Assessment of Standby Power Utilisation in New Zealand

Inge Flinte

A thesis submitted for the degree of

Masters of Technology in Energy Management

from Massey University, Palmerston North.

May, 2003

Resubmitted November 2004

Abstract

"Standby Power" refers to a product or appliance that is connected to a power source but does not produce any sound or picture, transmit or receive information or is waiting to be switched "on" by a direct or indirect signal from the consumer. This includes the "off" mode, even where there is no remote control.

Standby Power is currently a global problem in the developed world and is estimated to be responsible for 1.5 % of total electricity consumption. It contributes 0.6 % (68 million tons) of CO_2 emissions from the electricity sector. At the present time, standby power is a relatively new concept with very few statistics available on the standby power consumption in New Zealand.

To date New Zealand has not considered standby power to be important. While almost all first world countries are introducing legislation and making active movements toward reducing standby power in new appliances, New Zealand has yet to take action. There is a growing awareness of standby power in New Zealand that has gained some media coverage. However from this study it is clear that although 89% of surveyed consumers had heard of standby power, the general consumer was unaware of the extent to which standby power is emitted through appliances and the amount of power and money it consumes nationally per year. In the midst of a power crisis (at the time of writing, June, 2003), New Zealand has the capability to reduce power consumption by 10%, by turning all appliances off onto standby. Unfortunately, the lack of consumer education in regard to the extent of wastage in standby power in the average New Zealand household inhibits this saving from being made.
The possible future directions for New Zealand as a result of this study are as follows.

- Legislation needs to be put into place in New Zealand to encourage manufacturers to reduce standby power consumption of new appliances. This will help to bring New Zealand manufacturers up to standard with places like the USA, Europe, Australia, Japan and China, who are already taking active steps to reduce standby power. Legislation in other countries has shown that mandatory legislation is hard to police. A campaign educating the consumer on energy labelling and the cost of standby power teamed with a voluntary manufacturers' scheme to lower standby power consumption (using the worldwide energy star label) would be potentially effective. Previous studies

have called for a worldwide standardised standby power labelling scheme. This scheme is seen as being necessary as many New Zealand products are being manufactured overseas. The following changes need to take place to take an active approach to reducing standby power wastage:

- Research into the standby consumption of the commercial and industrial sectors within New Zealand.
- Improvements in energy labelling. Consumer education and awareness campaign with regard to energy labelling, needs to take place on a public arena.
  Energy labels need to be simplified so the average New Zealander can understand the energy emitted through standby power on market appliances and the amount that standby power costs both on a nation wide scale and to the individual consumer.

Acknowledgements

There are a number of people that contributed to my Masters Thesis that I would like to thank for their special help in what was a challenging and stimulating experience.

Firstly, I would like to acknowledge the generous financial help NZFRST gave me with their scholarship which enabled me to achieve this project. Fisher and Paykel Appliances and EECA provided me continual support, both financially and practically and their help was an integral to the carrying out and completion of this project. I greatly appreciated the generous EECA provided me with funding through their Bright Enterprise Scheme. I would like to thank Mr Richard Butler and Mr Bill Currie, managers at Fisher and Paykel for their informative interviews and for the time and equipment they lent me in allowing me to carry out tests at their site. Their help was invaluable. A further acknowledgement is in order for Farmers Trading Co, Dunedin, New Zealand Bond and Bonds and Smith City for their patience in letting me test within their sites.

The Massey University Centre for Energy Research provided me with the financial assistance to carry out this Masters Thesis through Massey University. I only hope that this thesis lives up to their expectations and provides them with vital research on which to base further investigation.

I would like to acknowledge and thank Professor Ralph Sims for his advice, direction and thoughtful ideas which were always tastefully worded and inspirational. His knowledge and supervision guided this research and helped me through some difficult interpretation in the drafting and final processes of this thesis.

Finally, I would like to acknowledge and thank all my family and friends for their support during the time of completing this thesis and throughout the course of my degree. Abigail Claridge was invaluable in her help with the fine tuning of this project and in the final presentation.

Table of Contents

Tables

Figures

1.0 Introduction

1.1 Introduction

In the late 1980's, researchers studying residential buildings began to notice the importance of plug loads; the miscellaneous power that could not be accounted for in total electricity use. These plug loads accounted for nearly 20% of residential electricity demand (Meier, 1987). Researchers continued to investigate ways of reducing plug loads throughout the 1980's and introduced 'sleep modes' that computers, printers and other office equipment would enter into after a period of inactivity. Until recently, there was little concern with the energy consumption of an appliance in 'sleep mode', as it appeared to be a low cost problem. However, in the late 1990's, researchers realised that standby power was responsible for up to 13% of all residential power consumed in developed countries (Lebot, Meier & Anglade, 2000). Standby power has now gained recognition as a significant user of electricity. Studies have shown that video cassette recorders (VCRs) can consume more electricity when in standby mode than when in play or record mode (Ross and Meier, 2000). A study in New Zealand revealed that over 40% of microwave ovens in standby mode, which powers the clock and keyboard, consumed more electricity throughout the course of a year than they did during the entire time they were used for cooking. (Energy Efficiency Conservation Authority, 1999).

1.2 Standby Power Definition

The International Electro technical Commission (IEC) has written a draft document for the measurement of standby power which included the following definition:

"The lowest power consumption mode which can not be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions."

This definition will be used within this thesis. However there are other 'low power modes' associated with standby power, which do not necessarily come under the definition suggested by the IEC, but nevertheless account for a percentage of standby power demand.

1) Active Standby Mode

This is when the appliance is ready to be used, but not carrying out its primary function. For instance, a VCR or stereo that is turned on but not actually playing is in active standby mode. Active standby mode is also applied to cordless appliances and re-charging systems when they are turned on but not charging (International Energy Agency, 2001).

2) Passive Standby Mode

Passive Standby Mode is when an appliance is switched into standby or "off" mode but can be activated using a remote control. Passive standby also applies to appliances that are performing a secondary function such as a clock or the powering of a keypad International Energy Agency, 2001).

3) "Off" Mode

The off mode refers to an appliance that is turned off using the main power supply switch on the appliance and has no obvious function. It is not possible for the appliance to be activated using a remote control (International Energy Agency, 2001).

Depending on the type and the design of the appliance, it is possible one or all of the above low power modes are present. This is exemplified by the fact that most televisions (TV's) have an off-mode (turned off at the set), passive standby mode (the TV is off but can be activated by the remote control) but no active standby mode. A VCR generally has a passive and active standby mode whereas a microwave only has a passive standby mode (powering of keypad and clock). Depending on the brand, design and type of appliance, different low-power modes can be present. The least low-power mode is defined as being standby power. This can cause confusion as some appliance groups have differing low power modes depending on the brand. For example, some microwaves only have a passive standby mode because they possess secondary functions (i.e. powering a clock and keypad).In comparison; other microwaves employ analogue technology and only have an off-mode (no clock or keypad to power). It is difficult to compare the standby data for a set of products such as microwaves as some are designated to be in standby power while in reality, they are in off mode. Furthermore, other microwaves are in standby mode when they are actually in passive standby mode (International Energy Agency, 2001).

1.3 Project Aim

The aim of this project is threefold. Firstly this project will ascertain the amount of energy consumed by appliances in the standby power mode. Secondly, it will investigate the consumer response to standby power mode in conjunction to the findings of this project. The last section of this project will evaluate the methods employed to reduce inefficient use of electricity used in standby power mode.

1.4 List of Project Objectives

The numerous facets of standby power that were researched cover four broad areas:

a) The standby power consumed by individual appliances thereby pinpointing high use appliances;
b) Minimising standby power via legislation, long term solutions, consumer education, and improved appliance design;
c) Consumer awareness and behaviour in regard to standby power consumption and appliance labelling.
d) Current relevant legislation and the future direction of both voluntary and compulsory regulation in New Zealand and overseas.

2.0 Literature Review

2.1 Objectives of the Literature Review

This literature review focuses on the methods used to collect standby power, information and consumption data, relevant international findings, the legislative and practical steps to reduce standby power demand being taken overseas, and the latest progress to reduce standby power demand by technological developments.

2.2 Standby Power Measurement

There are three ways of gathering standby power data:

- whole house measurements
- bottom up studies
- new product measurements

Each method of gathering data is outlined in the studies below.

2.2.1 Whole house measurement

Field studies of whole house measurement rely on two techniques:

a) measuring the standby power of each appliance in the house;
b) measuring whole-house consumption which can be found on the domestic power meter when all appliances that do not consume power in standby mode are turned 'off'. These include all appliances that are hard wired, but have no remote control i.e. a security system or an alarm clock.

By comparing the two results, researchers can determine whether any appliance with standby power has been inadequately omitted from the analysis (Rainer et al, 1996). The whole-house measurement can be a very credible way of estimating standby power (Bertoldi et al, 2002). Several factors however can bias this estimate:

- Identifying test homes can be difficult and researchers generally have to rely on volunteers allowing investigations to be undertaken in their homes. This affects the investigator's ability to attain a representative sample within a district or area. Another possible bias may be created if more energy conscious people respond than those who are not, thus hindering a true representation of the range of people within a community.
- The fact that it is easy to overlook appliances during the audit phase can produce poorly calculated results. Another hindrance is the physical difficulty that presents itself

when hard wired appliances are being measured such as security systems, ovens and dishwashers.

Currently, at least 21 surveys of whole-house standby power consumption have been compiled. These results are outlined in table 2.1.

Table 2.1: Standby power energy consumption and capacity per household from 21 whole-house studies conducted in 13 countries since 1997.

Country/Region	No. of Homes Surveyed	Year of Survey	Standby Power Use (W) per household	Standby Energy Consumption (kWh/year)
Australia (Harrington and Kleverlaan 2001)	64	2000	87	760
Australia (Harrington 2002)	1	2001	112	980
Canada/Nova Scotia (Aulenback et al. 2001)	79	2001	38	329
China/Beijing (Warner et al. 2002)	42	2001	33	n.a.
China/Guangzhou (Warner et al. 2002)	115	2001	35	n.a.
Denmark (Sidler 2001)	100	2001	60	530
France (Sidler 2000)	178	1999	38	235
France/Paris (Lebot 1999)	1	1999	70	600
Greece (Sidler 2001)	100	2001	50	440
Italy (Sidler 2001)	100	2001	57	500
Japan (Nakagami et al. 1997)	36	1997	60	530
Japan (Nakagami 2001)	42	2000	45	398
Japan/Tokyo (Muarakoshi 2000)	1	1999	80	700
New Zealand (EECA 1999)	29	1999	100	880
Portugal (Sidler 2001)	100	2001	46	400
Sweden (Molinder 1997)	1	1997	80	475
United Kingdom (Vowles et al. 2001)	32	2000	32	277
USA/California (Ross & Meier 2000)	10	2000	67	590
USA/California (Meier & Lebot 2002)	4	2001	115	1,010
USA/Colorado (Gellar 2002)	5	2001	46	405

Source: Meier & Lebot, 2002.

The field survey conducted in France (Sidler, 2000) is said to be one of the largest end use studies in the world at 178 homes, and the chief single compilation of standby power data. Investigations in China follow closely with a field of study consisting of 115 houses (Lin et al. 2002) Comparatively, New Zealand and Australia have two of the highest standby readings per household (Harrington, 2002). This may have been affected by the differences in voltage or the differences in testing methods used. In total, these 20 whole-house studies have measurements taken from over one thousand homes around the world. Studies are not fully comparable however because of diverse approaches to measurement procedures and differing definitions of the word "standby."

2.2.2 Bottom up studies

Bottom up studies require measuring hundreds of appliances, both new and old. The average annual standby usage of each appliance is multiplied by the average saturation (in terms of percentage of homes which own them) of the appliance measured (this may differ from country to country). The process is repeated for each appliance found in the home. The total electricity consumption for all appliances is then divided by the number of homes in the country to give the average standby consumption per home (Anglade et al, 2002).

This method is illustrated by the following example. Fifity TVs are measured and show an average standby power of 4Watts. The average home has 2.3 TVs, therefore the standby power per home for TVs is 9.2Watts (Bertoldi et al, 2002). To every one million homes, this equates to 9,200,000W of standby power. If each TV is on standby for 20 hours per day on average, the result is calculated at 67,160,000 kWh consumed per year (Bertoldi et al, 2002),. A table of results can be found in table 2.2 representing bottom up studies conducted throughout Germany, Switzerland, the Netherlands, Australia and the United States of America (USA). German and the Swiss studies relied heavily on standby measurements of new appliances reported in consumer magazines (Meier & Lebot, 2000).

Table 2.2: Average standby power use and fraction of total residential electricity use from 7 bottom up studies that have been conducted since 1995.

Country (Reference)	Year of survey	Average standby power use per home (W)	Fraction of total residential electricity use	Other Items (Included in addition to TV's, VCR's, set-top boxes*)
Australia (Harrington & Kleverlaan, 2001)	2000	86	12%	All; included a few heating devices and defective units
Canada (Aulenback et al. 2001)	2001	41		All
France (Sidler, 2000)	2000	38	7%	All
Germany (Rath et al. 1997; Cremer and Boede, 2001)	2001	52	n.a.	All; may include some heat standby
Netherlands (Siderius, 1995)	1995	37	10%	None
Switzerland (Meyer & Schaltegger AG, 1999)	1999	19	3%	Stereos, some rechargeable appliances, PCs
USA (Rainer et al. 1996)	1996	50	5%	All

Source: Meier & Lebot, 2002 * Set-top boxes are commonly known as sky decoders.

Bottom up estimates are usually acceptable for common appliances but are not necessarily accurate for 'minor' appliances because less information is often available about their market share. As a result, bottom-up estimates probably underestimate actual standby power use (Bertoldi et al, 2002). When compared, the results from table 2.1 and table 2.2 confirm that in most cases the bottom-up estimates are lower then the whole-house surveys. Preferably, a more accurate way of measuring standby power usage such as a whole house measurement can be used for calculating and examining results.

2.2.3 New Product Measurements

Measurements of new appliances are taken in stores or factories where many products can be measured at one time. The results that come from new product measurements will not match whole-home measurements, because the standby power usage of newer products differs greatly from older appliances. It has been found that many new TVs in Europe (Group for Energy Efficient Appliances 2002) and Japan (Energy Conservation Centre of Japan 2002) consume less standby power than older models typically found in homes. This methodology gives the researcher a good idea of state-of-the-art designs with regard to standby power.

2.3 Residential

Standby power estimates for countries have been fairly similar, except for a few differences. At present, according to table2.1, the USA, New Zealand and Australia appear to be in the upper average range with the highest average standby power load of approximately 115W, 125W and 112W respectively. One New Zealand estimate was based on only 29 houses (EECA 1999) which may not be a representative sample. It included appliances that do not usually fit into the accepted definition of standby such as towel racks and defective fridges. New Zealand and Australian appliances operate at 240 Volts. Anglade et al (2002) suggested that power supplies have higher losses at higher voltages. Therefore the same appliance may have higher standby power consumption in Australia than in Japan where appliances operate at 100 Volts.

The standby power load in Japan is also high (45 - 80 watts) due to the high penetration of electronic appliances and white goods with microprocessor controls (Anglade et al, 2002). According to table 2.2, Switzerland and the Argentina appear to have the lowest average standby values but this is possibly because only the most widely used appliances were included in the survey (Anglade et al, 2002). Through data analysis and as shown in table 2.1 with a standby power usage of 35 Watts, it has been found that less-developed countries such as China have a higher standby consumption of common appliances in comparison to developed countries such as the USA (whose standby power usage stood at 115 Watts in table 2.1) due to a large stock of older, less-efficient appliances (Bertoldi et al 2002). At present there is no information regarding standby power consumption in South Asian areas like India and Pakistan, South America and Africa. Bertoldi et al (2002) stated that although comprehensive studies need not take place, it is important to pinpoint standby usage variations between countries to influence what policies will be most effective in reducing standby power use.

