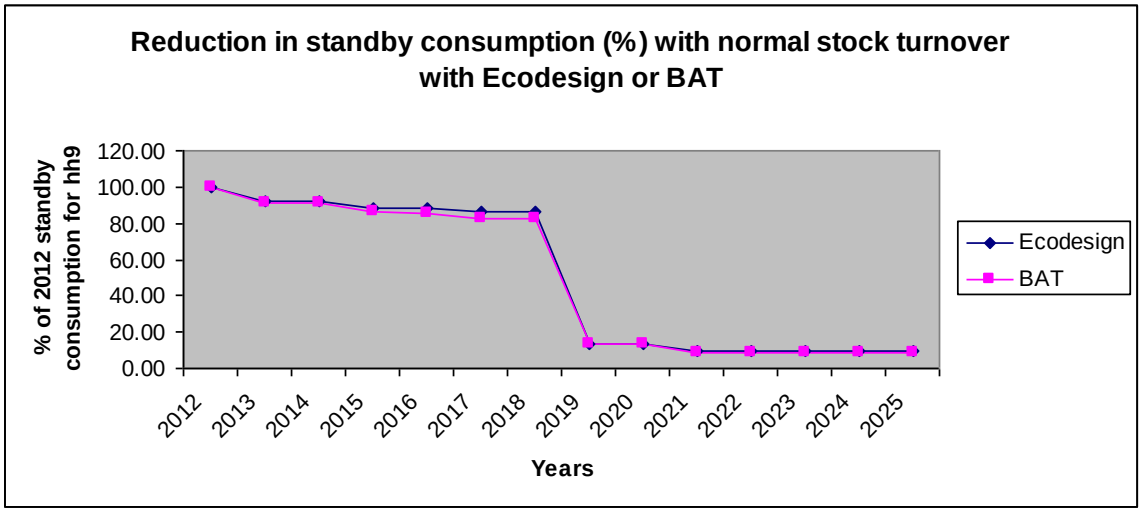

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh4
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

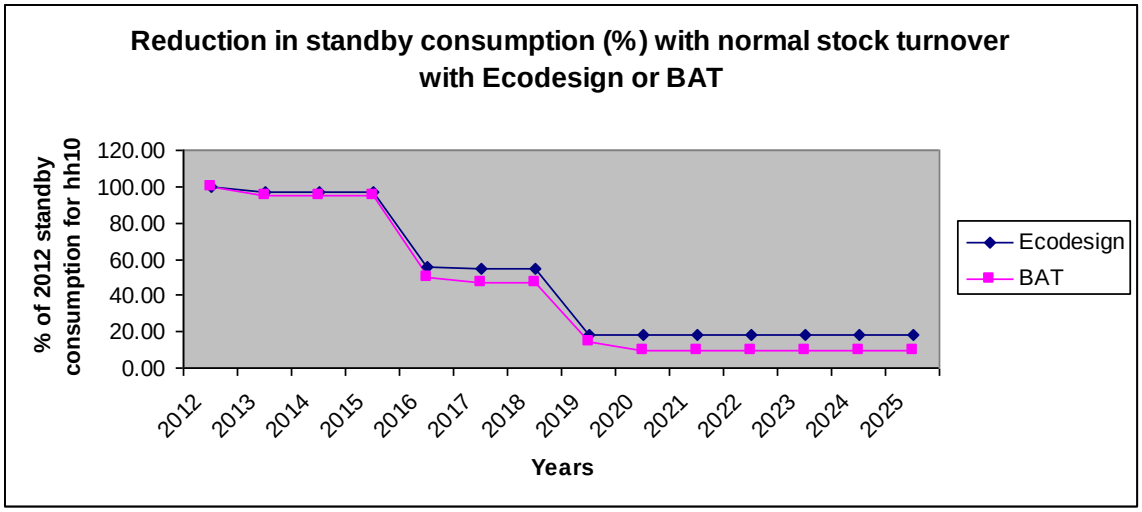

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh5
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

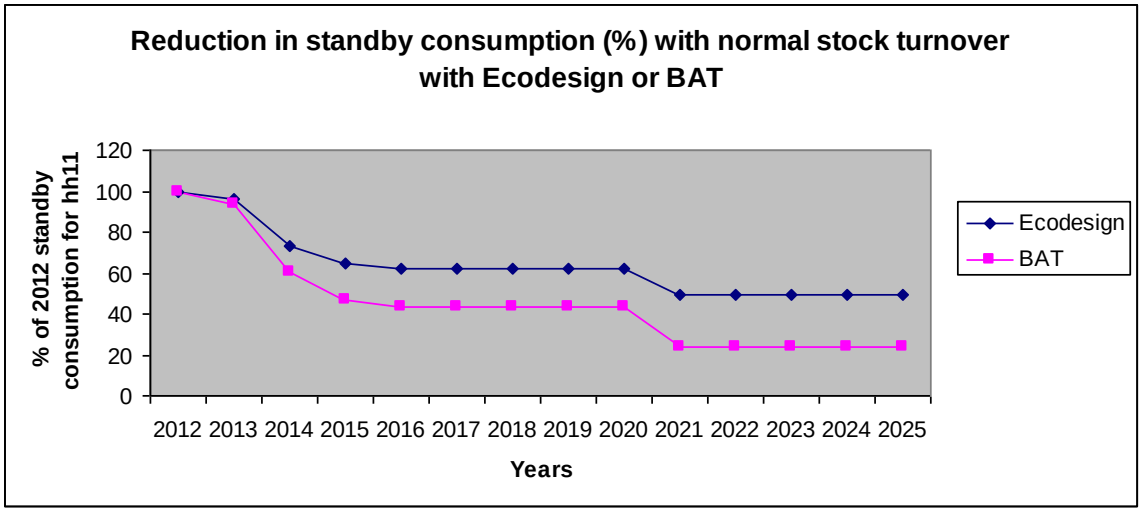

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh6
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

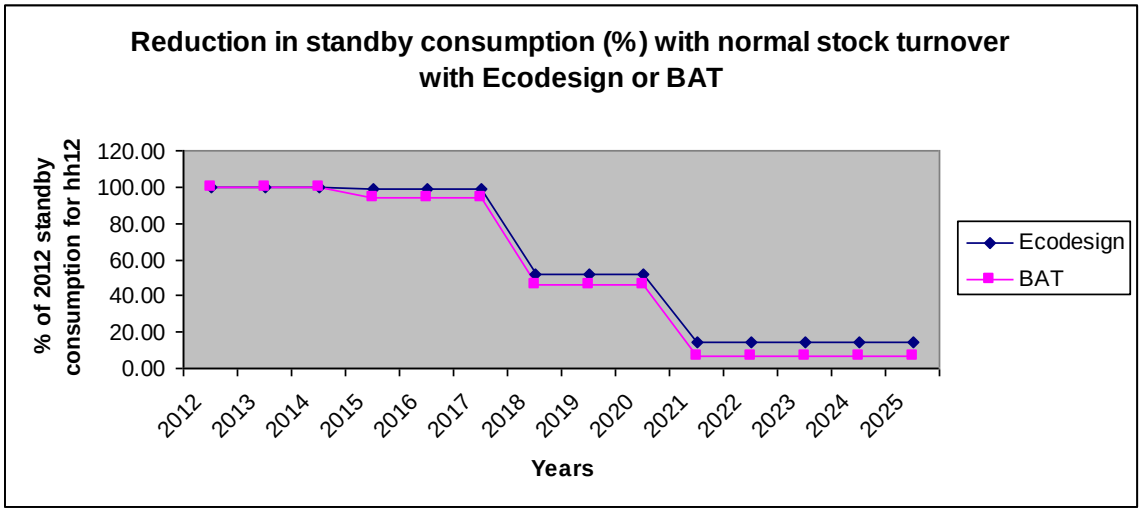

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh7
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

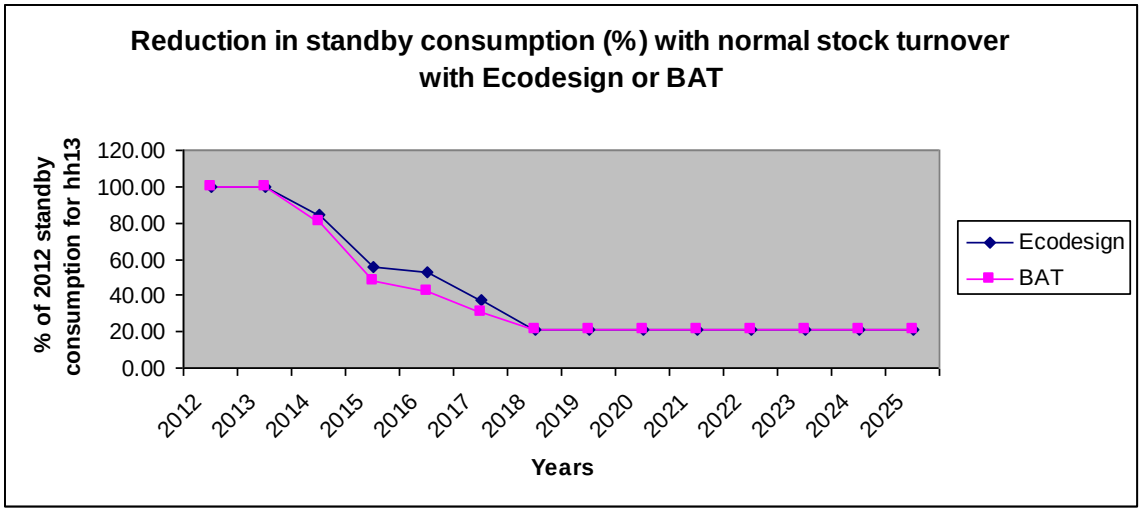

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh8
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesgn
BAT

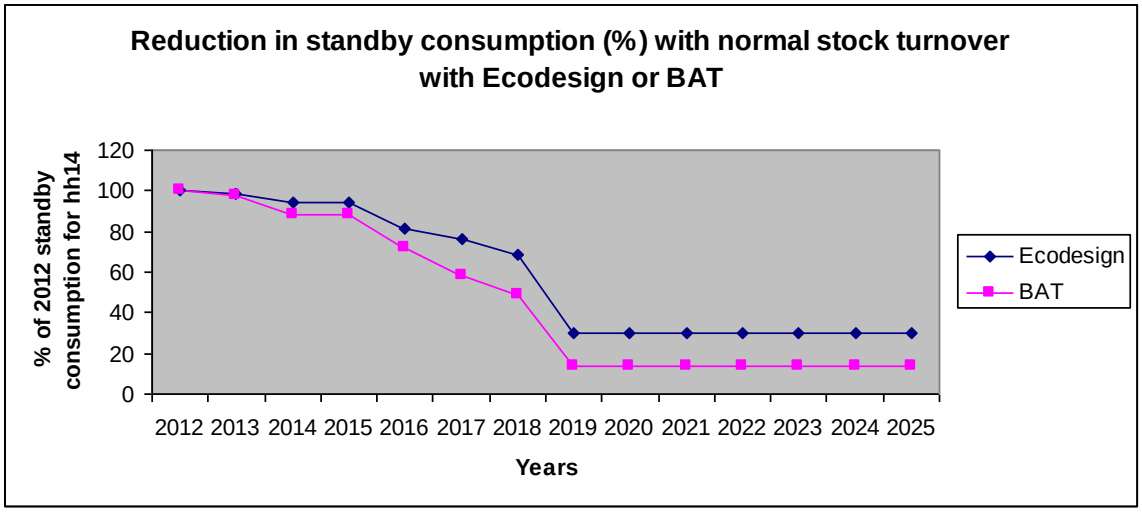

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh9
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

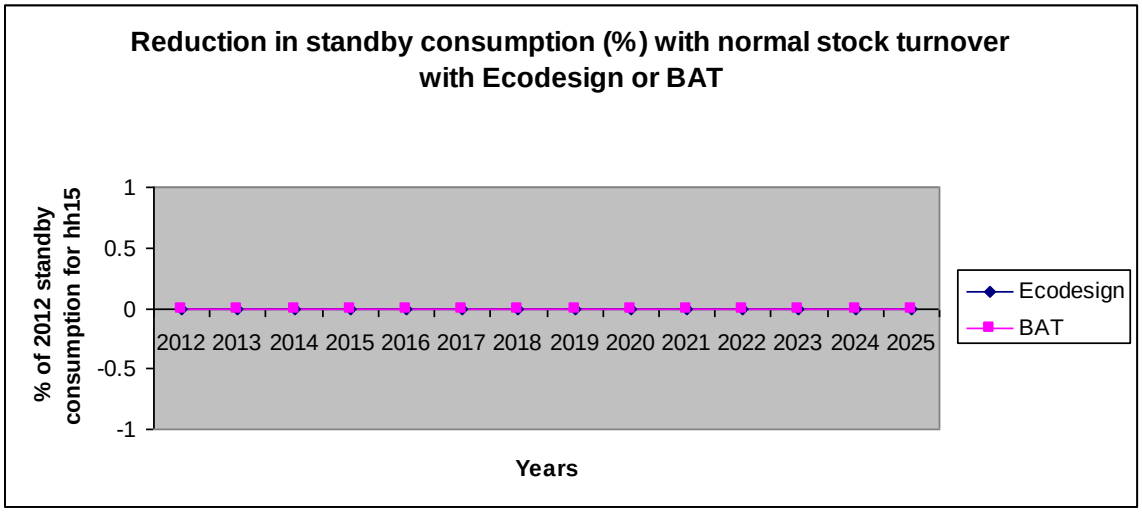

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh10
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

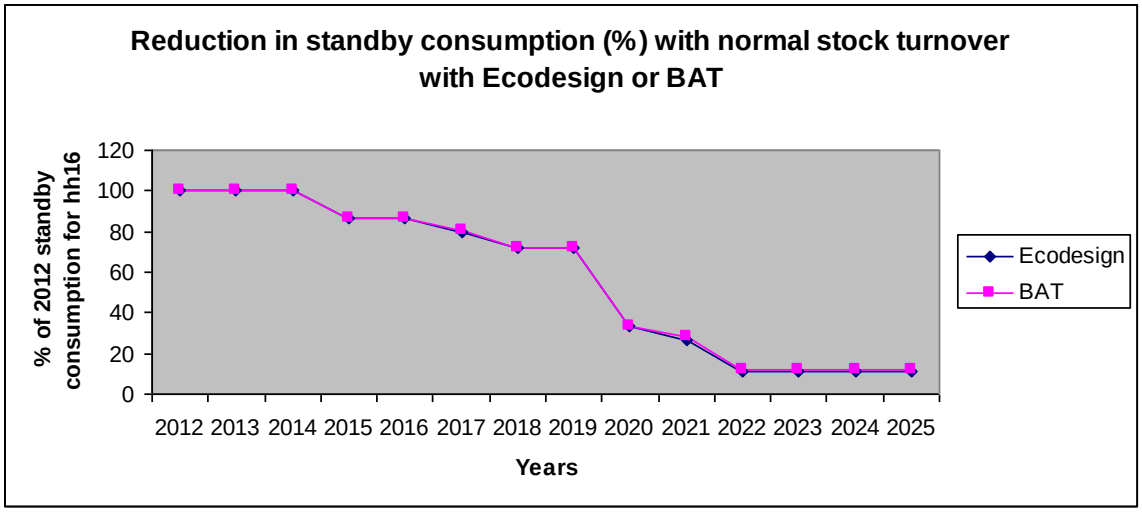

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh11
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

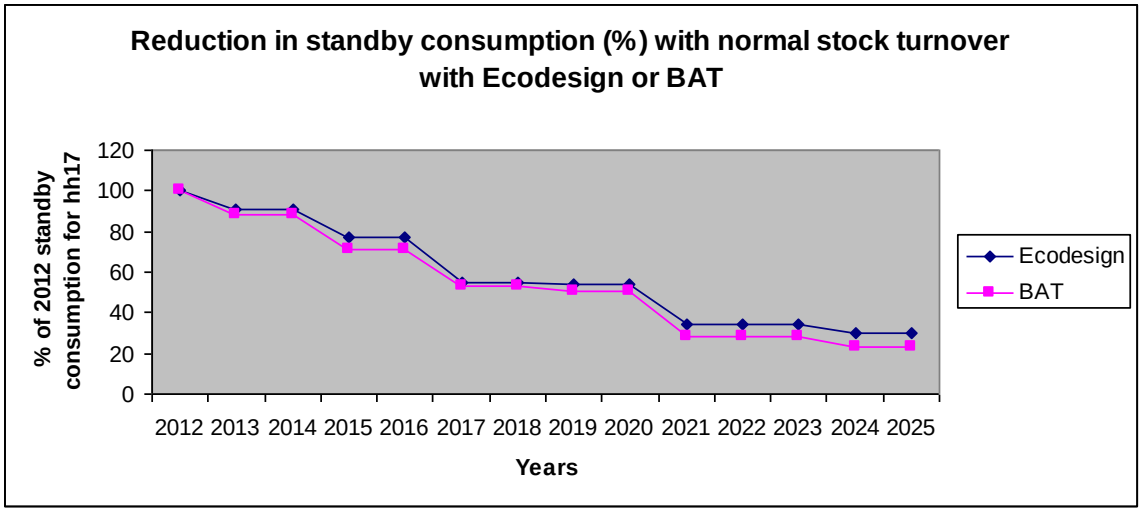

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh12
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