2.3.1 Australia

Harrington and Kleverlaan (2001) carried out a study of standby power for the Australian Greenhouse Office (AGO) and the National Appliance & Equipment Energy Efficiency Committee (NAEEEC). The study aimed to:

- quantify the magnitude of electricity used by appliances in standby mode in the Australian residential sector
- assess the current penetration of appliances in standby mode
- quantify the magnitude of electricity currently used by small appliances which do not strictly fall into the definition of standby but are likely to contribute to miscellaneous energy consumption; and
- identify product types with poor standby profiles and with current or forecast rapid growth that are likely to contribute to an increase in standby energy consumption within the residential sector in Australia.

The study used both field and bottom up techniques such as intrusive field studies of 64 houses and physical measurements of appliances in two major retail stores. It also used appliance ownership telephone surveys to ascertain the types of appliances present in households, the age of those appliances and householder behaviour in relation to appliance usage (Harrington and Kleverlaan, 2001).

The study found that average standby and miscellaneous consumption was 86.8 watts or 760 kWh per year per household. This equates to 11.6% of total residential power use in Australia during the year 2000 (Harrington and Kleverlaan, 2001). A list of appliances' data collected in this study can be found in table 2.3.

Table 2.3: Australian survey results of a range of appliances showing appliance load, standby load, off load, saturation per household, market share, average units per household and average age of appliances.

Appliance	On (W)	Standby (W)	Off (W)	Saturation Per Household	Average Units per Household (Ownership)	Market Share (Penetration)(#2)	Age (average years)
Televisions	67.2	9.6	0.2	1.90	1.9	99.6%	8
Clock Radios	1.4	N/A	N/A	1.73	1.398	80.4%	N/A
VCRs	19.1	7.8	4.49	1.35	1.206	89.0%	6
Stereos	11.7	9.5	1.3	1.41	1.190	84.3%	8
Mobile Phone Chargers	6.2	1.2	N/A	1.59	1.051	65.8%	2
Electric Kettles	N/A	N/A	N/A	1.06	0.949	89.0%	4
Microwaves	N/A	3.9	0.3	1.03	0.925	89.0%	7
Personal Computers	N/A	N/A	2.0	1.27	0.734	57.4%	4
Smoke Detectors	N/A	N/A	N/A	1.98	0.664	33.4%	N/A
PC Monitors	59.4	4.5	1.2	1.24	0.661	53.2%	N/A
Printers	N/A	7.7	2.7	1.15	0.593	51.5%	4
Speakers	N/A	3.3	2.1	1.28	0.583	45.4%	N/A
Cordless Home Phones	3.6	2.7	0.9	1.08	0.508	46.9%	N/A
Answering Machines	N/A	3.3	3.0	1.04	0.417	40.1%	N/A
Electric Shavers	5.8*	0.6	N/A	1.13	0.389	34.2%	6
Play Station / Game Consoles	N/A	7.5*	1.2*	1.19	0.319	26.8%	N/A
Plug in Air Fresheners	1.9	N/A	N/A	1.74	0.281	16.1%	N/A
Dustbusters	N/A	1.3	N/A	1.03	0.257	24.9%	N/A
Coffee Machines	N/A	0.8*	0.0*	1.07	0.249	23.3%	7
Bread Makers	N/A	2.0	N/A	1.01	0.219	21.7%	3
Electric Toothbrushes	N/A	1.6	N/A	1.23	0.205	16.6%	2
Fish Tanks#	N/A	N/A	N/A	1.21	0.182	14.9%	N/A
Fax Machines	N/A	8.2	0.4	1.01	0.172	17.0%	5
Scanners	N/A	10.4	0.9	1.03	0.163	15.7%	2
Laptops	18.7*	N/A	2.3*	1.15	0.141	12.2%	N/A
DVDs	19.8	11.2	0.7	1.09	0.089	8.2%	2
Digital TVs	N/A	N/A	N/A	1.11	0.073	6.6%	N/A
Multi-Function Devices	N/A	9.1*	N/A	1.04	0.062	59%	4
Photocopiers	N/A	N/A	N/A	1.05	0.047	44%	4
Modems	N/A	5.7	1.7	N/A	N/A	N/A	N/A

Source:Harrington and Kleverlaan, 2001

* :Sample less then 10 valid readings

:Various components of fish tanks were measured including filters, heaters, pumps and lights and any combination of these maybe present in households. Therefore, a combined reading is not a practical indicator of on power consumption for fish tanks.

#:2 Penetration results were calculated by the following equation

$$\text{Penetration} = \frac{\text{Ownership}}{\text{Saturation}} \times 100$$

Harrington and Kleverlaan (2001) made outlined several observations about householder behaviour in relation to the use of appliances:

- A small proportion (15%) of appliances were found "unplugged".
- A large proportion of appliances were found to need power consumption in both standby and off modes. Many appliances did not have a hard off switch. Such

products included: VCRs, computer peripherals, audio and visual equipment like integrated stereos, Digital Video Disk (DVD) and an increasing number of white goods in particular, those that incorporate "soft touch" electronic controls.

- Computer peripherals (e.g. scanners, modems, speakers) are a significant problem as they have no off mode.
- Audio and visual equipment is an emerging concern and is compounded by the large number present in households.
- Standby and miscellaneous power consumption in the residential sector could be increasing at approximately 8% per year.
- Programs to influence household behaviour in relation to the use of appliances are not going to have a significant affect on standby power consumption, except on selected items such as TVs where there is still a substantial difference between standby and off modes. While consumers can be encouraged to unplug and switch appliances off at the wall when not in use, this is not a realistic basis for a communication campaign (Harrington and Kleverlaan, 2001).

2.3.2 New Zealand

The Household Energy End-Use Project (HEEP) was established in late 1994, to focus on energy use in New Zealand households (EECA 1999). The third year report (EECA 1999) uncovered the extent of standby power usage in New Zealand and the amount of power that was used by an appliance while in standby mode. For example, a washing machine is used only a few times a week for about 60 minutes each cycle. In between cycles, the power load does not drop to 0W, but to 9W, which is the stand-by power of the washing machine. As this washing machine is only used for one hour a day, 0.207kWh is consumed daily. This equates to 44% of energy consumption that is 'wasted' in the sense that it performs no useful 'clothes washing' work EECA, 1999). This investigation conducted a field study of 29 houses in the Wanganui and Wellington area and found that the average standby usage per household was 100W (please refer to table 2.1).

2.3.3 USA

According to table 2.2, researchers estimated that the average American home in 1996 had a standby power load of 50W or 450kWh/year, which was an average of 5% of a home's electricity use (Rainer et al, 1996). The average standby power fluctuated from study to study. Ross &Meier (2000) performed whole house measurements on 10 Californian houses. As shown in table 2.1, this study reported that the average standby power in the year 2000, per house was 67W or 590kWh/year. In 2002, table 2.1 outlines another study in California (Meier and Lebot, 2002) that rendered slightly different results of 115W of standby power per house with an average of 1,010kWh/year. The growing trends are becoming increasingly evident Meier et al (1997) conducted spot measurements of over 400 appliances from two large electronic stores and 15 homes, and created an analytical definition of standby losses.

$$\mathbf{W_{sb} = P_{sb} \times t_{sb} \times s \times n}$$

W_{sb}: Standby losses in terms of watt-hours per day or year

P_{sb} : Effective output consumed, watt

t_{sb}: Time in the standby mode

s: Saturation in % of US households

n: Number of households

Part of this investigation identified product types with poor standby profiles and with current or forecasted rapid growth that were likely to contribute to an increase in standby energy consumption. The following table represents ten appliances that account for an estimated 70% of power consumption in the residential sector (Meier et al, 1997).

Table 2.4 Standby power of 10 popular appliances in America showing millions of units sold, individual standby power and total electricity standby consumption.

Appliance	Millions of Units	Standby Power (W)	Calculated Total Standby Consumption (TWh/year)
TV set	186	4.0	5.4
VCR	120	5.6	4.9
Compact Audio	53	10.6	4.7
Cable Box (Sky decoder)	58	11.6	3.7
Rack Audio	55	7.0	3.2
Microwave Oven	78	3.1	2.1
Battery Charger	98	2.4	2.1
Answering Machine	66	3.3	1.9
Clock Radio	105	2.0	1.8
Cordless Phone	61	2.8	1.5

Source: Meier et al. 1997

The results of this study (and others) have shown that there is a broad range of standby power consumption for many of the appliances, which indicates that design improvements could reduce standby power greatly. The proliferation of new appliances such as cell phone re-chargers, digital satellite boxes and rechargeable lawn mowers could change the current hierarchy of standby power usage. The appliance of main concern is the digital satellite receiver box as it is experiencing rapid sales growth. Current measurements suggest that these standby losses range from 5 to 17 watts (Lebot et al. 2000). The main concern with this product it is unlikely to be turned off there is virtually no difference between the on-mode and the standby mode (Lebot et al. 2000).

2.3.4 Europe and France

Several large studies have taken place in Europe and standby use is about 30 to 60 watts per household (Bertoldi et al. 2002). A field study of 178 individual households was conducted in France (Sidler, 2000). The individual standby consumption of some of the appliances from the French study is detailed in table 2.5. The results show that many of the appliances tested have very low standby powers of 1 and 2W. Potentially, this low standby could be achieved in all appliances if adjustments were carried out and therefore 1W standby power could become a future reality.

Table 2.5. Results of a survey of the standby power modes found in household appliances in 178 individual French households showing maximum, minimum and average loads for the number of appliances measured in a range of categories.

Appliances	Max. Standby Power (W)	Min. Standby Power (W)	Average Standby Power (W)	No. of Models Monitored
Television Set	22	1	7.3	205
VCR	30	1	9.9	169
DVD Player	15	15	15.0	1
Video Games	7	1	1.7	20
Satellite Dish Decoders	17	5	8.7	26
Hi-fi Stereo	24	1	7.2	108
CD Player	7	1	3.1	18
Discman	1	1	1.0	1
Radio Alarm Clock	4	1	1.4	175
PC Central Unit	2	2	2.0	2
PC Monitor	10	1	6.5	4
PC Central Unit + Monitor	3	2	2.7	3
PC Whole Unit	27	1	6.9	14
PC Laptop	20	1	6.5	4
Ink-Jet Printer	8	1	3.8	13
Laser Printer	4	4	4.0	2
Scanner	6	5	5.5	2
Photocopy Machine	10	10	10.0	1
Wireless Telephone	7	1	2.6	100
Independent Answering Machine	6	1	2.8	56
Cellular Phone Re-charger	3	1	1.5	4
Induction Cook-top	18	4	13.2	10
Microwave oven	12	1	3.5	32
Kitchen Oven	18	6	14.5	4
Electric Fence	1	1	1.0	1
Security Systems	1	1	1.0	2
Electric Toothbrush	3	1	1.8	12
Clothes Washer	7	1	4.0	2
Electric Bed	5	5	5.0	2

Source: Lebot et al. 2000

2.3.5 Japan

In 1999, a standby power research study took place (Jyukankyo, 1999) with whole-house measurements of 51 houses and 955 appliances as well as a questionnaire distributed to 933 households asking the householder the number of appliances owned, the approximate hours of use, and whether the appliances were left un-plugged when not in use (Jyukankyo, 1999). A similar questionnaire was distributed in 2001, this time with 1503 respondents. In the year 2000, two surveys were distributed to 40 electric appliance manufacturers and 92 gas and oil equipment manufacturers asking manufacturers the power usage per mode for products made in 2000, what activity was being undertaken to reduce standby power and what information was provided to consumers about standby power in the manufacturer's instructions (International Energy Agency, 2001).

There were a significant number of reductions in the standby power consumption of many appliances through improvement in design. This is demonstrated by the comparison of the 1999 household stock survey to new appliances placed on the market in 2000 shown in table 2.6

Table 2.6 Comparison of standby consumption averages in Japan between household appliances used in new products in the market between 1999 and 2000.

Product	1999 Household Stock (Average Standby, Watts)	2000 New Products (Average Standby, Watts)	Difference (Watts)
Audio Components	6.5	4.8	1.7
TV	1.9	0.8	0.8
VCR	6.2	2.4	3.8
Set top box for Satellite TV	12.3	6.4	5.9
Personal Computer	2.3	2.0	0.3
Telephone with fax machine	5.9	3.8	2.1
Washing Machines	0.9	0.3	0.6
Rice Cooker	1.9	1.7	0.2
Microwave oven	2.8	0.8	2.0
Portable Heating	2.8	5.7	2.9

Source: Jyukankyo Research Institute, 1999

If the above findings were taken intro consideration and improvements were carried out by replacing old appliances with new over time, standby per household could fall from 11.7% of total energy consumption to 8.4% (524kWh to 361kWh). Manufacturer participation in reducing standby power is yet another breakthrough (Nakagami et al 2001). On average 44% of manufacturers were labelled as very active in reducing the standby power of products, 36% took an active approach and only 16% took no action. The significant percentage of manufacturers (80%) taking part in standby power reduction could be directly related to Japan's mandatory "top runner plan" (see section 2.4).

2.3.6 China

China is one of the largest consumers and producers of consumer electronics in the world with over 40 million colour TV's produced in the year 2000 (Warner et al, 2002)
Results from studies in China show that there is a definite standby power usage pattern (Warner et al, 2002). The older generation generally unplug their TV's and audio-visual equipment to traditionally guard against voltage spikes. However this practice is fast losing popularity particularly among the younger generation due to factors such as convenience and aesthetics of the product. A survey of 400 households revealed audio visual appliances spend 9 to 10 hours a day plugged in. This translates into a standby loss of almost 10% of residential household electricity use (International Energy Agency, 2001).

The major appliances in the Chinese home according to Warner et al (2002) are the TV and audio visual equipment. China, as shown in table 2.1, has a relatively low standby power use per household at an average of 33W per household recorded for the year 2000. Currently China has employed a specification (in line with the energy star program) for TV products and there are plans to introduce similar technical specifications for other consumer and office electronics over the next two years (Warner et al, 2002).

2.4 Commercial Buildings

Commercial buildings consume standby power through appliances such as personal computers, copiers, phone systems and central computing devices. The definition of standby power however is more ambiguous. Researchers have not differentiated between powers used for lighting, security or standby, hence many conclusions cannot be drawn. Studies have been carried out in Germany, Switzerland, Belgium, Japan and California. In comparison to the residential sector, standby power in the commercial building sector is not well documented.

In the German study Rath et al. (1997) found that there was a ratio (per m^2) of 2W of standby power found in the German commercial sector for every 1W in the residential sector. There is every indication that the commercial standby consumption is growing as more office appliances are built with standby functions.

A theoretical and physical investigation took place in Switzerland. Menti (1999) made the suggestion that standby power consumption in commercial buildings should account for less than ten percent of the total power consumed in a commercial building. However in the physical study, actual measurements of thirty-two commercial building appliances were made which showed that an average of 36% of total consumption was due to standby consumption, particularly at nights (between 8pm and 6am) and during weekends. The study did not investigate what fraction of this consumption was due to equipment switched off or not performing its main function when on standby power. Neither did it stipulate what fraction was due to building maintenance such as lighting and security (Bertoldi et al 2002).