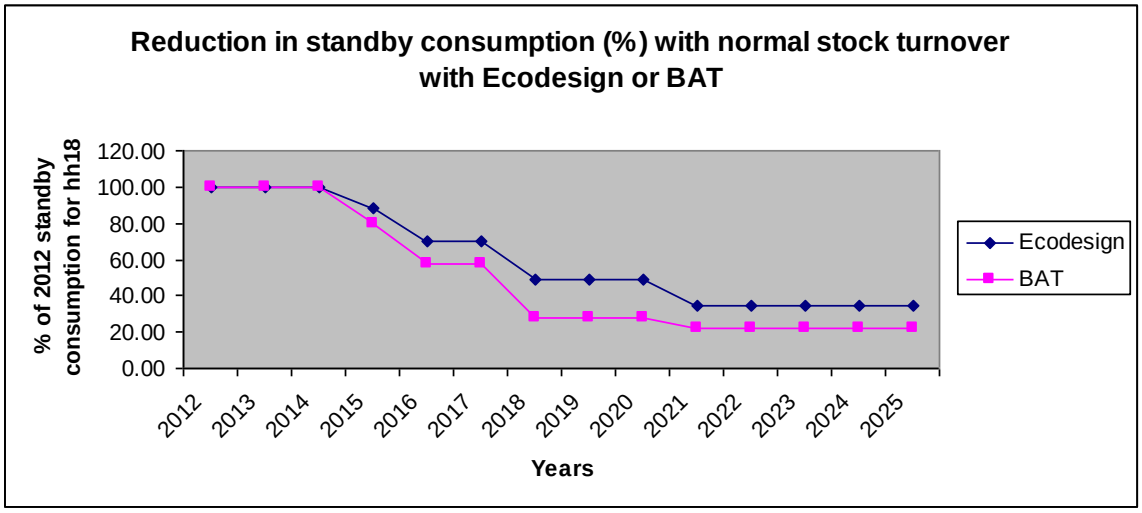

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh13
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

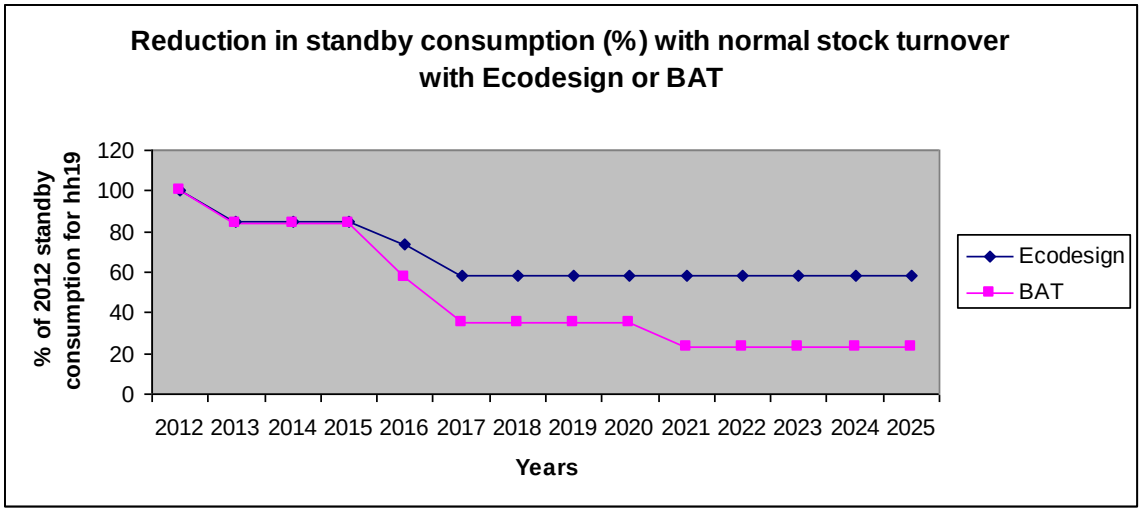

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh14
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

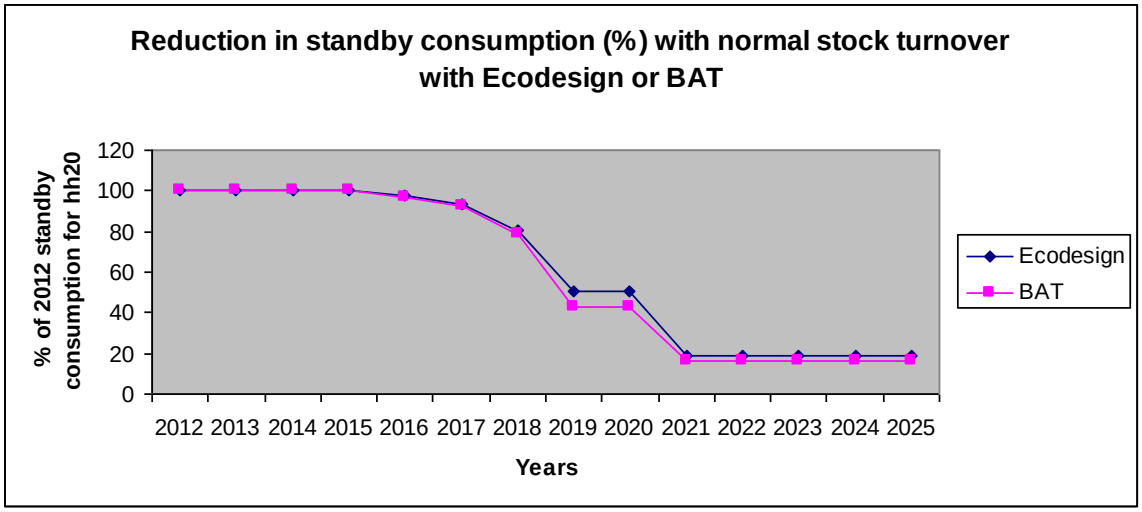

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh15
1
0.5
0
-0.5
-1
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

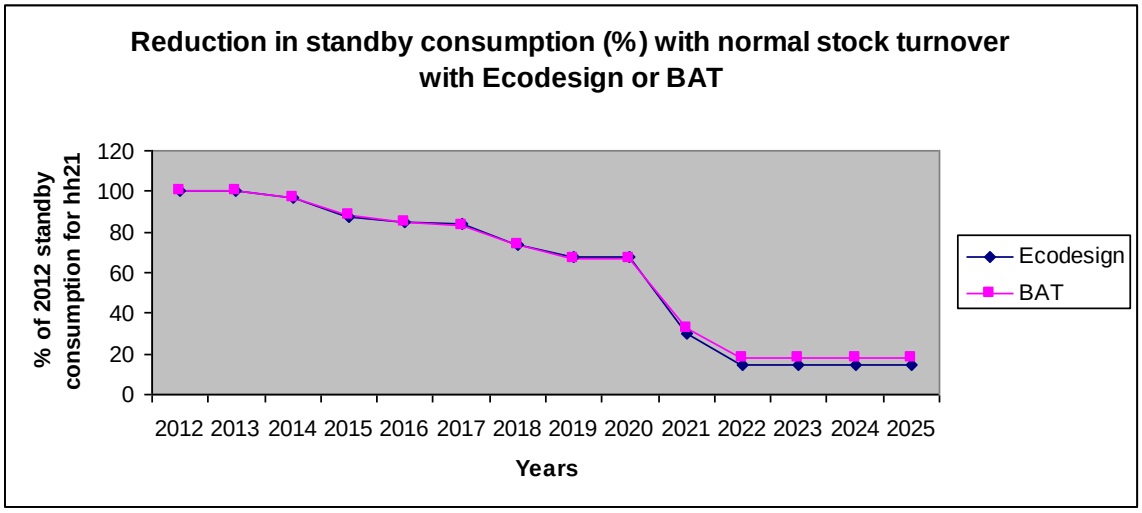

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh16
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