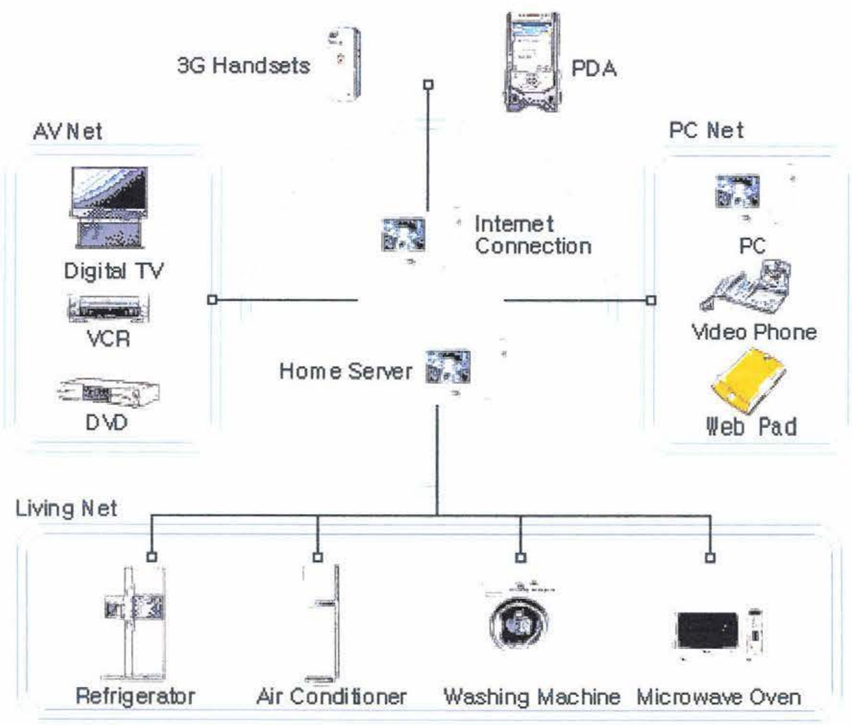
De Groote (2001) studied five office buildings in Belgium. Through this study it was found that for every square metre of office space there was 10-15 kWh of standby power consumed.
De Groote claimed that the standby consumption in the best-designed offices in Europe equalled roughly half of the total electricity consumption. In Japan, the standby power consumption of one commercial building was monitored where it was found standby power was responsible for 10% of total electricity used per year (Nakagami 2001). Webber & Robertson (2001) audited ten Californian commercial office buildings. The numbers of office appliances and main activity modes were recorded, and this information was then combined with estimates of the standby power of each appliance. The standby power consumption was 0.06W/ ft^2 when all equipment was turned off or in standby mode.
At the present time, no research has taken place in New Zealand with regard to standby power usage in the commercial sector.

2.5 Standby Trends

At present, the existing data available is insufficient to determine trends with an acceptable degree of accuracy. However, it looks as though standby power consumption is on the rise because the improvements in efficiency of appliances are outweighed by the increase in the numbers of appliances that consume power in standby mode. The European Commission estimated in 1999 that residential standby consumption would increase from 36TWh in 1995 to 62TWh in 2010 without significant intervention (Bertoldi et al, 2002).

Standby power consumption may increase as households become 'totally automated'. LG Electronics is one of many appliance manufacturers introducing 'home networking' (www.lge.com). They have developed home appliances that can be operated using mobile phones or the internet. LG Electronics are developing home appliances with the ability to connect to each other through a network. In June 2002, the company introduced the internet controlled refrigerator (that includes features such as automated inventory, access to the internet, digital camera and local organiser calendar), Internet protocol (IP) phone and the internet controlled washing machine (figure 2.1). Future appliance planned releases include the internet controlled air conditioner, microwave oven and drum washing machine (www.lge.com). LG Electronics did not mention the standby power consumption of these new products on their website but a Swiss study (Aebischer & Huser, 2000) indicated that standby power use (due to home networking) in the Swiss residential sector may be as high as 400kWh per household by 2020.

Figure 2.1: LG Electronics home networking plan for appliance usage through the internet and mobile phones to reduce standby power usage



Source: www.lge.com

2.6 Policies and practical steps to combat standby power.

Standby power is an international problem because appliances are made not just for the local market but are increasingly developed for the global market It is hard to apply a standard across the board that reduces standby power globally. As the international economy becomes increasingly global, the amount of products that are essentially for the same purpose but are produced differently, result in varying degrees of standby power usage. It is argued that an international standard is the only way to reduce the energy used by many household appliances. It may present an initial difficulty for manufacturers to comply to an international standard, but other goods and services such as motor vehicles have successfully implemented and adhere to international standards and compliances. Standardisation may be a future possibility.

The difficulties that stop manufacturers of many appliances using an international standard for standby power levels are that they are often based in different countries. For example a computer may be designed in the US, assembled in China using parts from Japan and Korea and ultimately be sold in Europe (Bertoldi et al, 2002). Lastly, many governments are looking to find ways to reduce CO_2 emissions in order to meet the Kyoto Protocol. The standby usage is estimated to be 1.5% of total electricity consumption or 124TWh of OECD countries. This contributes 0.6% (68 million tons) of CO_2; and is equivalent the greenhouse emissions from 24 million cars from European roads (Anglade et al. 2002). An implementation of a uniform target to limit standby power consumption to 1W would reduce this estimated global standby power usage by 80% and therefore produce a reduction of 54 million tons of CO_2. This result is based on a gas powered station. The changes would equal 3.4% of the OECD's proposed reductions in CO_2 emissions (Anglade et al 2002). These kinds of statistics make reducing standby power an attractive CO_2 mitigation measure.

Although standby power seems to be an attractive and simple way to reduce overall power consumption, Horowitz (2002) points out that many of the technological approaches used to reduce standby power do not automatically improve active mode efficiency. The most advanced power supply technologies can reduce both standby energy consumption as well as improving full and partial load efficiency. Horowitz also stated that given the larger energy savings that can come from reducing active power mode, policy makers and efficiency program designers should move beyond the current focus on "sleep" and "standby modes" and consider active mode energy usage as well.

The problems that are being encountered with current legislation and programmes are that the definition of standby power differs from case to case and not all standby power modes are being included in legislation. This results in policies that cannot be readily compared as they are inconsistent.

2.6.1 Mandatory Certification Programs

Brazil has passed legislation for a mandatory certification program to be put in place. Legalisation changes would require all consumer appliances to display their standby power usage at the first point of sale. The legislation was supposed to take effect in 2003, however there has been a lack of testing procedures released to date. Brazil is the only country that has implemented a mandatory certification program in regard to standby power (International Energy Agency, 2001).

2.6.2 Voluntary Certification Programs

Energy Star

Consumer information labelling has become widespread and may be the most useful way in allowing consumers to gain knowledge about a product's energy efficiency. The most well-known international energy efficiency labelling programme is the United States (US) Energy Star programme (International Energy Agency, 2001). Energy Star was created by the US Environment Protection Agency (EPA) in 1992. Appliance manufacturers can join the programme, and in return must develop at least one appliance that meets the energy star criteria. This appliance is then allowed to display the energy star label. Many countries, including New Zealand have adopted energy star labels and criteria as part of their energy efficiency programmes (International Energy Agency, 2001).

Energy star runs three programmes:

1) A consumer electronics program (TV's, VCR's and audio equipment)
2) An office equipment program
3) An appliance program

Currently only Australia and Canada participate in the Energy Star consumer electronics program. This program has established minimum standby specifications for TV's, VCR's, set-top boxes and audio equipment.

The Energy Star office equipment program is the oldest programme being established in the early 1990's. At present this program operates in the United States, Canada, Japan, Europe, Australia, New Zealand and Taiwan. Energy star has established specifications for computers, printers, copiers, fax machines and other types of office equipment. It is even possible to go to the energy star website (www.energystar.gov) and perform a financial analysis of how much standby power is costing you in the workplace. The first goal of this programme is to reduce the number of hours the device is on to establish a 'low power' mode. In today's economy different formulae are used to set maximum levels for standby consumption whilst appliances are in sleep mode. New specifications are being explored that capture all major modes: off, sleep and active (International Energy Agency, 2001).

The Energy Star appliance programme covers white-ware including refrigerators, dishwashers, clothes washers and air conditioners. Only refrigerators and freezers are certified for standby power. The other appliances in this program do not cover standby and low-power modes as the current appliance performance test does not include it. This may be changed in the near future as the test for dishwashers was revised to include standby power use (International Energy Agency, 2001). This test is still in the drafting stages and has not yet been officially released and adopted into the Energy Star certification program. The limitations of this scheme are that manufacturers can independently choose whether they participate, hence the program is sometimes reduced to a simple use of stars in one from or another across different countries. Further action needs to be taken on a national level to raise legislation and establish a standard that requires participation across the board.

Group for Energy Efficient Appliances

The Group for Efficient appliances (GEA) is a forum of representatives from national energy agencies and governments who are working with industry on voluntary information activities to improve the efficiency of electronic products, mainly household appliances. The GEA label is part of a voluntary programme that was started in 1996. Energy agencies from eight European countries; Austria, Denmark, Finland, France, Germany, The Netherlands, Sweden and Switzerland are members of the GEA (International Energy Agency, 2001). The GEA programme covers a broad spectrum of appliances: televisions, VCRs, television-VCR combinations, set-top boxes, DVD players, audio sets, audio components, wall packs and battery chargers, personal computers, monitors, printers, mailing machines, fax machines, scanners and copiers. The GEA was the first program to include specifications for more than one standby power mode. This is exemplified by GEA specification for an audio product which must include maximum levels for "off-mode" and "standby-passive" power usage. The GEA labels are awarded to appliances within the top 20-30% of all models available in the combined market of those countries taking part in the GEA voluntary agreement. The GEA provides an internet database of all products that have earned the label. Each country carries out activities that promote these products either by maintaining a national web-site or distribution lists (International Energy Agency, 2001).

European Code of Conduct

The European Commission established the Code of Conduct on Efficiency of External Power Supplies (European Commission, 2001). A study conducted in Europe by Molinder (1997) calculated an increase of consumer consumption in wall packs and chargers from about 8TWh in 1996 to about 14TWh in 2006 (Business as Usual scenario). Through implementation of the code of conduct it is projected that savings of 5TWh per year from 2010 could be achieved, equivalent to a total saving of 500 million Euros per year (Molinder, 1997). The code of conduct encompasses external power supplies for electronic and electrical appliances including AC adapters, battery chargers for mobile phones, domestic appliances, power tools and Information Technology equipment with an input ranging from 0.3W to 75W 9Molinder, 1997). These external power supplies and chargers all lack an on-off switch and consume electricity in a no-load situation. The aim to introduce at least 80% of models of external power supply after the dates set should follow the no-load power consumption targets laid out in table 2.7

Table 2.7: European Code of Conduct Standby Power Targets

Rated Input Power	No-load power consumption		
	Phase 1 1st January, 2001	Phase 2 1st January, 2003	Phase 3 1st January, 2005
≥ 0.3 W and < 15 W	1.0 W	0.75 W	0.3 W
≥ 15 W and < 50 W	1.0 W	0.75 W	0.5 W
≥ 50 W and < 75 W	1.0 W	0.75 W	0.75 W

This code of conduct has already begun monitoring of the manufacturer and reporting to the European Commission in a confidential manner. The results will be discussed in an anonymous manner with parties involved and will be published by the European Commission.

Australian Greenhouse Office and Australian Government

In 1999, Commonwealth, State and Territory Government agencies responsible for energy matters made an agreement to consider standby power levels a national imperative. A seminar was held in March 2000 and a consensus was agreed that not only does the Government need to signal the importance of standby power to the Australian community but that a 1W standby policy should be endorsed. Short-term actions were decided upon from this forum such as collecting and publishing of product-specific data, establishing consumer information programs and focussing on encouraging manufacturers to redesign products. As a result, the Australian standby study (Harrington and Kleverlaan, 2001) was released in 2001.

The Australian Greenhouse Office (AGO) has more recently released a discussion paper entitled "Standby Power Consumption. A long-term strategy to achieve Australia's One-Watt Goal 2002 to 2012" (July 2002) and is accepting submissions from stakeholders. These comments will assist the government to shape policies that minimise standby power consumption by the year 2012. Australia is already an energy star partner for both office equipment and consumer electronics, thus has many major appliances already covered by voluntary programs.

The State Economic and Trade Commission (SETC), China.

The SETC began negotiating with Chinese TV manufacturers in 2002 to reduce standby power to the desired 3W energy star level. Chinese TV manufacturers have now adopted the ENERGY STAR levels but have not yet implemented the programme (International Energy Agency, 2001). This is a voluntary target, but it is generally understood that a mandatory standard will be established if compliance is low. The SETC are looking to broaden this application to other products (International Energy Agency, 2001).

TCO Development

TCO Development is a Swedish labelling programme that began environmental labelling of office equipment in the early 1990's. TCO development deals with establishing both ergonomic, safety and environmental criteria for electronic appliances and currently evaluates and labels computers, monitors and keyboards. The specifications for standby in these appliances generally follow energy star specifications. It is now recommended that monitors be able to achieve a sleep-mode power consumption of no greater than 5W.

Blue Angel (Blauer Engel)

The German eco-label is part of a voluntary programme that provides standards for a range of environmental impacts. Currently, the scheme covers personal computers and monitors, portable computers, printers, fax machines, copiers, televisions, washing machines, dishwashers, tumble driers and refrigerators. The programme is carried out under the German Ministry for the Environment. The labelling criteria specify maximum energy consumption for each product group in different modes of operation. It also sets criteria, such as the maximum 'wake-up time' from the energy-saving mode and the maximum time required for energy-saving features to switch on. Product groups are categorised by function. Manufacturers who are certified as meeting the criteria can apply the label to their products. (International Energy Agency, 2001)

Nordic Swan

The Nordic Swan scheme is another voluntary eco-labelling programme that covers a range of impacts to the environment. It is organised by the Nordic Council of Ministers and is currently in usage in Finland, Norway and Sweden. Nordic Swan covers product types such as personal computers and monitors, portable computers, printers, fax machines, copiers, televisions, VCRs and television-VCR combinations, stereo systems, washing machines, dishwashers and refrigerators (International Energy Agency, 2001). The criteria for the standby power consumption of office equipment are equivalent to those of Energy Star or GEA. Several of the consumer electronic appliances must have the 'on' mode is taken into account as well as standby mode. The Nordic Swan eco-label is administered by national boards that cooperate through the Nordic Eco-labelling Board. (International Energy Agency, 2001)

2.6.3 Mandatory Efficiency Standards

Top Runner

The top runner programme is Japan's mandatory energy efficiency program. It is run by the Japanese Ministry for Economic Trade and Industry (METI). Top Runner covers automobiles, appliances, office equipment and consumer electronics. The programme sets energy efficiency targets for 11 products including air-conditioners, heaters, fluorescent lamps, television receivers, copying machines, computers, magnetic disk devices, VCRs, refrigerators and freezers (International Energy Agency, 2001). The standards within the top runner programme were only agreed upon after intensive discussion and negotiations between the Japanese government and industry sectors. The consequence for not achieving these standards result in recommendations being made to the company in question, and if these are not complied with the name of the firm will be made public or an administrative order issued. The Top Runner programme provides a strong incentive to meet the standards in place. Some of the test procedures used by Top Runner capture standby and low power modes. For example, the TV test includes all major operating modes. Efficiency specifications for other appliances such as room air conditioners capture energy use and efficiency only in the active mode.

The Federal Energy Management Program (FEMP)

On the 31st of July, 2001, President George W. Bush released an Executive Order for Energy-Efficient Standby Power Devices as illustrated below. This order requires all federal agencies, when purchasing appliances, to purchase products that have a standby power usage of 1W, or the lowest possible alternative. This order has been described as being a milestone in addressing standby power consumption (Bertoldi et al, 2001). Prior to the order, the federal policy employed to address standby power was the Energy Star program.