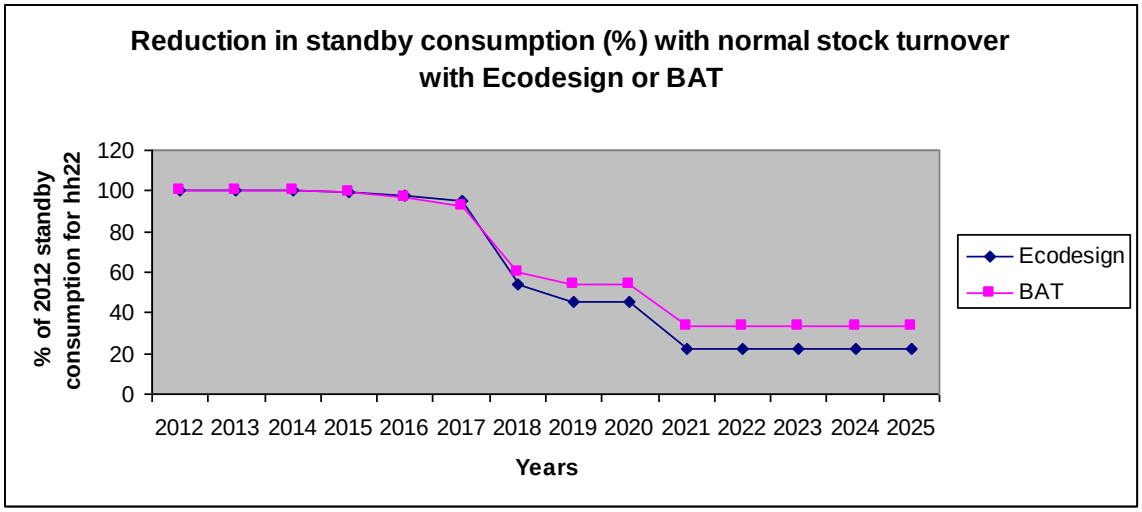

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh17
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

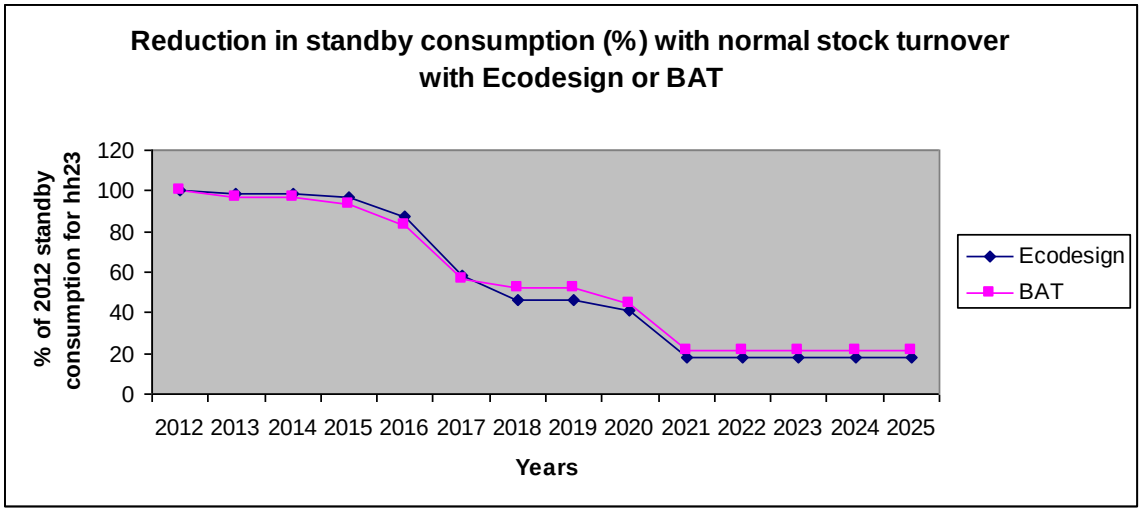

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh18
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

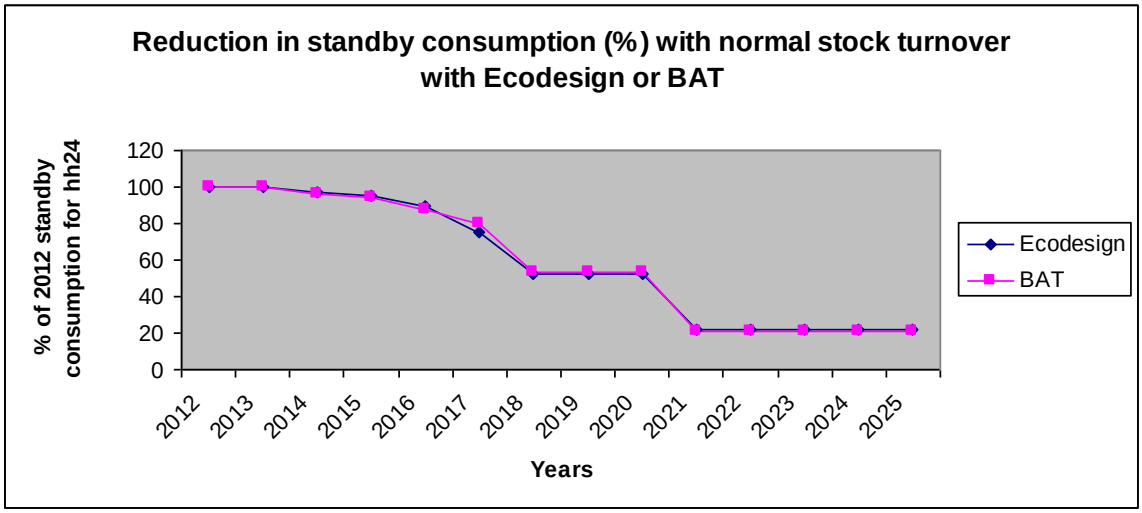

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh19
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

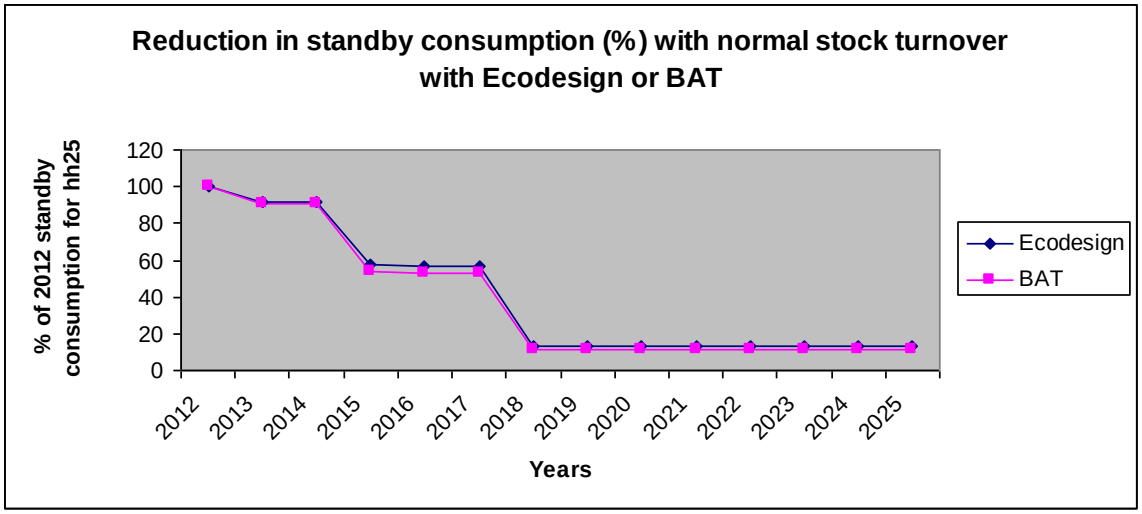

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh20
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

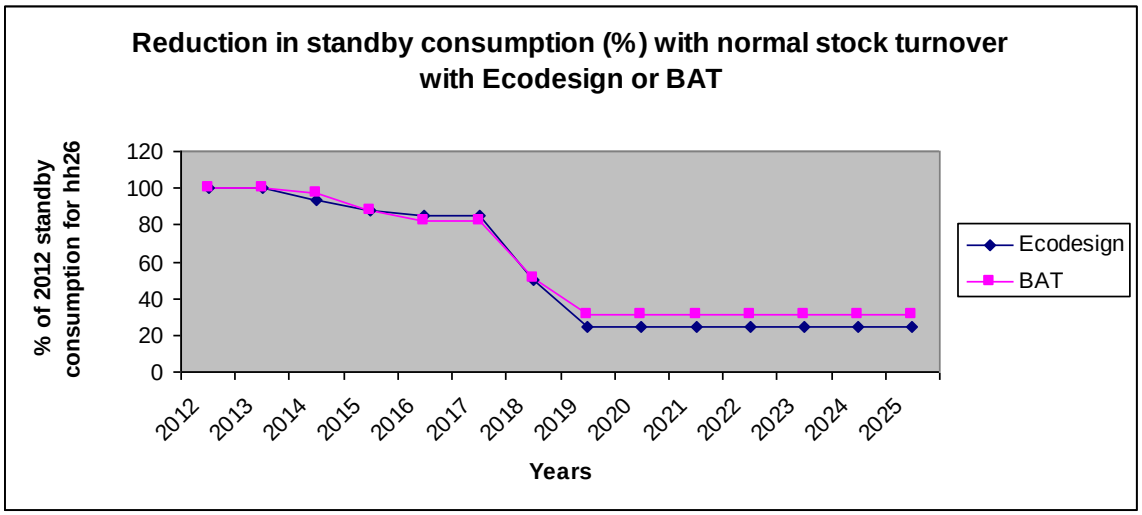

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh21
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