Executive Order 13221

Energy-Efficient Standby Power Devices

By the authority vested in me as President by the Constitution and the laws of the United States of America, including the National Energy Conservation Policy Act (Public Law 95-619, 92 Stat. 3206, 42 U.S.C. 8252 et seq.), as amended by the Energy Policy Act of 1992 (EPACT) (Public Law 102-486, 106 Stat. 2776), and section 301 of title 3, United States Code, and in order to further encourage energy conservation by the Federal Government, it is hereby ordered as follows:

Section 1. Energy-Efficient Standby Power Devices. Each agency, when it purchases commercially available, off-the-shelf products that use external standby power devices, or that contain an internal standby power function, shall purchase products that use no more than one watt in their standby power consuming mode. If such products are not available, agencies shall purchase products with the lowest standby power wattage while in their standby power consuming mode. Agencies shall adhere to these requirements, when life-cycle cost-effective and practicable and where the relevant product's utility and performance are not compromised as a result. By December 31, 2001, and on an annual basis thereafter, the Department of Energy, in consultation with the Department of Defence and the General Services Administration, shall compile a preliminary list of products to be subject to these requirements. The Department of Energy shall finalize the list and may remove products deemed inappropriate for listing.

Section 2. Independent Agencies. Independent agencies are encouraged to comply with the provisions of this order.

Section 3. Definition. "Agency" means an executive agency as defined in 5 U.S.C. 105. For the purpose of this order, military departments, as defined in 5 U.S.C. 102, are covered by the Department of Defence.

George W. Bush
The White House
July 31, 2001

The FEMP was then charged by President Bush to implement a plan to purchase low-standby products for the government. In 2002, FEMP issued purchasing requirements for major types of office equipment and consumer electronics. In the case of consumer electronics, the federal purchasing requirements specify a lower standby level than Energy Star.

The International Energy Agency (IEA) Standby Power Initiative

The IEA organised three workshops to facilitate international discussion and co-operation on standby power issues, the first of which was held in 1999. The purpose of the workshops was to explore the benefits of international cooperation and to encourage national efforts to combat standby power. From the workshops it was found that it was crucial to coordinate efforts internationally and to facilitate participation by industry. The workshops also exposed the danger of the proliferation of national and regional initiatives to reduce standby power consumption. The IEA now recommends that the best way to reduce standby power worldwide would be firstly to internationally co-ordinate efforts between governments and industry in order to reduce the burden on manufacturers of globally marketed products and secondly to develop an international approach toward energy labelling. This would eliminate the confusion created by the many energy efficiency labels that have been formed in different countries. By creating a uniform international policy, the IEA believes this could simplify the process of educating consumers and this in turn could stimulate greater demand for energy efficient products (Bertoldi et al, 2002).

The results of the three IEA standby power workshops can be found at the following websites:

- Paris, January 18-19, 1999: First International Workshop on Standby Power "Standby Power: A Global Issue" http://www.iea.org/standby/workshop.htm (viewed May, 2002)
- Brussels, January 17-18, 2000: Second International Workshop on Standby Power "Reducing Standby Power: Opportunities & Challenges" http://www/iea/org/standby/brussels.htm (viewed May, 2002)
- Tokyo, February 7-8, 2001: Third International Workshop on Standby Power "Towards a Harmonised Solution" http://www.eccj.or.jp/iea/01/text/index.html (viewed May, 2002)

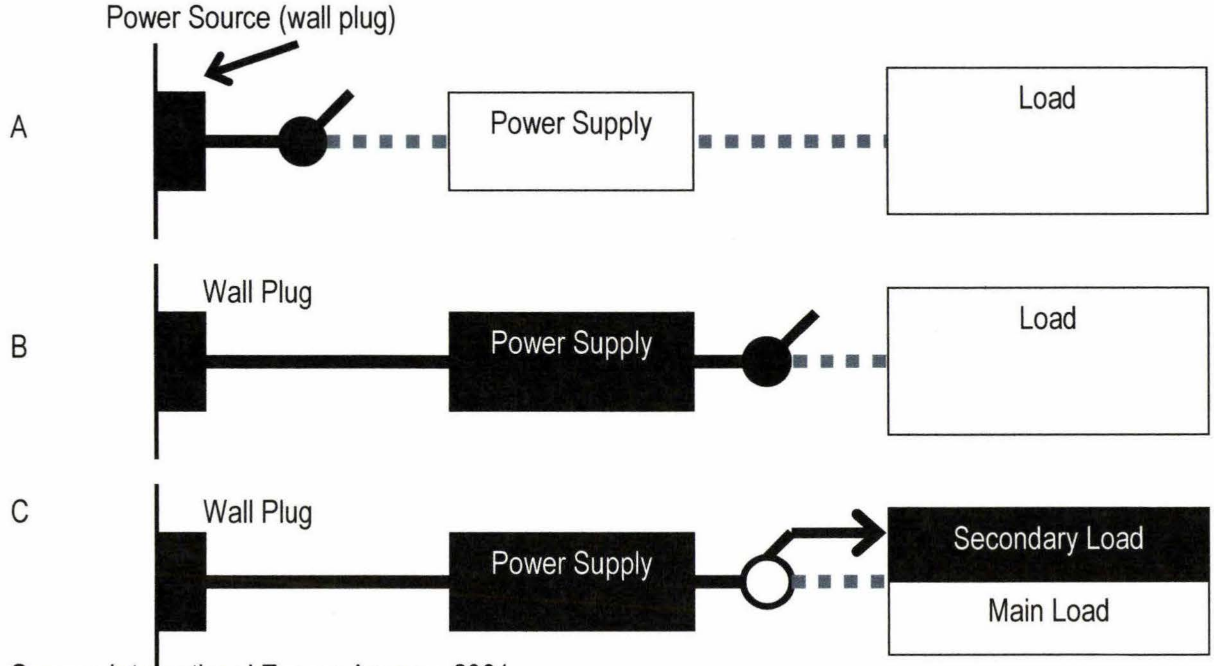
2.7 Technical solutions

Currently there are many technical solutions available to lower standby power consumption to the proposed 1W threshold. Barriers to the improvement of standby efficiency improvements primarily relate to the perceived cost of improvement for the manufacturer, and whether this cost will be of benefit to the manufacturer's financial interests.

2.7.1 Power Switch Placement

A simple solution to reduce standby power consumption involves the placement of the switch in relation to the power supply. The type and placement of the switch dictate whether a device that supplies power to an appliance has to consume energy when the appliance is not being used (International Energy Agency, 2001).

Figure 2.2 Common power switch designs of appliances with standby power features



Source: International Energy Agency, 2001

A: Ideal standby power state (i.e. no electricity consumed when appliances are switched off.

B: Active standby mode.

C: Passive standby mode (can be activated by remote control or performs a secondary function such as powering a clock or keypad). See definitions on page 6 and 7.

If the switch is placed between the power source and power supply (figure 2.2, diagram A), no electricity is consumed when the appliances are switched off as the current does not reach any energy-consuming components (International Energy Agency, 2001).

When the switch is placed between the power supply and the load (figure 2.2, diagram B), some electricity will be consumed when the appliance is turned off as the current will flow through the power supply and the energy will be dissipated as heat (International Energy Agency, 2001). Audio equipment and halogen desk lamps are generally designed with the mechanical switch between the power supply and load resulting in energy consumption, even though the product has no function at the time. Standby power can be eliminated by placing the switch between the power source and power supply (as shown in figure 2.2, diagram A)

The mechanical switch can be placed between the power supply and load to power a secondary load that the appliances may offer, for example, a clock or timer (figure 2, diagram C). In this case there are three options that time can be utilised to reduce standby power:

- add an extra power supply for use at low levels;
- use a power supply with two operating ranges; and
- incorporate a separate power source such as a small battery or photo-voltaic cell (International Energy Agency, 2001).

In most small appliances, power switches are located on the low voltage side of the transformer (figure 2.2, diagram C). These cheap transformers have high core losses, and can leak up to 3W. This can be solved by reconfiguring the circuit such that the off switch is on the high voltage side of the power supply. Another method is the use of a photovoltaic (PV) array to replace the grid as a source of electricity. The PV array provides sufficient electricity to meet the leaking and recharge needs of the battery charger. The PV array and battery eliminates leakage caused by the transformer and the entire end use. The cost of this PV array is not yet known.

2.7.2 Power Supplies

The power supply present in most electronic goods and appliances is a low voltage power supply (3 - 4V), typically unregulated and linear. The linear power supply can be replaced by a switch-mode power supply, typically saving 1-3W. This method works well, is very reliable and extremely cheap (Rainer et al, 1996); the extra cost may be only up to $1 (International Energy Agency, 2001). In addition, they are more efficient in the on-mode.

Switch-mode power supplies may lower other costs. Switch-mode power supplies can be used in all countries (lowered inventory cost), the lighter switch-mode power supplies weigh less then traditional designs hence have cheaper freighting costs. The lighter switch-mode power supplies make the product more durable and less likely to separate itself from the framework when dropped which means fewer repairs (International Energy Agency, 2001).

2.7.3 Power Management

Power management involves de-energising components that are needed during standby mode. Many home electronics rely on sophisticated chips to control their operation and have a power management feature already built into them. The incremental cost of enabling power management is very low and often these features are left out as manufacturers try to get new products out on to the market as soon as possible (International Energy Agency, 2001)

2.7.4 Visual Displays, Lower Power Components

Low power light emitting diode (LED) technologies have become available in a range of colours and intensities and are currently undergoing price reductions. By using lower power components, many appliances can lower their standby power consumption (International Energy Agency, 2001).

Another, far simpler alternative is to unplug the device when not in use, or install a manual switch between the plug and the outlet. Some countries such as the United Kingdom require all outlets to be equipped with power switches, so the aforementioned retrofitting would not be necessary (Rainer et al, 1996)

2.8 Recommendations

The following recommendations have been taken from the American Council for an Energy Efficient Economy (ACEEE) 2002 study (Bertoldi et al, 2002). These recommendations are applicable for both international and national application as both are needed to control the escalating problem that is standby power.

Develop guidelines for lowering standby power use in appliances not currently covered by any programme.

Many of the newest technologies will use some standby power. To avoid having "networked homes" that are also "high-standby-consumption homes," it is important to identify new appliances that will consume standby power and develop guidelines for lowering standby power use in these appliances as well as those that are not presently covered by any program.

Avoid the proliferation of different labels to reduce standby power.

Some regions or countries have introduced their own labels or schemes to encourage the purchase of equipment with low standby power consumption. If these labels are maintained after the adoption of an international scheme, it would be appropriate to, at a minimum, ensure that the criteria among them are consistent. To this end, it is recommended that the consumption levels specified in the EU Code of Conduct for External Power Supplies be used by all labelling schemes, public procurement and efficiency standards programs.

Address the specific case of STBs (set top boxes – Sky decoders) for tomorrow's digital TVs.

Television broadcasting is rapidly moving toward digital technology; as a result, STBs will likely soon be responsible for significant new standby power demand in most economies. Countries should rapidly coordinate efforts, especially communication and power management protocols, to ensure that the standby power mode of the new generation of STBs is as energy efficient as possible. Service providers must be closely involved in this effort.

Include standby power information on existing appliance energy labels.

Appliance energy labels are used in most IEA member countries. Most of these labels do not indicate how much energy is consumed while the appliance is on standby. For some appliances, such as electric ovens in some countries, the annual standby consumption is as high as the on-mode consumption. Future updates of appliance energy labels should include an indication of standby power consumption. A first step toward this goal has been achieved with the new European Union label for electric ovens. In New Zealand, it is difficult to say with whom the responsibility of appliance labelling would lie. Possibly the best approach would be to create legislation that would make the energy labelling of appliances compulsory and then introduce energy labelling at an early stage of the design process so that it is not neglected in any way.

Stimulate research on new low-standby technologies.

New solutions to reduce standby power should be encouraged. Research and development activities should be stimulated at all levels, especially to help manufacturers encountering technical obstacles to reducing standby power.

Establish an international network of accreditation organisations.

An international network of accreditation organisations should be set up by the IEA to reduce the costs to manufacturers of qualifying products with low standby consumption under multiple different regional programs.

2.8.2 Viewing Standby Power from an alternative angle

There are some benefits to standby power. Health officials are becoming increasingly worried that homes are too cold, hence during the winter this waste energy (standby power) adds to the general warmth of the home or office building. Wasted energy may actually serve as a positive measure against peak demand power times, when everyone switches on electrical appliances at once, and overloading occurs.

A further positive outcome of standby power is that electronic circuits perform more consistently within the degree of warmth and humidity provided by standby power (International Energy Agency, 2001). Negative arguments against using standby power positively are the worries and further resources which need to be directed toward protecting appliances from power surges as well as the fire and electrical risk posed (especially significant in countries that experience a lot of earthquakes, like New Zealand) when leaving appliances running.

Guarding against standby power usage can cause losses in productivity within firms that cost more money in the end, such as staff constantly having to turn computers on and off, networks being placed under the constant demand of logging on and off and overload within intranet systems. The efficient switched off power mode can also interfere with other radio and TV receptions, as well as causing an electrically noisy environment.

3.0 Methodology of new product measurement survey and appliance behavioural survey

3.1 Introduction

This section outlines both the methodology used in this project as well as addressing the limitations found in the methodology and encountered when carrying out the surveys.

3.2 Aims

1) To evaluate the standby energy use performance of those products currently on the market or being introduced, by direct measurement.
2) Research and identify the current social attitudes toward the use, convenience and awareness of standby power in New Zealand.

3.3 Project Tasks and Outputs

Research techniques were employed for the study, including:
1) New product measurement survey.
2) E-mail surveys with consumers.
3) Interviews with Fisher and Paykel staff.
Each of these is described in more detail below.

3.3.1 New Product Measurement Survey

Physical measurements of new appliances were taken in three major retail stores in Dunedin and in the Fisher and Paykel manufacturing plant in Mosgiel, New Zealand. In total, 235 appliances were measured including: TV's, VCR's, DVD's, microwaves, washing machines, clothes driers, dishwashers, ovens, stereo equipment, laptops, personal computers and Sky television decoders.

The main purpose of conducting a new product measurement survey was to measure the standby consumption of new stock and to focus on 'outliers' – products that were consuming excessive levels of standby power.

3.3.2 Appliance Behavioural Survey

This survey involved e-mailing and printing out of a questionnaire about consumer attributes looked for in appliances, social attitudes to energy consumption, and general knowledge about standby power (Appliance Behavioural Survey, Appendix 1). The survey was initially given to a group of 50 people to be completed and requested them to send it onto a further respondent. The sample was primarily based on a group of people from Dunedin City Baptist Church. Due to time restraints, the initial group from church was selected because it included a demographic mix of ages and social standings, secondary and tertiary educated people, trades people, students and other professionals. One additional uncompleted survey was given to the secondary respondent by the primary respondent. The secondary respondents covered a range of people, including patients and professionals at Dunedin Public Hospital, parents and friends of students that the survey had been sent to or through further e-mails sent to friends and family.

The limitation of this survey was that it was not randomly selected according to the accurate statistical definition. Furthermore, the survey covered a small study group, which were not representative of the whole New Zealand population. For instance, the survey was conducted in Dunedin, which is based around a student and professional population. The initial group was taken from a community based, student populated church, which was not necessarily a fair representation of different groups of people from differing ethnic, religious and socio-economic backgrounds in New Zealand. However, this survey can be useful in supplying energy researchers with an indication of where to direct future research. In retrospect, it was realised that a survey encompassing the entire population would have been more accurate. Although the survey population did not properly represent the New Zealand population, the results shed some light upon attitudes toward appliances and appliances usage in Dunedin, if not New Zealand.

The purpose of the survey was to ascertain:

- Appliance specifications that are perceived to be important to the consumer.
- General consumer awareness of standby power.
- Changes in householder behaviour in relation to appliance usage.
- Public awareness of energy labelling.

3.4 New Product Measurement Survey

3.4.1 Aims and Objectives

The primary aim of the new product measurement measure survey was to measure the standby power consumption of new appliances on the market and to pinpoint appliances that produce excessive standby power.

3.4.2 Approach

The new product measurements survey used a WT200 Yokogawa digital power meter. Measurements were taken in three appliance retail stores in Dunedin, New Zealand Bond and

Bond electronics, Smith City and Farmers as well as at the Fisher and Paykel manufacturing site in Mosgiel, New Zealand. The following stores were approached, but were not able to allow testing to take place for various reasons; Dick Smith Electronics, PowerStore and Noel Lemmings The remaining stores were cooperative with proceeding with the arranged tests on their appliances during the investigation. Measurements were taken of the present floor stock in all three stores, as well as appliances from testing stations at Fisher and Paykel. The following appliances were tested and calibrated:

- Washing machines
- Clothes driers
- Dishwashers
- Ovens
- Microwaves
- TVs
- VCRs
- DVDs
- Stereo equipment
- Laptops
- Personal Computers and Monitors
- Home Theatres

The appliances were chosen as were a broad representation of most new household appliances socially available for sale in New Zealand.

3.4.3 Preparation and equipment

The power meter used for measuring appliance energy usage was borrowed from Fisher and Paykel Appliances, Mosgiel, New Zealand. The WT200 Yokogawa digital power meter was recommended by the engineering staff at Fisher and Paykel Appliances as the best power meter to use for this project and was the same power meter that was used in the Australian standby power project in table 2.3 (Harrington 2001). This particular meter has been selected because the WT200's 5mA range enables current as low as 25μA to be measured, making it ideal for measuring small amounts of current appliances on standby power use (www.dqm.it.com). A WT200 can measure standby power as well as the rated power for that device because it has a wide current range also reaches from 5mA to 20A. The Yokogawa WT200 also has a power accuracy of 0.2%, a frequency range of Direct Current (DC) to 50kHz and a crest factor of 3 at a rated current range (www.dqm.it.com). The power meter was plugged into the main power supply and the appliance was plugged into the power meter. For purposes of controlling possible variable factors, appliances were given two minutes to stabilise before a measurement was taken.

The appliances were placed in the following modes (see below), and where possible, the active power (Watts), power factor and crest factor result of the current were measured:

Off modes
- Active standby
- Passive standby

The results show the crest factor as well as the power factor of the tested appliances. Crest factor represents the peak amplitude of an electrical waveform divided by the RMS value. The purpose of the crest factor is to supply the researcher with a quick idea of how much impacting is occurring in a waveform. Impacting is associated with roller bearing wear, cavitation and gear tooth wear within electrical appliances (www.dliengineering.com). Power factor expresses the relationship between working power and the capacity that must be supplied to start an appliance working. It is registered as kW on the meter. Power factor also helps to define the difference between the power needed to start an appliance in comparison to the standby power mode (www.my.dteenergy.com).

Detailed information on all appliances was collated including:
- Model numbers
- Brand
- Price
- Product Description

3.4.4 Problems encountered during data collection

The study was unable to follow the International Energy Agency (IEA) 62301 draft protocol for measurement of standby power of household electrical appliances (IEA, 1999). The stabilisation time was reduced from five to two minutes to minimise the time spent in the stores and the interruption to floor staff at the retail outlets. Both the IEC 62301 draft protocol and the testing protocol for this study were examined and compared at the Fisher and Paykel manufacturing site. It was noted that there was no difference found between the two measurement techniques, except for the difference in stabilisation time.

Thirty computers could not be measured due to staff resistance. Staff members in Bond and Bond Electronics and Smith City had reservations with the computers having their power consumption measured, as they felt this may potentially damage the computer in some way. A second problem encountered was that many of the show models did not have an automatic operating system installed, hence making it impossible to measure the computer's standby power consumption within the store.

A third problem focused on the larger 500V plug that ovens and ranges require. An adapter was prepared by the engineering staff at Fisher and Paykel Appliances so that Yokogawa power meter could take the 500V (30A) oven plug. However this adapter could only be used in the Fisher and Paykel manufacturing site, limiting the ability to gain results for ovens and ranges in the three participating stores.

3.5 Appliance Behavioural Survey

3.5.1 Aims and Objectives

The e-mail survey was necessary to gather behavioural information of the New Zealand consumer in relation to appliance purchasing and standby power. Other information such as preferential appliance brands, age group and income levels of the consumer were collated.

3.5.2 Approach

The e-mail survey was conducted by sending out the survey to a sample of 50 people, asking the respondents to complete the survey and send the questionnaire onto one other person.
This survey technique was chosen due to time constraints within the project. Mail surveys allowed 50 people to be quickly and efficiently surveyed and forwarded to fifty more. Initially the project was only going to conduct the new product measurement survey, however 10 months into the project it was advised that an appliance behavioural survey should also take place. As a result, 66 people were surveyed. Survey questions can be viewed in Appendix 1.

3.6 Interviews with Fisher and Paykel Staff

3.61 Aims and Objectives

The interviews were carried out solely with the Fisher and Paykel staff in Mosgiel, Dunedin. The interviews conducted were with Mr Bill Currie, Head of Engineering and Mr Richard Butler, Head of Electronics. They were approached for interview through email and the interviews were carried out together on November 12th 20002. These interviews were to provide an understanding of Fisher and Paykels' Appliance's approach toward standby power. Questions such as

(1) What Fisher and Paykel's philosophy was on standby power usage
(2) What would have to take place to implement changes within the company and in New Zealand
(3) Who the onus was on to initiate and implement changes and whether they would be willing to move ahead by making changes to their appliances to reduce standby power usage in New Zealand

The findings of this interview are discussed in the results section.

4.0 Results

4.1 Overview

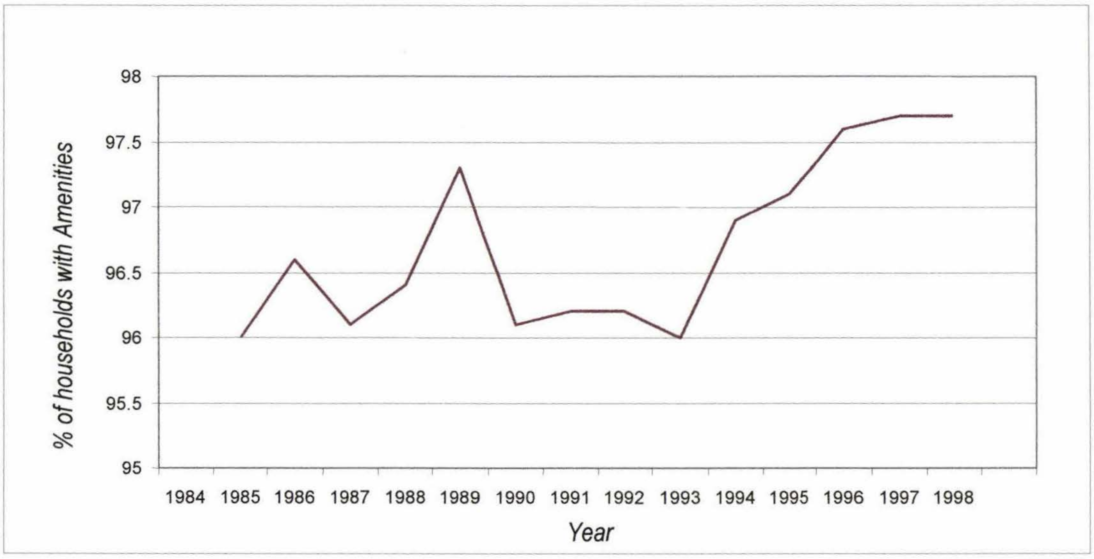
The results summarised in this section are from the new product measurement survey, in-store consumer interviews and two interviews with the main people responsible for overseeing the manufacturing of appliances in Dunedin, Fisher and Paykel.

A few problems were encountered in the new product measurement survey with many of the in-store staff uneasy concerning the measurement of expensive products. This led to a smaller sample of appliances being able to undergo testing, thus limiting the sample size of the investigation. Another difficulty experienced was measuring of appliances such as ovens, as they required a different plug and were impossible to measure in-store without destroying the power meter. Fisher and Paykel staff made a device that takes oven plugs so that a normal three pin plug could measure the standby power of ovens, however this could only be used at Fisher and Paykel, as staff would not allow this to be used off site. There were no oven plugs available in the stores that appliances were tested at. Therefore the sample of ovens was limited to ovens made only by Fisher and Paykel.
The statistical household data comes from Statistics New Zealand and is part of the Household Economic Survey that has been running since 1984 (Statistics New Zealand, 2002).

4.2 Washing machines

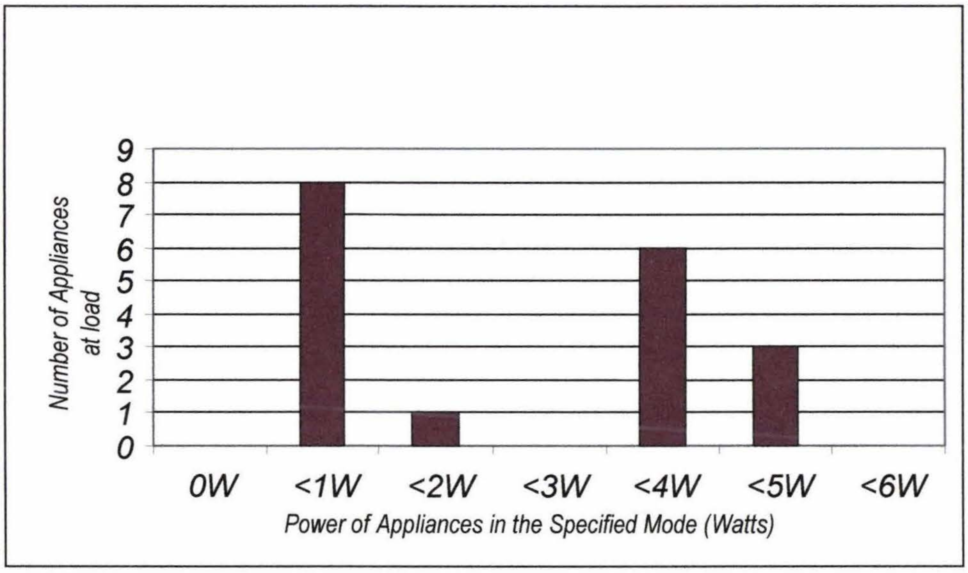
Washing machine ownership was found to be 97.2% (Statistics New Zealand, 2002) in New Zealand and the market appears to be saturated with little or no market growth. This is exemplified by figure 4.1 on the following page.

Figure 4.1 Percentage of New Zealand households with washing machines (source: Statistics NZ, 2002)



18 valid readings of new washing machines in the 2002 retail market were made. Eight out of eighteen (44%) of the washing machines tested, were found to have a standby power of under 1W when in off mode. Of these 44%, none incorporated "soft touch" electronics and all brands were imported from overseas. Recommended actions such as product improvement and outlining standards that reduce standby power, as discussed in previous, sections could be applied to future washing machines. It also outlines the need to reduce overall power consumption internationally, especially in regions such as Europe and the US where power prices are considerably higher than those in New Zealand. Fisher and Paykel dominated the higher readings (between 4 -5W), due to the level of sophistication of the "soft-touch" electronics.

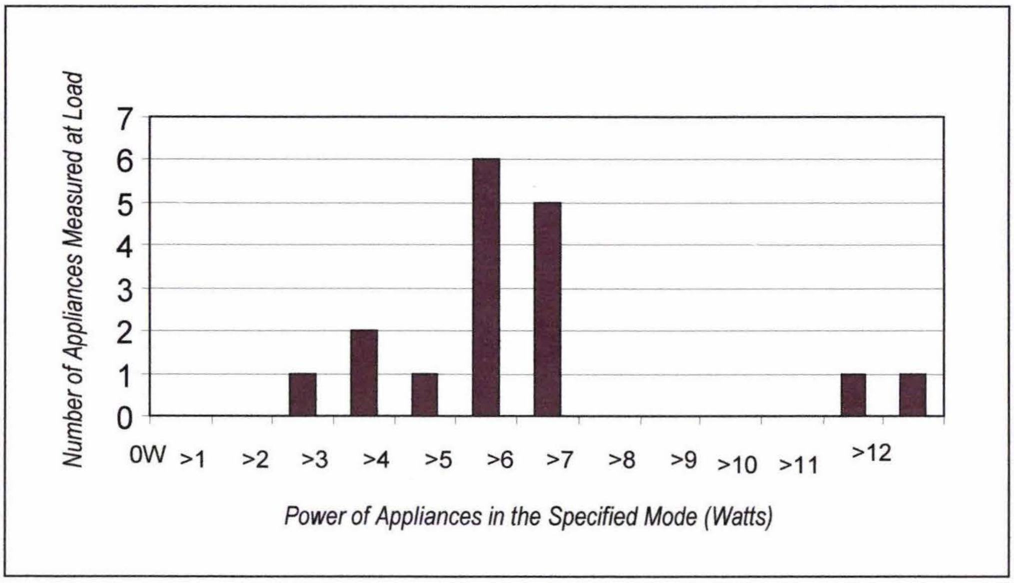
Figure 4.2: Standby power measurement for new washing machines, off mode (2002)



All 18 washing machines tested possessed an 'off-mode' standby power reading (figure 4.2), and all but one had an active standby feature (figure 4.3). This is due to the analogue dial present on many of the washing machines that had no 'soft touch' functions.

Of the 17 washing machines that had an active standby mode, 15 had readings below 6W (figure 4.3) although this 'active standby' is only on for a short period of time per day, for example, when the appliance is first turned on to be used so it has no significant effect on overall power. The two front loading washing machines (the Haier 5kg front loading washing machine and the Fisher and Paykel front loader auto washer) both had very high active standby modes. A problem that could present itself would be if the consumer keeps the washing machine running for a long period after the cycle has finished, for instance. the washing machine is started before the consumer goes to work or just before they go to sleep. The reason as to why front loaders had a higher active standby power remains to be resolved.

Figure 4.3: Standby power measurements for new washing machines (active-mode, 2002)



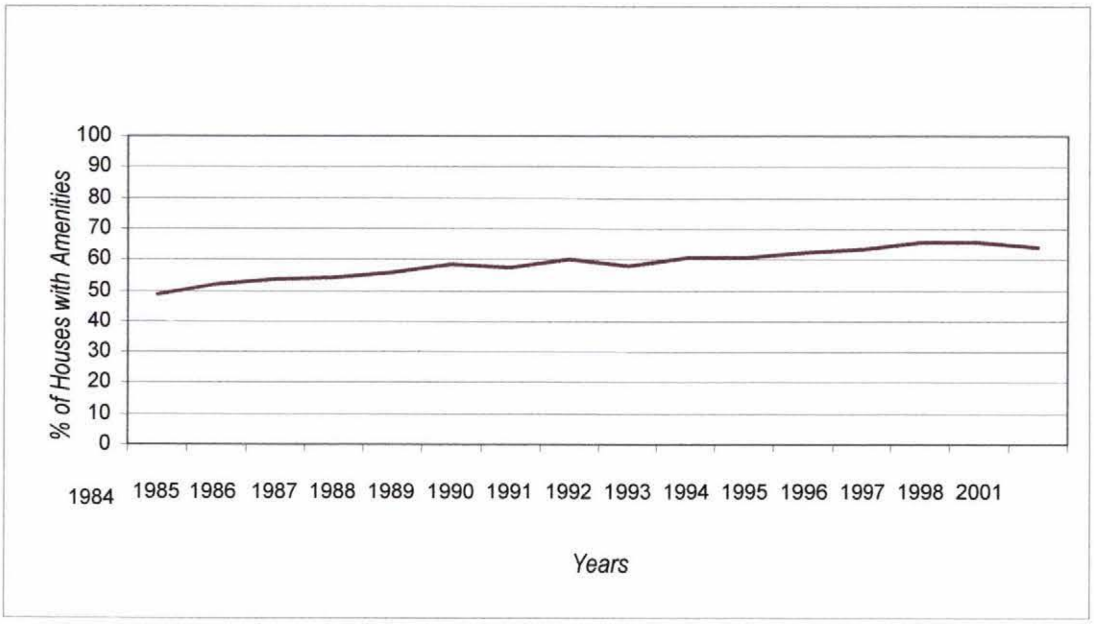
All washing machines tested either had an off-mode or an active standby mode. No washing machine tested in the study had a passive standby mode. The off-mode was found to be the designated mode in which standby power consumption took place.