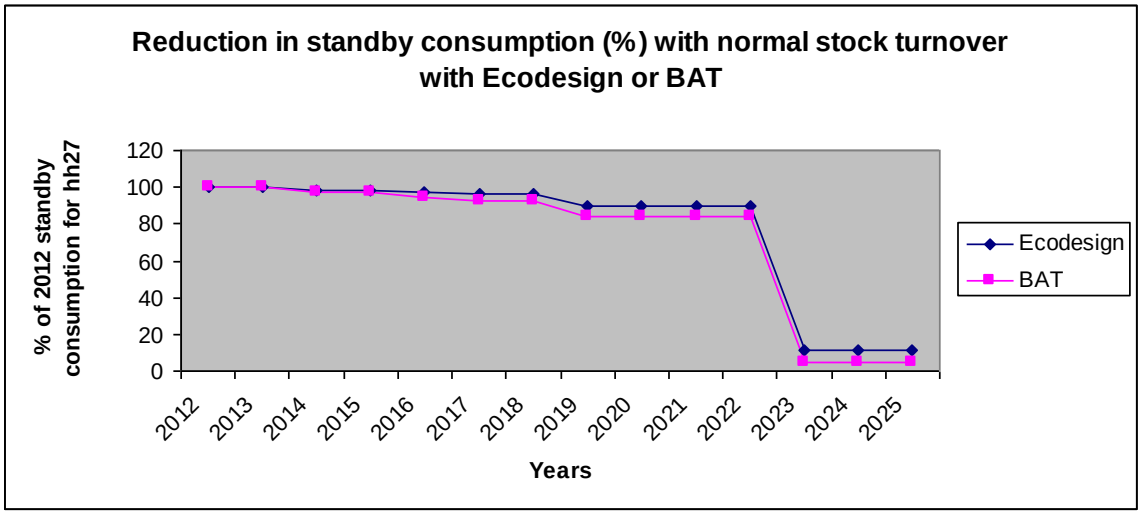

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh22
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

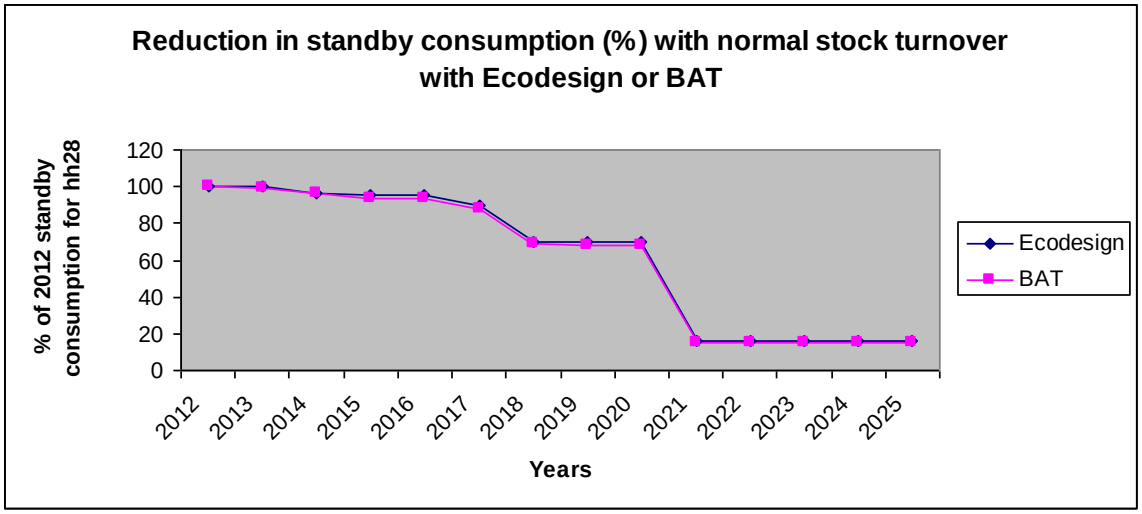

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh23
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

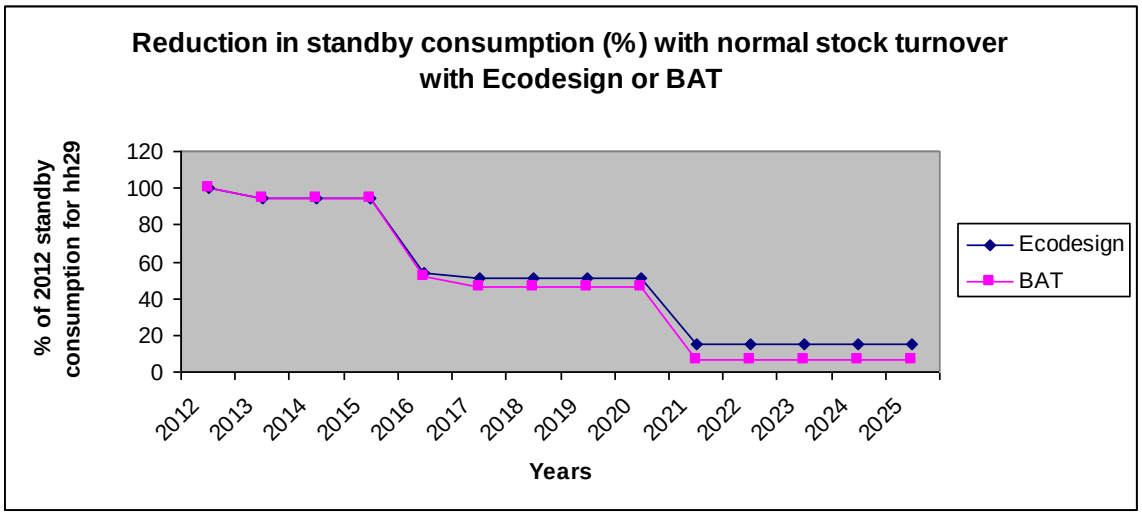

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh24
120
100
80
60
40
20
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Years
Ecodesign
BAT

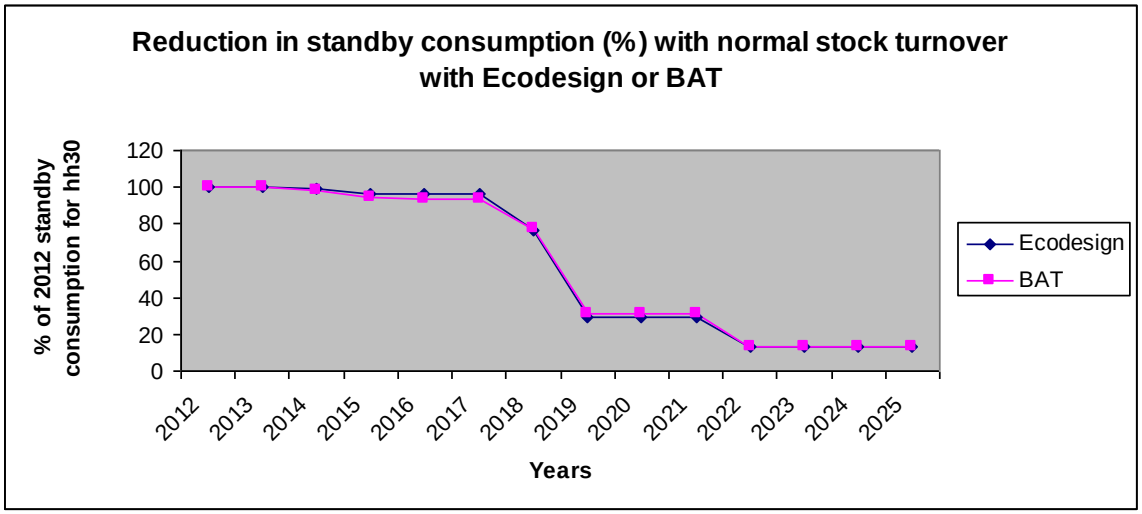

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh25
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