It was found that 23.5% of consumers surveyed turned their washing machines off at the wall after use.

4.3 Clothes driers

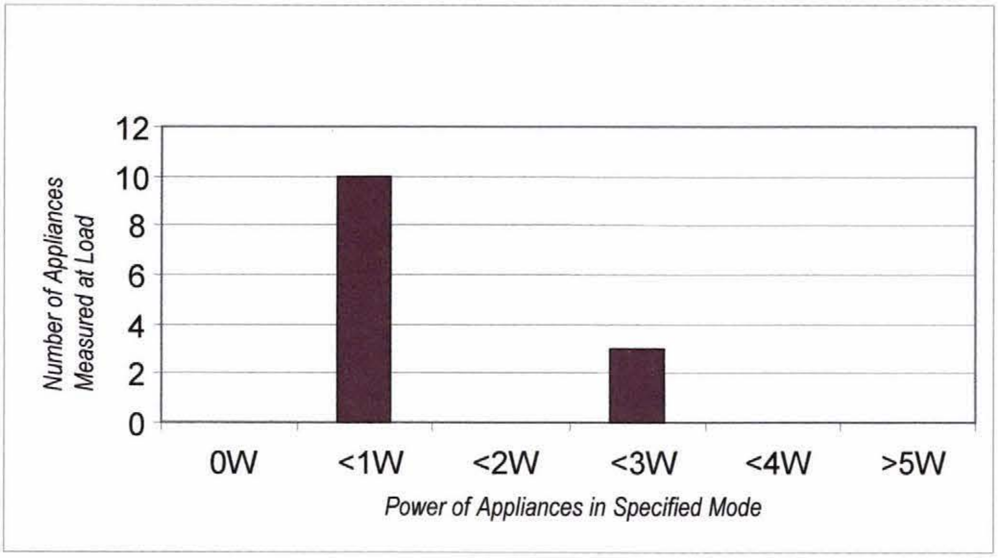
Clothes drier ownership stands at 63.7% of households in New Zealand (Statistics New Zealand, 2002) and over the past 15 years the market appears to have been growing slowly (figure 4.4).

Figure 4.4: Percentage of households with clothes driers (Source: Statistics NZ, 2002)



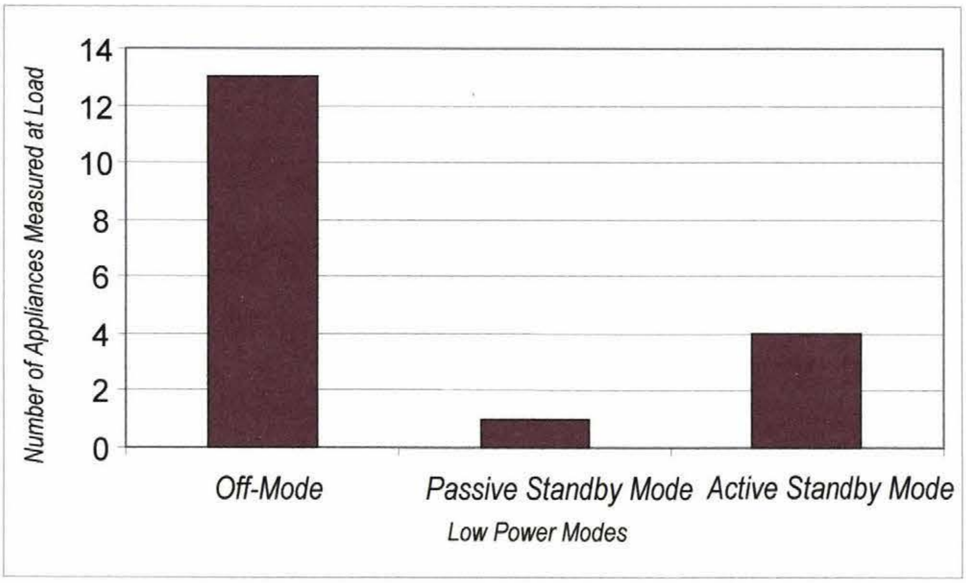
The standby power mode for all new clothes driers was the off-mode with all models having off-mode readings of under 3W. 13 valid readings of new clothes dryers available in the 2002 retail market were made and of these, 10 (77%) had a standby power of under 1W (figure 4.5). No dryer under 1W incorporated "soft touch" electronics and all used a manual mechanism (generally in the form of a knob that would turn in a clockwise direction and the preferred drying time can be set) to turn the drier on and off. These driers use power in one of two modes; off or on. The remaining 3 clothes driers (23%) had off-mode power readings of approximately 2.5 W. Again, Fisher and Paykel dominated the higher readings due to the level of sophistication of the power consuming "soft-touch" electronics.

Figure 4.5: Standby measurements for new clothes driers in off-mode (2002)



All clothes driers tested had an off mode and only the driers that had either a delay start function or soft touch electronics had a passive standby mode (1) or an active standby mode (4) (figure 4.6). Although the Fisher and Paykel driers tested were branded as a New Zealand company, all driers were manufactured overseas. It must be mentioned that Fisher and Paykel were however the first to invent the clothes drier.

Figure 4.6: Distribution of low power modes in clothes driers (2002)

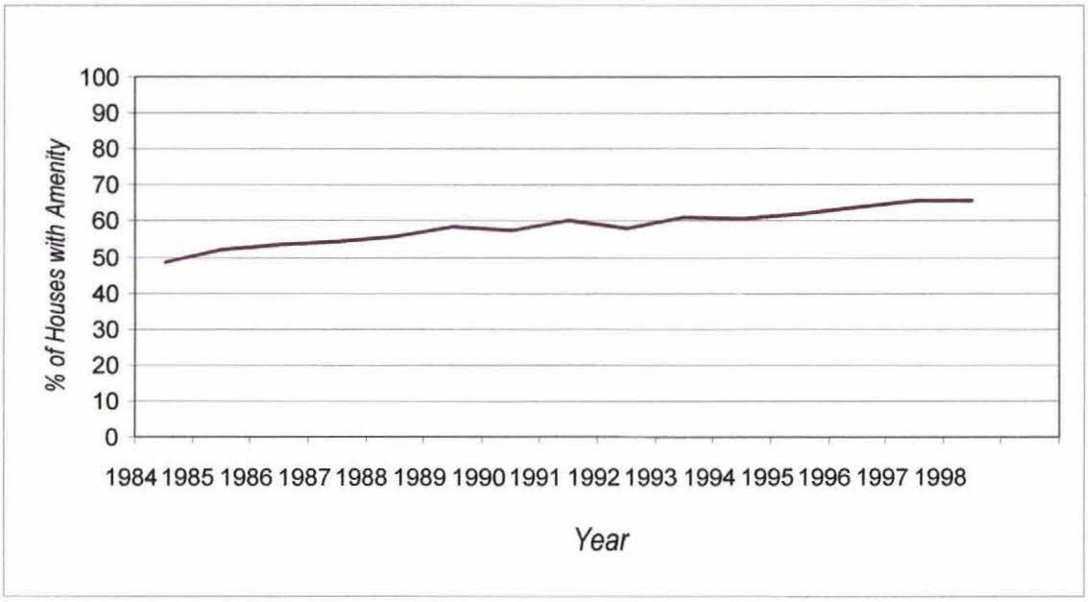


NB: All raw data from the results of the investigation including make, model, standby power off-mode, passive standby mode and active standby mode can be found in Appendix 2. This data is more detailed in terms of actual readings including decimal places, rather than providing a general indication as in the results graphed in figure 4.5. An analysis of these results is also included Appendix 2.

4.4 Dishwashers

Dishwasher ownership was found to be 38.9% of household in New Zealand (Statistics New Zealand, 2002). The market appears to be growing with recent strong market growth (figure 4.7)

Figure 4.7: Percentage of households with dishwashing machines (Source: Statistics NZ, 2002)

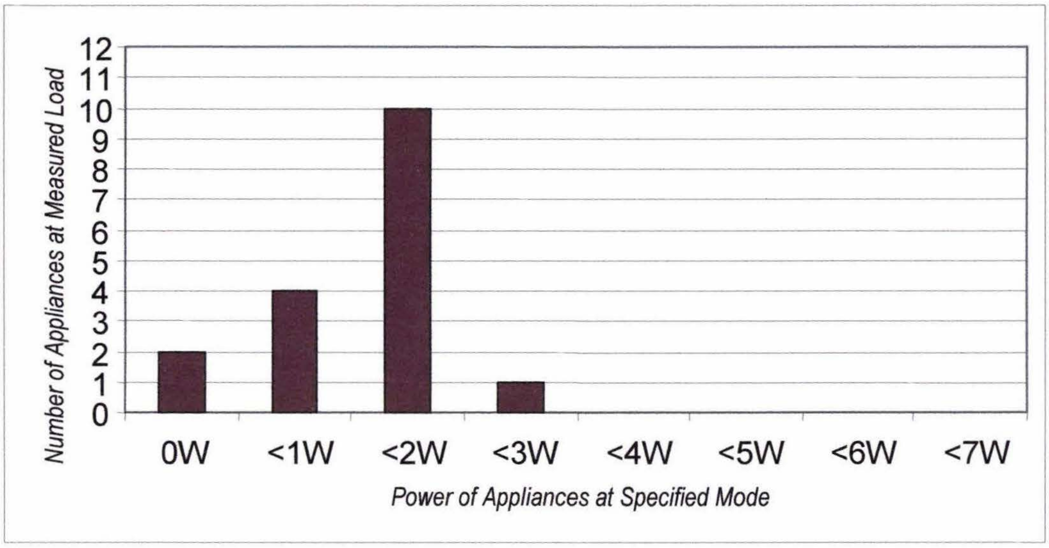


No dishwasher tested had a hard off-switch (that disconnects power completely) which would be difficult to test outside of the store showroom because most dishwashers are hardwired into a kitchen after purchase, which requires an electrician.

The lowest power mode for dishwashers is the off-mode (where the appliance appears to be switched off and function-less). Measurements were taken from 19 appliances, 10 of these measurements being from the same brand of dishwasher. There was found to be a variation of 0.01W between the different dishwashers. In total there are 8 different dishwasher brands present in New Zealand. The dishwashers with analogue settings had extremely low (0.831W) standby power measurements. Most of these brands were designed in Europe perhaps for the European market that demands low energy consumption appliances because of increasing electricity charges.

57% of the dishwashers tested had a standby power of under 1W with the remaining 43% above 1W, as shown in figure 4.8

Figure 4.8: Standby power measurements for new dishwashers, off-mode (2002).



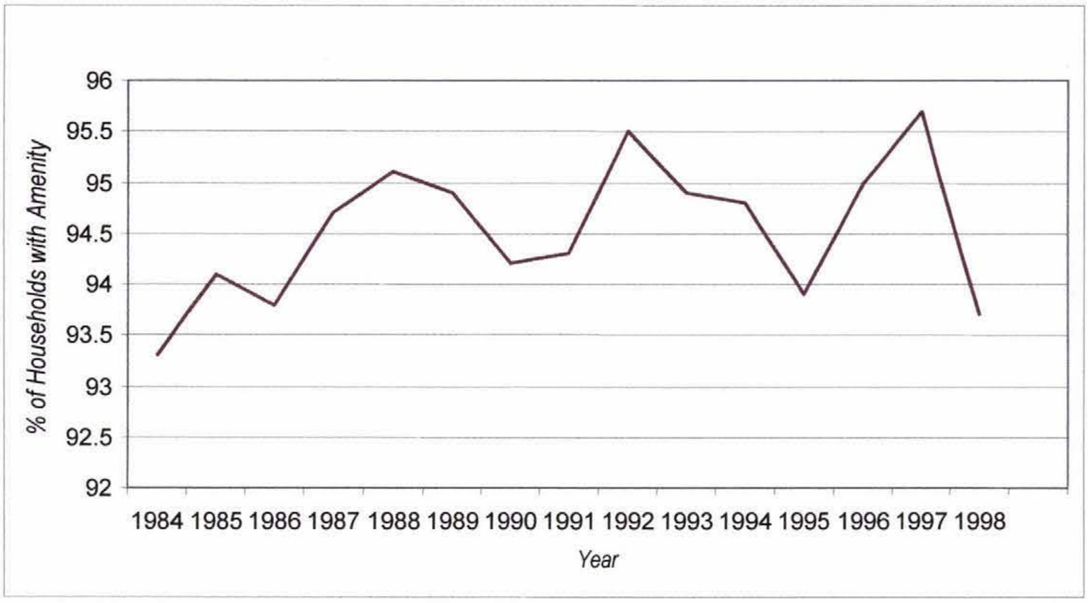
All the dishwashers tested had the off mode and the active standby mode. The active standby mode occurs when the dishwasher has finished its cycle and is waiting to be turned of by the consumer, or when the delay start option is being utilised.

Depending on the time of day the dishwasher is in use, the active standby power mode can be left on for up to five hours of the day. The average active standby power of new dishwashers on the NZ market in 2002 was 2.10 W (2dp).

4.5 Ovens

According to Statistics New Zealand (2002), Wall oven and electric range ownership stands at 93.7% of households in New Zealand. The market appears to be saturated with little to no market growth anticipated (figure 4.9).

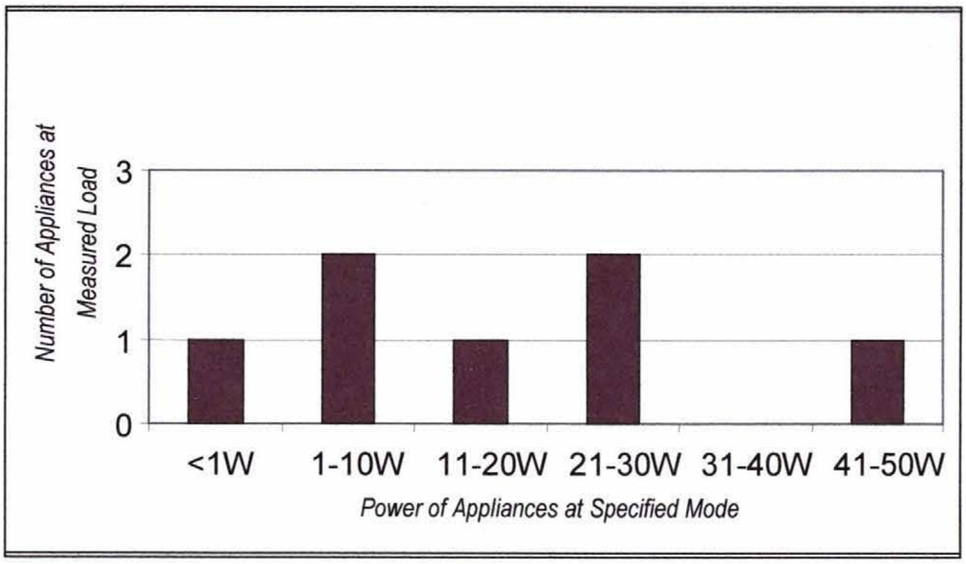
Figure 4.9: Percentage of households in New Zealand with electric ranges or wall ovens (Source: Statistics NZ, 2002).



The standby power of 7 new Fisher and Paykel ovens and ranges was collected from 7 different models, 1 of which was a freestanding range. There was a large variation in standby power between the Fisher and Paykel ovens. One of the simpler free-standing ranges that employed the use of analogue clocks and temperature dials had standby powers of under 1 W. Other ovens that employed more sophisticated clocks and soft-touch devices was significantly higher, with one reading up to 43.4W while in standby (please refer to figure 4.10).

The variation between the different brands, for example, a Fisher and Paykel oven 'pepper' with an off-mode standby reading of 0.706W and another Fisher and Paykel oven 'essence' with a standby reading of 43.4W, indicates that it is possible to reduce standby power on these appliances by changing the design functions that run on standby power, For instance one could remove the digital display panels that the results have shown use more standby power, and opt instead for the analogue option.

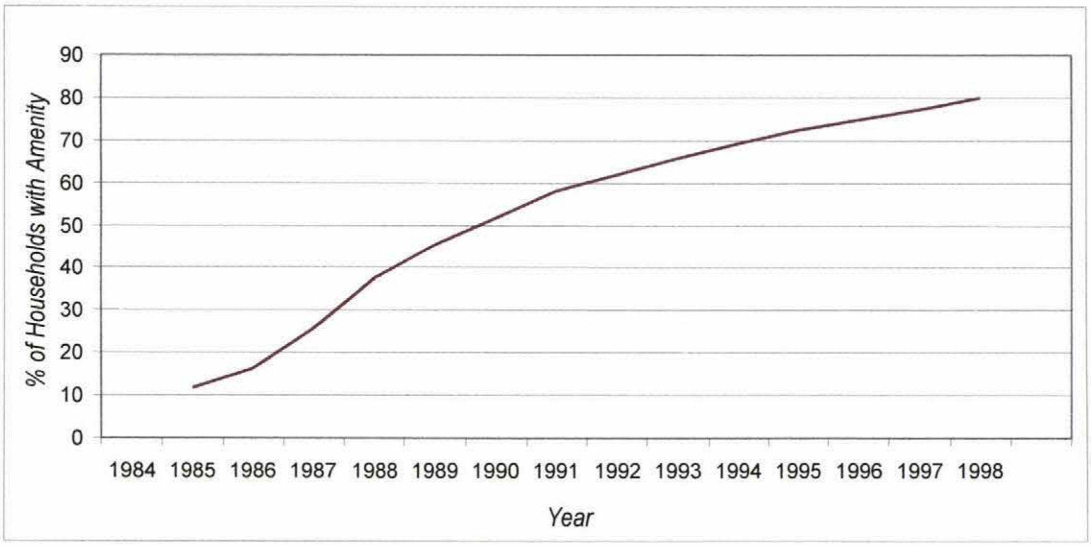
Figure 4.10: Standby measurements of new ovens and ranges, off-mode (2002).



4.6 Microwaves

Microwave ownership was found to be 81.7% of households (Statistics New Zealand, 2002) in New Zealand. The market appears to have grown at an exponential rate and is now levelling off with little market growth (figure 4.11).

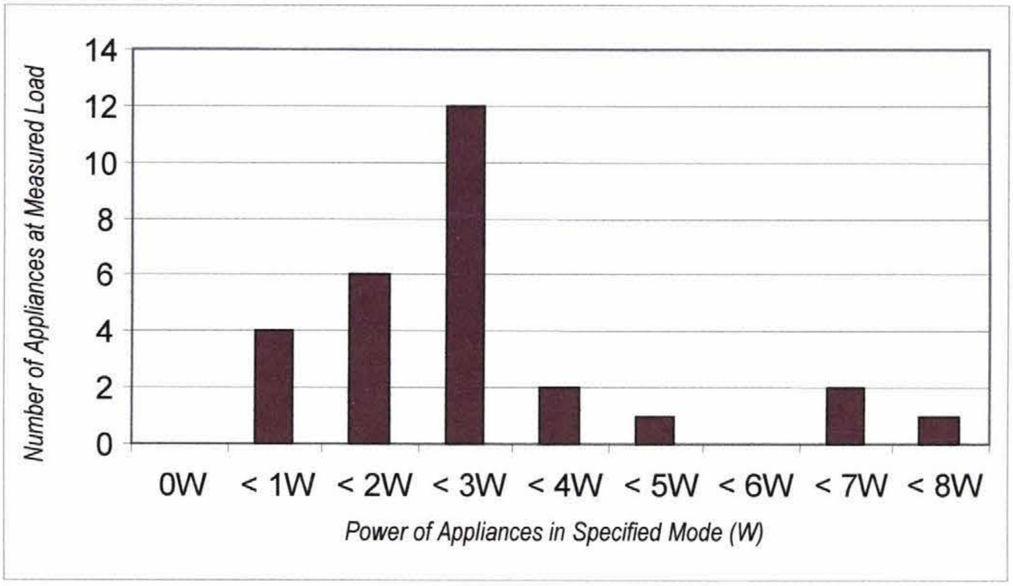
Figure 4.11: Percentage of households in New Zealand with microwave ovens (Source: Statistics NZ, 2002).



28 new microwaves were measured in the new product measurement survey. Of these, 24 microwaves (85%) were found to have their standby modes in the 'passive standby' low power mode. 24 of these microwaves all had a clock and keypad function. One of the microwaves tested even had a 'touch-screen' that allowed the consumer to use the microwave screen as

an interface that was not able to be turned off (unless at the wall) by the consumer. This obviously led to a higher overall rate of standby power. 4 microwaves (4%) had a standby power of less then 1W, this is due to the microwave having no clock and relying on a dial mechanism to start the microwave (i.e. the dial is tuned clockwise to set the time required). 3 microwaves had a standby power of above 6W. The standby power of these microwaves measured with passive standby can be viewed in figure 4.12.

Figure 4.12: Standby power measurement for new microwaves in passive standby mode (2002)

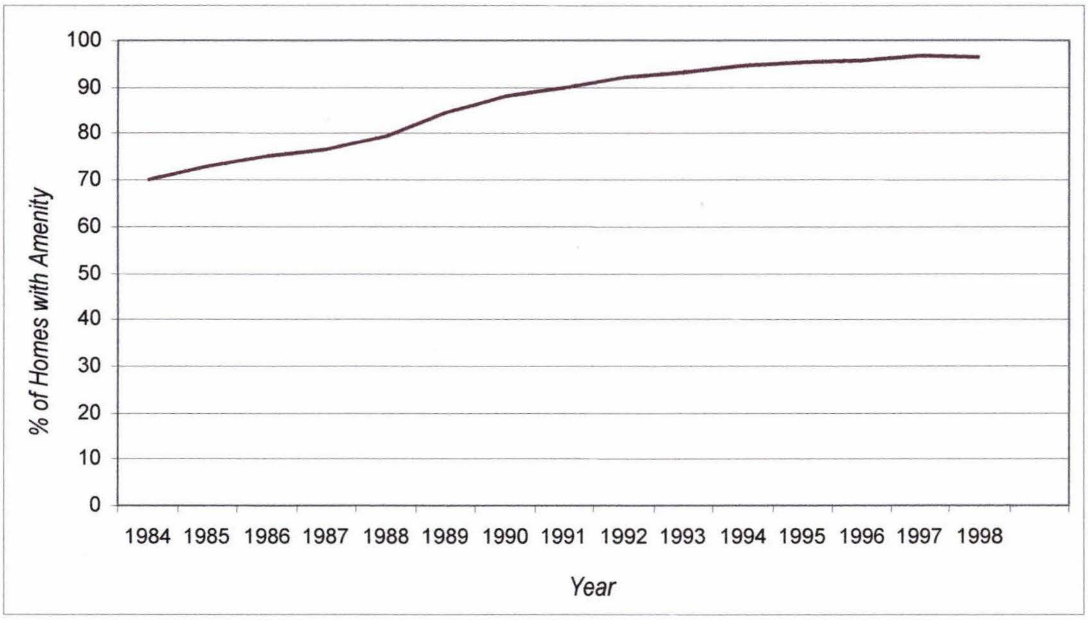


It should be noted that microwaves that do not have clocks or keypads and thus low levels of standby power are not especially common.

4.7 Televisions

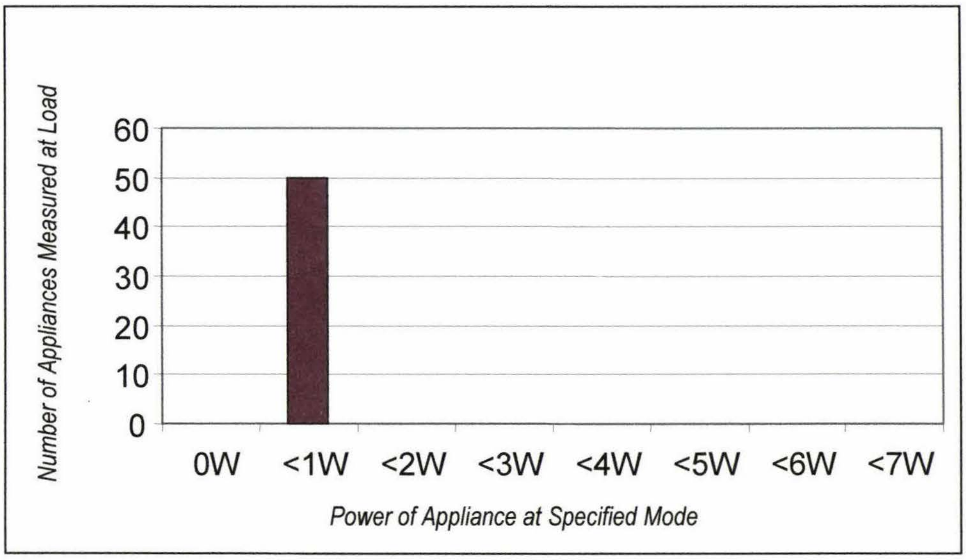
Colour television ownership was found to be 98.1% in New Zealand (Statistics New Zealand, 2002). The market appears to have grown consistently over the last 15 years and is still increasing (figure 4.13). The quantification of residential standby power consumption study that took place in Australia indicated that television ownership is currently 1.9 televisions per house and is on the increase (Harrington and Kleeverlaan, 2000). Future projections can therefore surmise that television numbers in New Zealand per household will still be increasing.

Figure 4.13: Percentage of houses with colour televisions in New Zealand (Source: Statistics NZ, 2002).



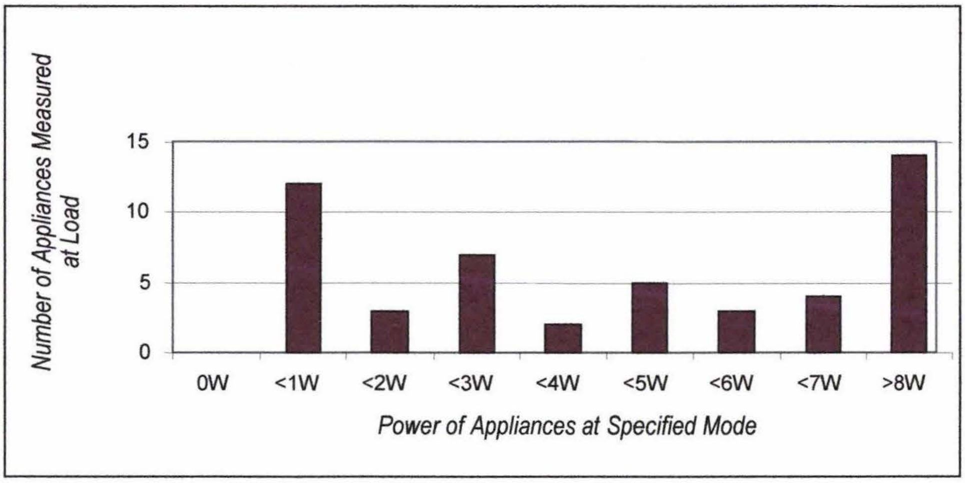
All the televisions tested had a hard-off switch where the TV could not be turned on using the remote control. The social survey showed that only 10% of people in the sample used this hard off-switch. The remaining people switch off the TV using the remote control, which is a passive standby function, hence giving rise to a new range of standby measurements. The standby power of 50 new televisions was collected and all had an off-mode standby power of under 1 Watt (figure 4.14).

Figure 4.14: Standby power of new televisions (off-mode, 2002).



All televisions tested also had a passive standby mode, the results of which can be found in figure 4.15. There is a broad variation between the passive standby readings and many of these that are brand-oriented. For instance, a brand such as Sony carrying the energy star label had a passive standby reading of under 1W. One Panasonic TV (Quintrix) was as high as 14W in passive standby mode. There does not appear to be any clear reason to why there is such a variation between different brands and even different models within brands as none of the TVs had a 'special feature' that would dramatically increase the standby power. This variation between brands indicates that attaining a passive standby reading of under 1W is an achievable goal. It should be noted that only two (out of 5 Sony TVs tested) of the Sony televisions carried Energy Star labels. No other brand carried the Energy Star label.

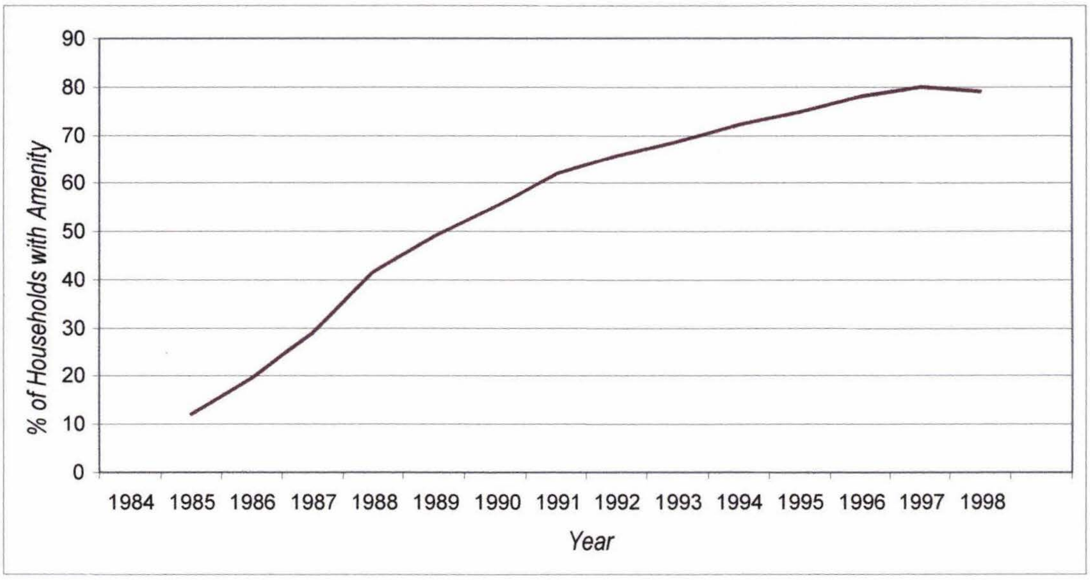
Figure 4.15: Standby power of new televisions in passive standby mode (2002).



4.8 Video Cassette Recorders (VCRs)

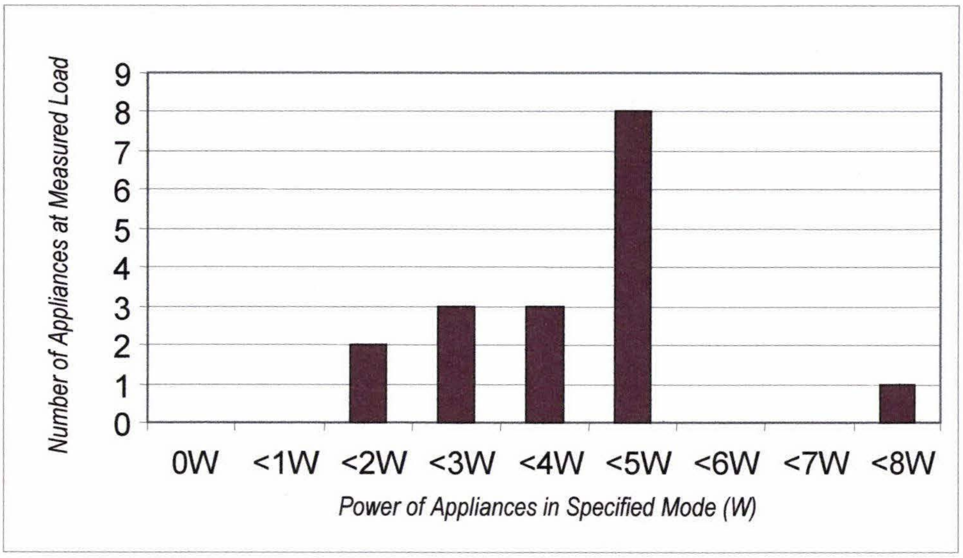
VCR ownership was found to be 82.6% of households in New Zealand (Statistics New Zealand, 2002). The market appears to have grown dramatically over the last 15 years, however it appears to now be saturated with little market growth (figure 4.16).