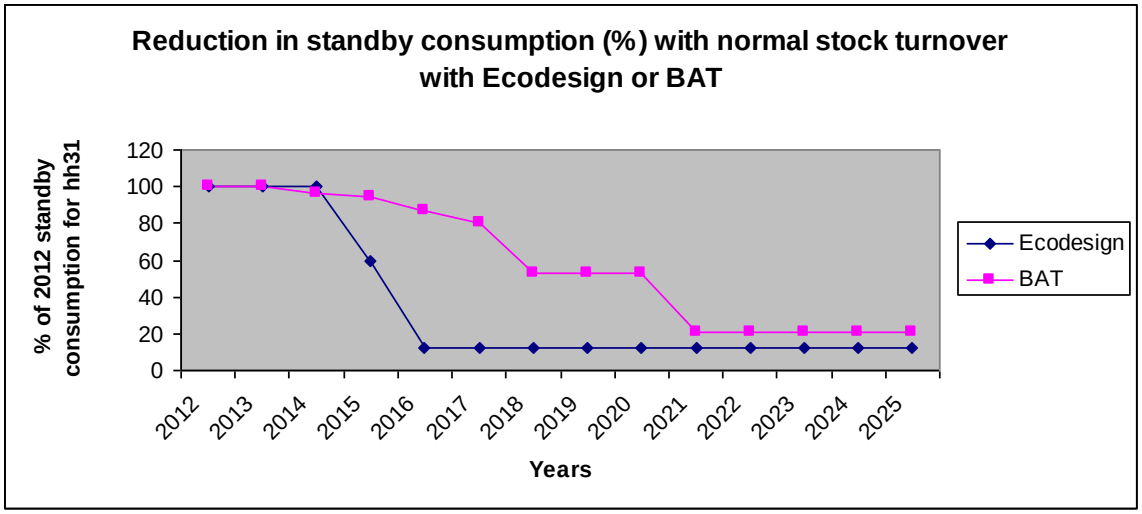

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh26
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

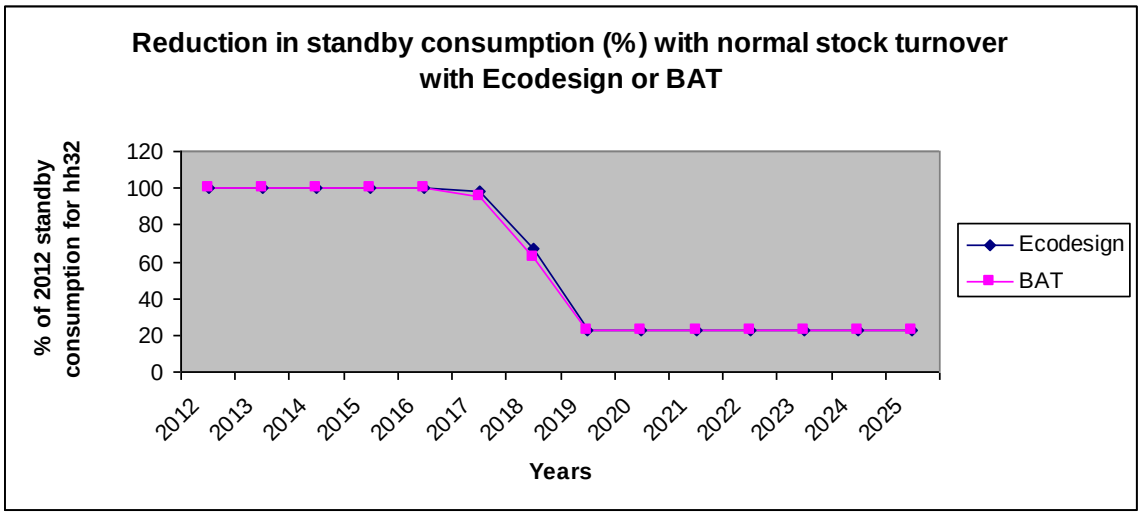

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh27
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

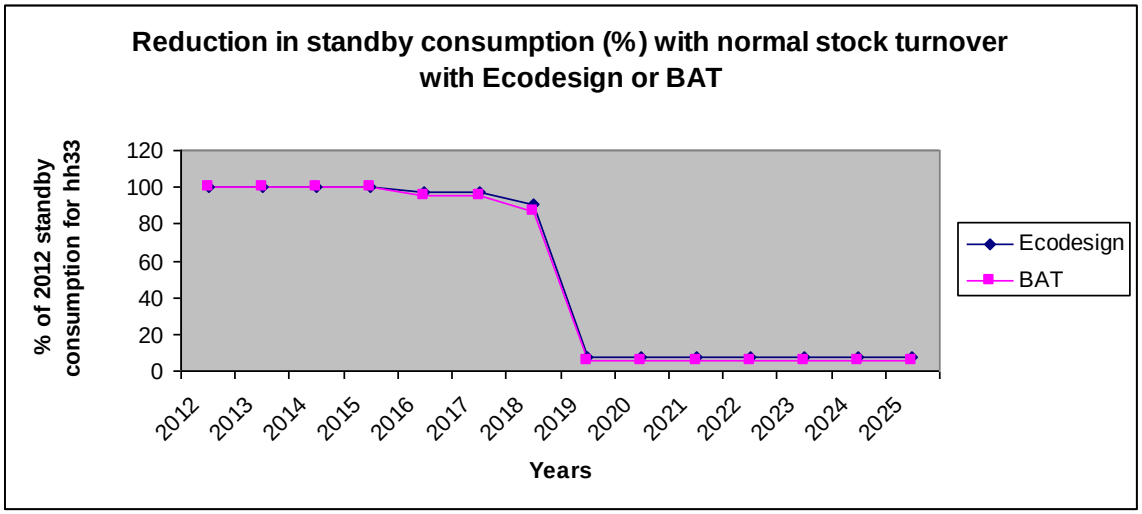

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh28
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

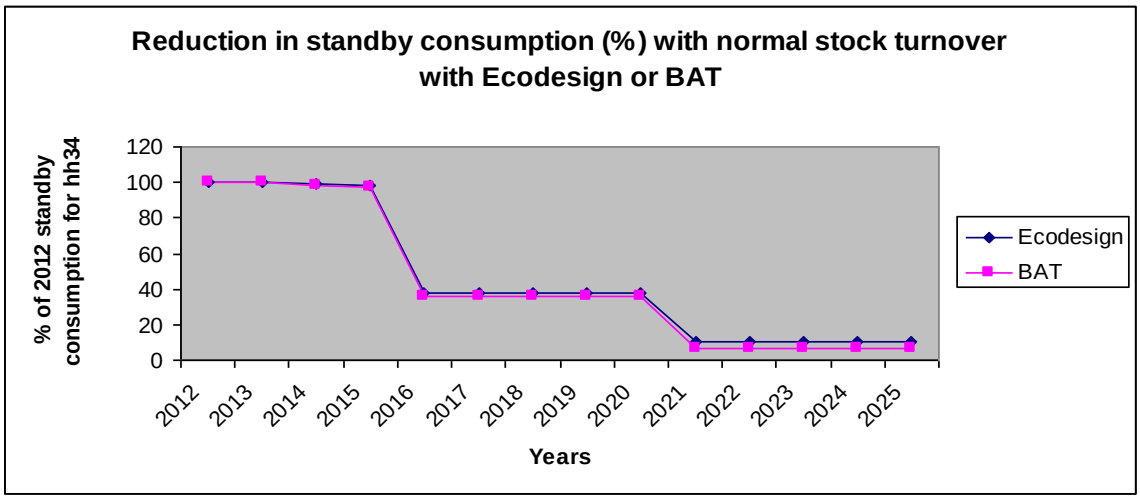

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh29
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

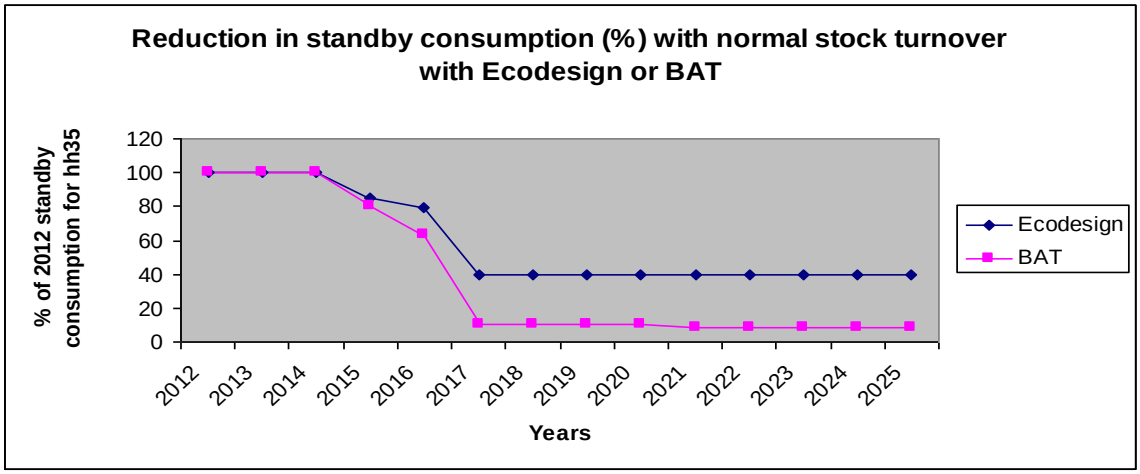

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh30
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

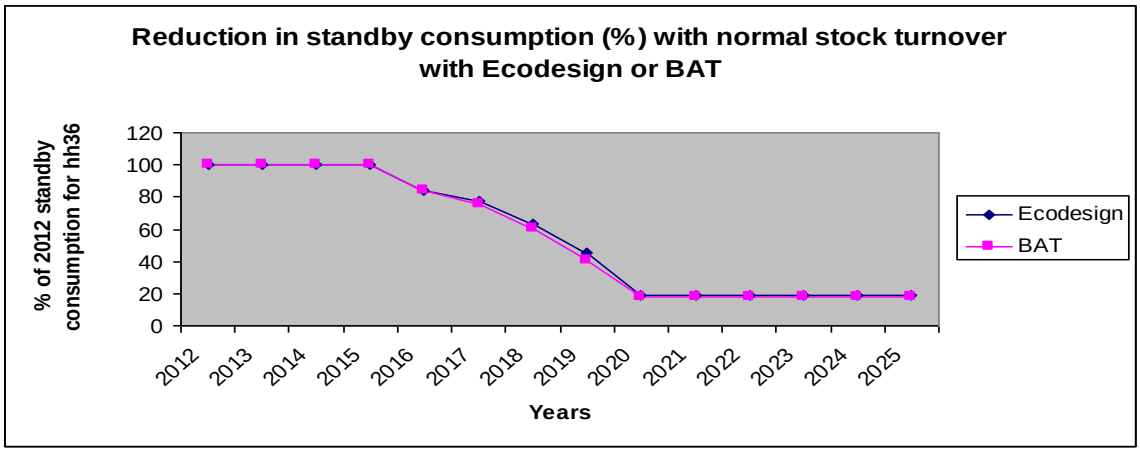

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh31
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

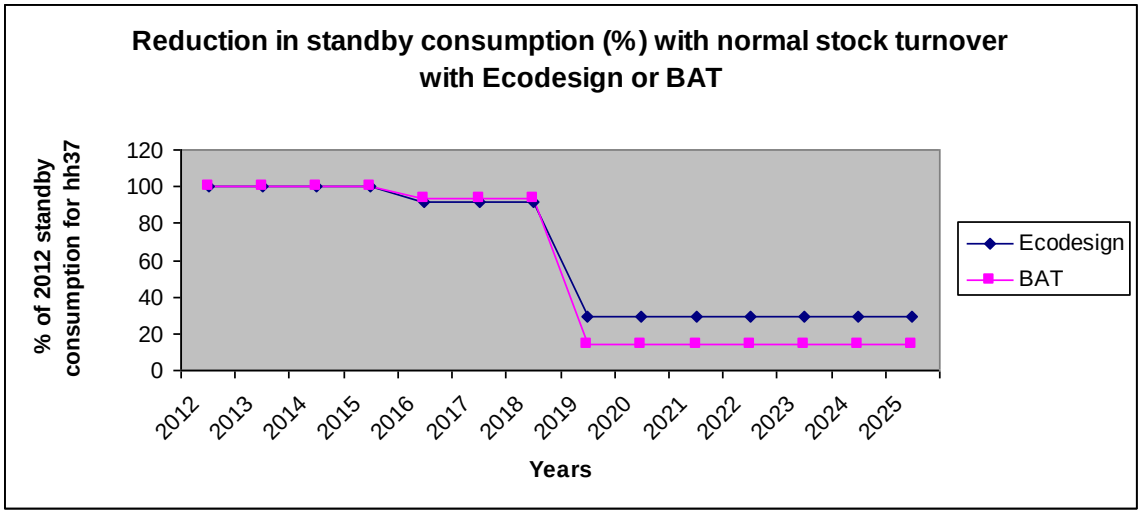

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh32
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

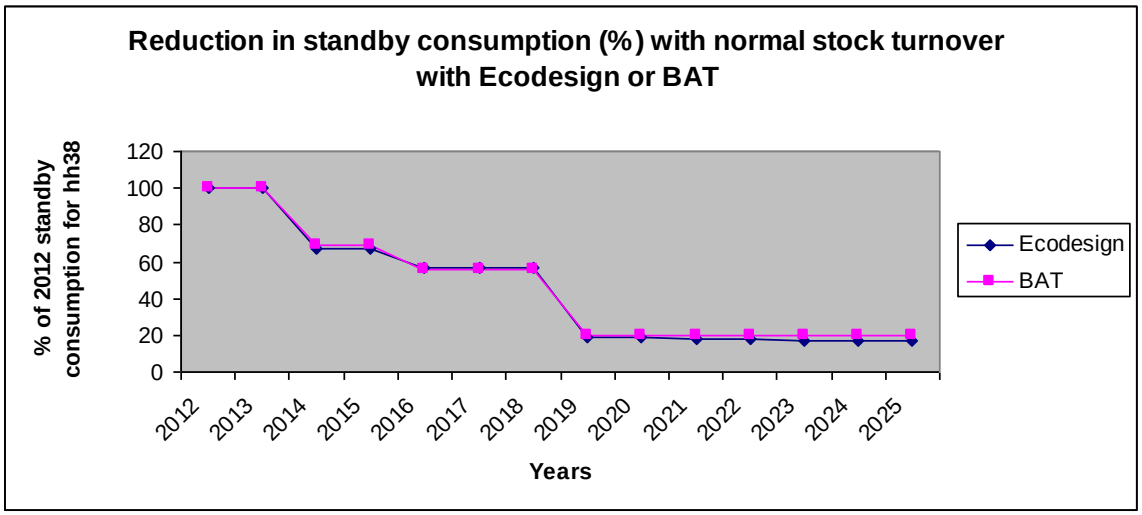

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh33
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

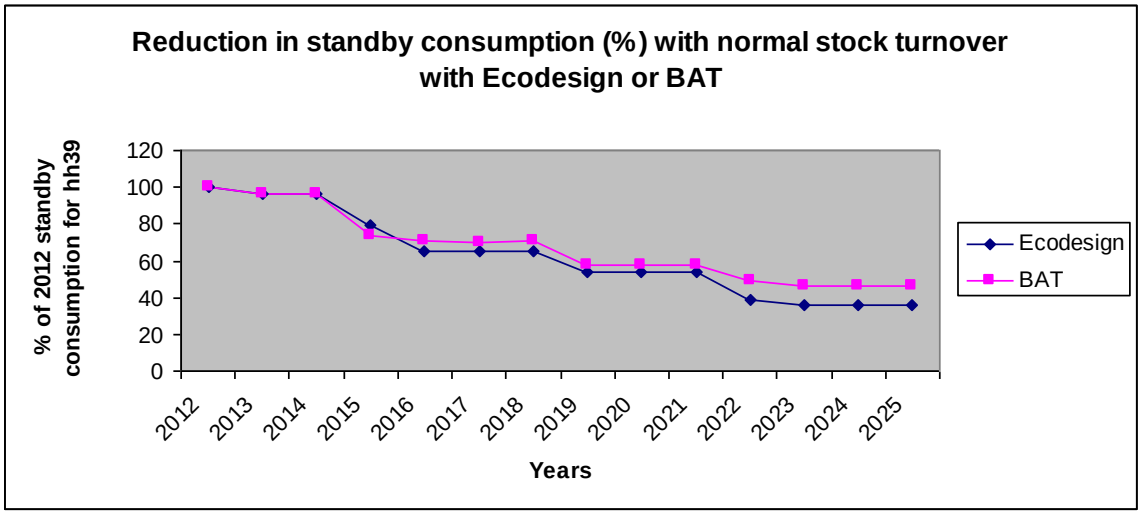

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh34
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

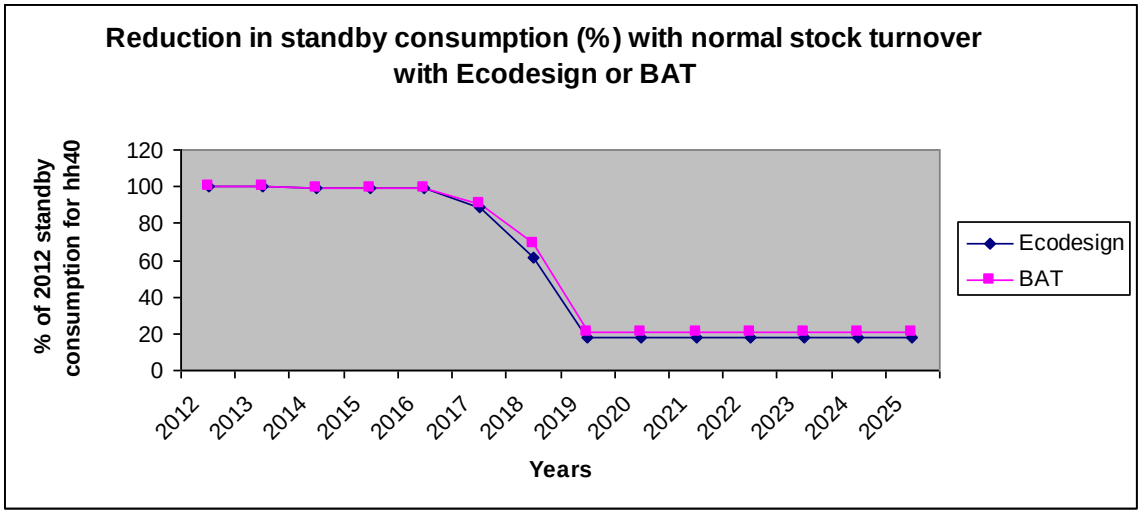

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh35
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

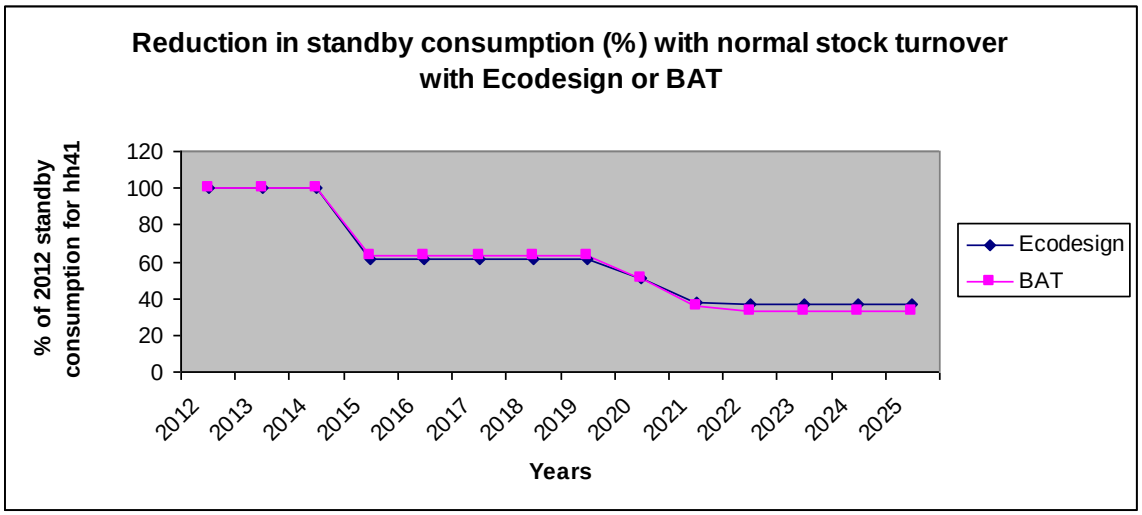

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh36
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

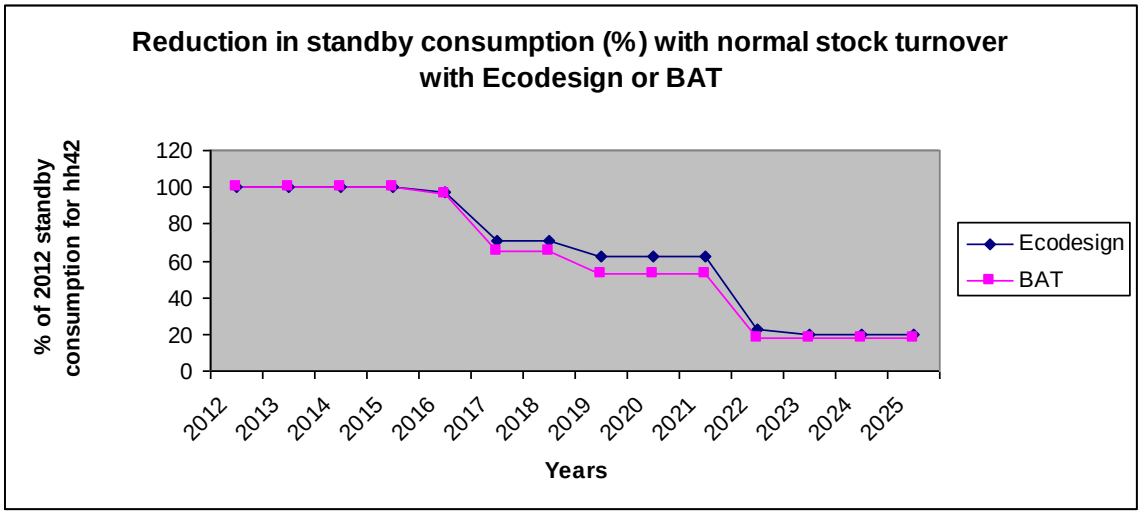

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh37
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

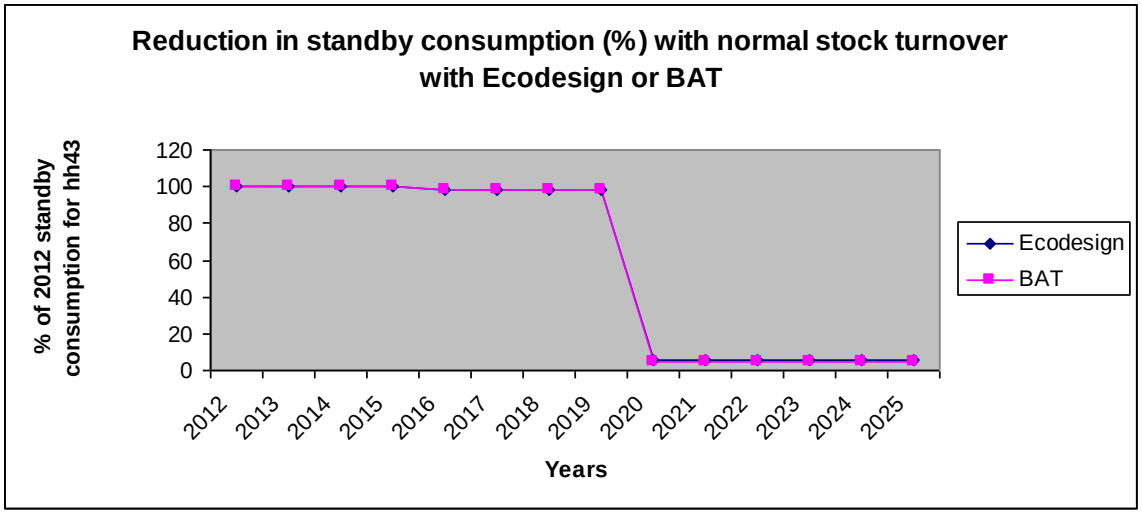

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh38
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT

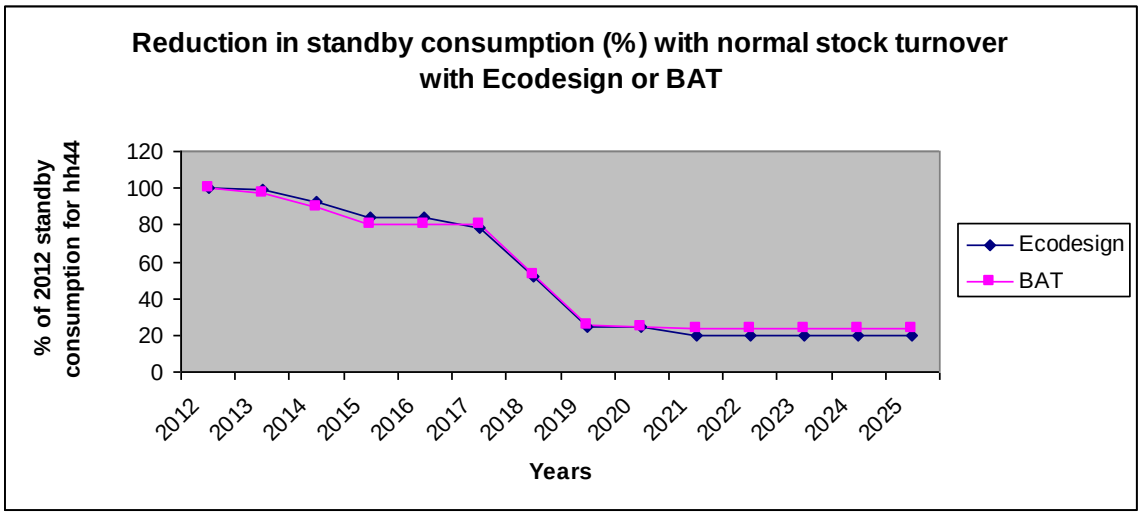

Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh39
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT


Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh40
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT


Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh41
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT


Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh42
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT


Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh43
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT


Reduction in standby consumption (%) with normal stock turnover with Ecodesign or BAT
% of 2012 standby consumption for hh44
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Years
Ecodesign
BAT