Figure 4.16: Percentage of households in New Zealand with video recorders (Source: Statistics NZ, 2002).



The standby power of 17 new VCRs was collected. None of the models had a standby reading of below 1W (figure 4.17). 8 of the appliances were found to be under 4W (47%) and 9 had standby power of above 4W (53%). The high standby power readings in this case were because there were no hard off-switches on VCRs tested in this project, hence the standby power readings were always on a passive standby mode. Passive standby mode refers to the VCR awaiting a signal from the remote control so that it may turn on. There were no apparent differences in features that the VCR offers that would imply such a wide variation and one would conclude that the inner circuitry would be the component accounting for the difference in standby power.

Figure 4.17: Standby power of new video players in passive standby mode (2002).

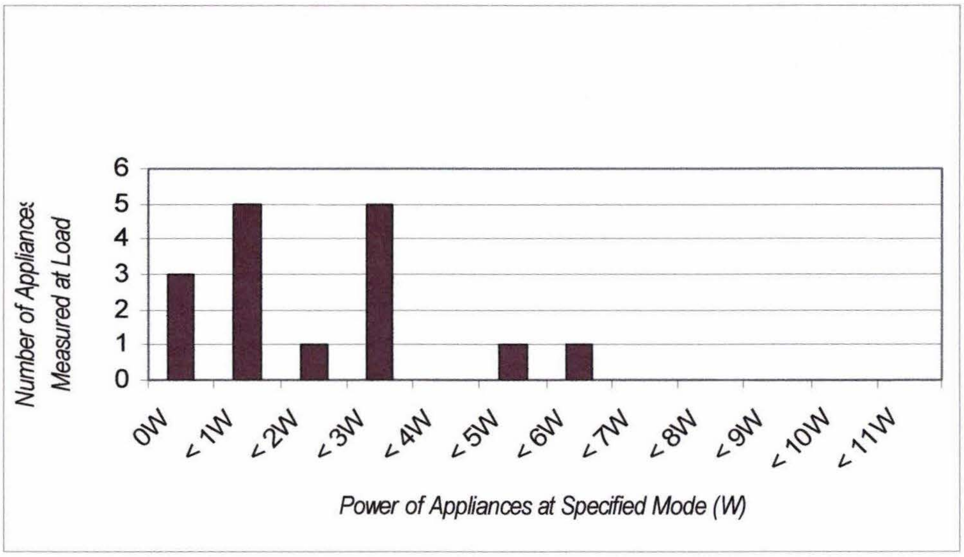


4.9 Digital Versatile Discs (DVDs)

There is no data available regarding the ownership growth of DVD players within New Zealand. However, with the price of DVD players on the decrease and the proliferation of DVD movies in the consumer market, one can expect the market to be on the rise. With the rapid introduction of DVDs onto the market and with the emergence of DVD re-writable players, the VCR market will almost definitely become obsolete within the next decade.

The standby power of 16 new DVD players was measured. There were several different low power modes associated with DVD players. 2 of the new DVD players (12.5%) had an off-mode, passive standby mode and an active standby mode. 4 of new DVD players (25%) had an off-mode and an active standby mode. Off-mode was available because of the presence of a hard-off switch where the DVD player could not be activated using a remote control. The remaining 12 (75%) had a passive standby mode and active standby mode whereby the DVD player could be activated at all times using a remote control. Figure 4.18 shows the figures for the two standby modes found for the 16 DVD players, off-mode and passive standby. All 4 of the players that had an off-mode and 5 of the players with passive standby modes had standby modes under 1W. The two outliers were the Sharp and the RCA brands, however it is unknown to why these DVD players had higher power readings as there was no difference in features between the players.

Figure 4.18: Standby power of DVD players (Off-mode and passive standby mode, 2002).



87% of all new DVD players that were tested had a standby power of under 4W. DVD players are relatively new appliances to the consumer market, and the moderately low standby power values indicate that industry would be able to lower standby power consumption in newer appliances.

4.10 Stereo equipment

There was no statistical information available concerning the ownership of stereo equipment in New Zealand. However, the new products survey found that out of the 51 stereos tested only 9% had an off-mode (these were all portable stereos). It was found that the Aiwa brand of which 9 were measured, often had significant off-mode and passive standby-mode consumption. A feature found only in stereos and audio equipment was the 'demo-mode'. The demo-mode uses the stereo's display panel to inform the consumer of different sound modes available on the stereo while the stereo is on standby, for example, disco or movie. The demo mode can be switched onto standby mode or 'eco-mode,' which is generally the passive standby mode. However in the Aiwa brand, the demo mode uses as much power as the standby mode, in some models up to 30W. This may be due to the flashing digital display on the stereo face-pad that is used in shops such as Farmers to help sell the product. This however, can be turned off when the appliance is taken home. This raises issues of consumer awareness that need promotion so that the public is fully informed when purchasing such a product. The distribution of standby power can be viewed in figure 4.19 and 4.20 below. JVC, Panasonic, Sony, Pioneer, Sharp and Phillips all consistently had low standby power of under 4W, and quite often under 1W.

Figure 4.19: Standby power of new stereos in passive standby mode (2002).

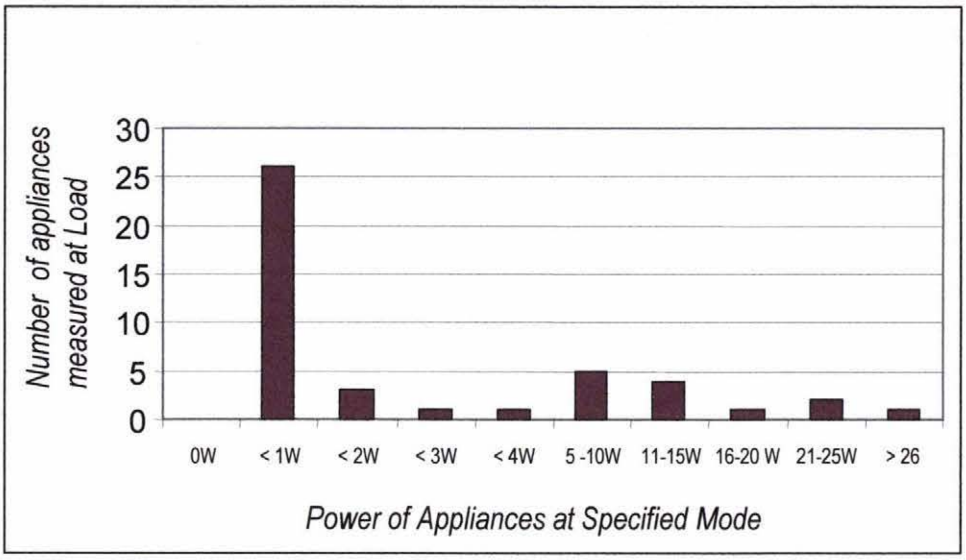
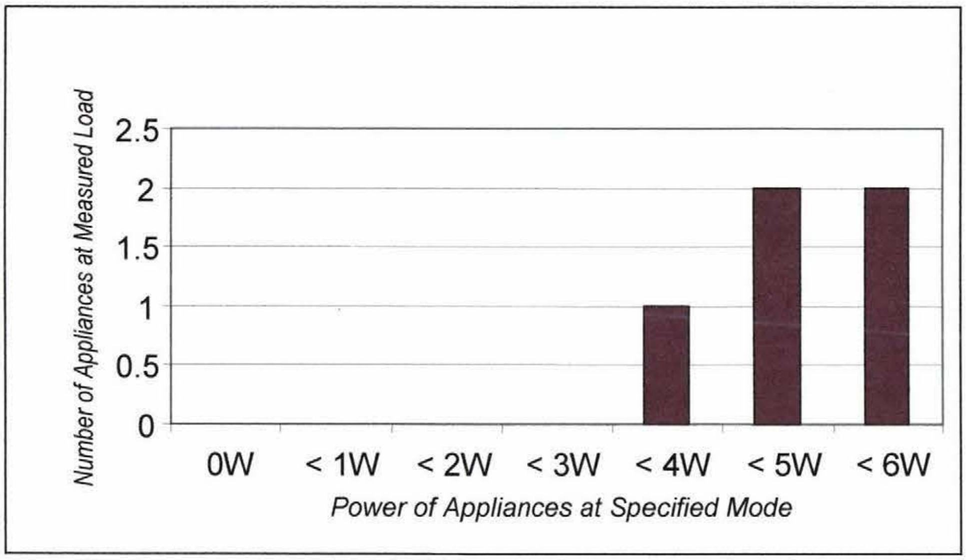


Figure 4.20: Standby power of new portable stereos in off-mode (2002).



The stereos with high standby power seemed to be limited to one manufacturer, Aiwa (8.01W, 9.02W, 14.81W, 15.38W, 20.44W, 21.69W, 25.91W, 37.9W). As mentioned above, this seems to be a result of the fact that the demo mode uses as much power as the standby mode, which may be due to its digital features. Many of the smaller mini and micro systems had standby readings of under 1W.

4.11 Personal Computers and Monitors

No household data on computer ownership is currently available. However in Australia it was found to be 0.73 per house and this appears to be increasing fast (Harrington and Kleeverlaan, 2002). One could assume that similar trends are happening in New Zealand. The off-mode was found to be the standby power mode for monitors and computers alike. Only a limited sample of 15 new computers and peripherals could be tested from the stores, these being at Farmers, Dunedin. The distribution of standby power in new computers and monitors can be seen in figure 4.21 and figures 4.22.

Figure 4.21: Standby power of new computers in off-mode (2002).

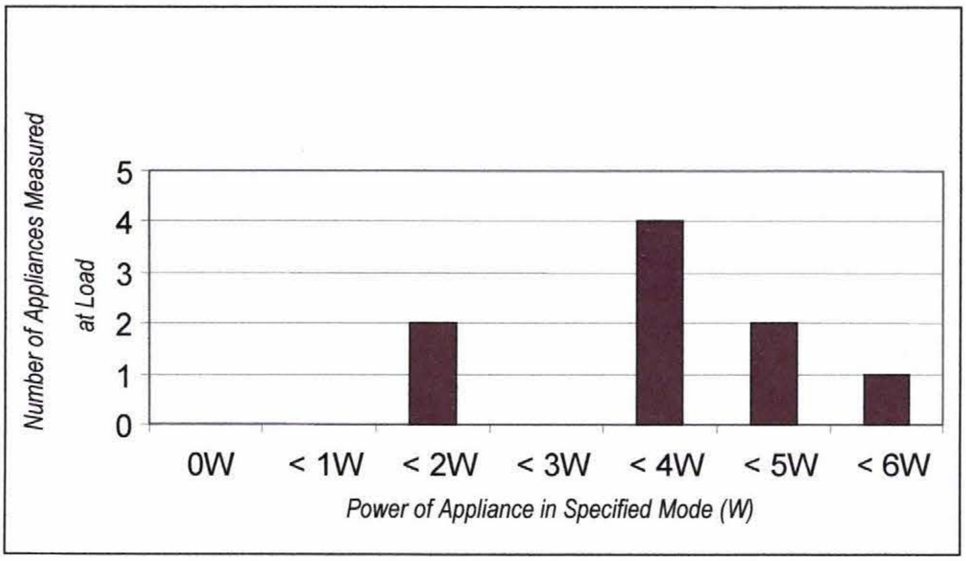
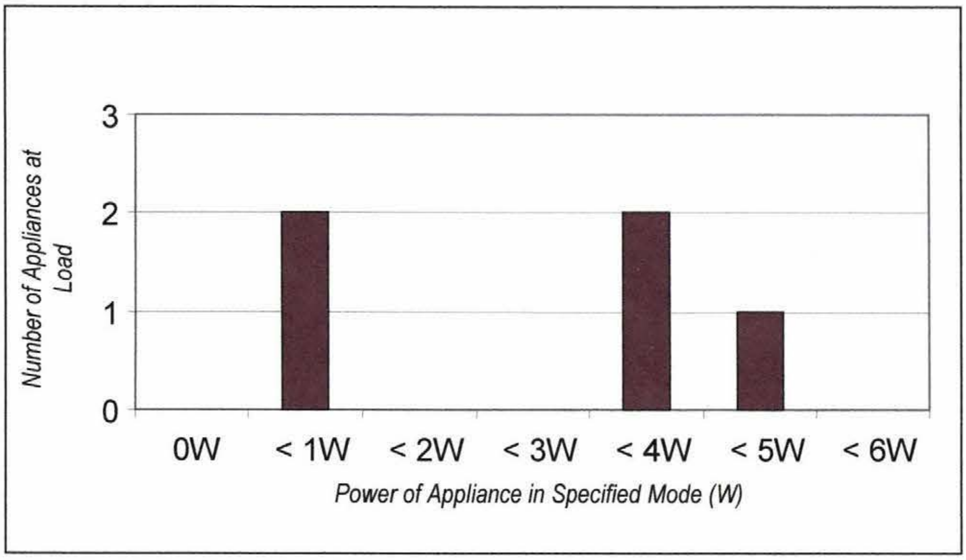


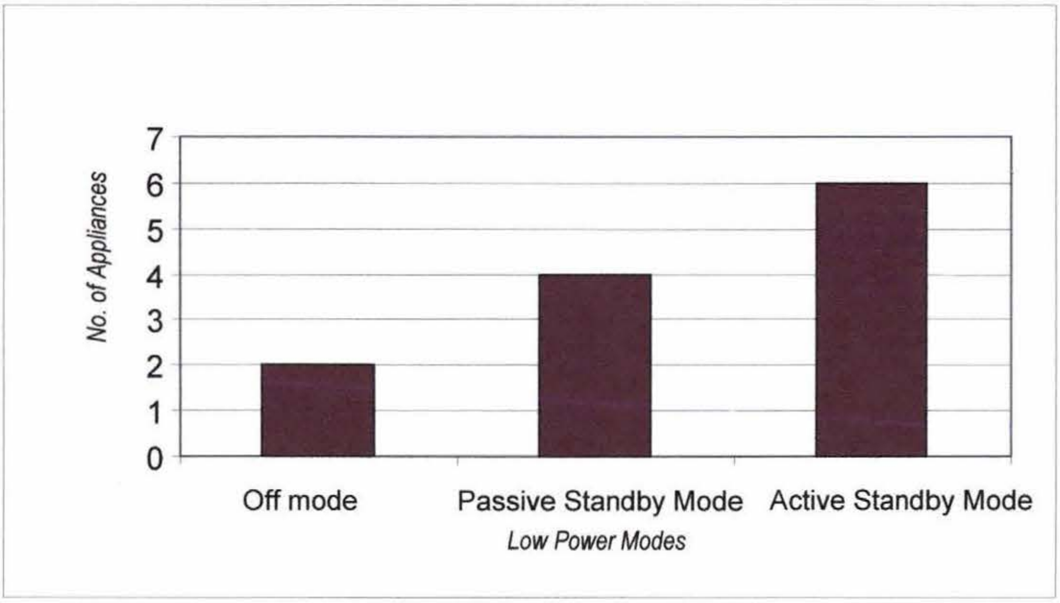
Figure 4.22: Standby power of new monitors in off-mode (2002).



4.12 Home Theatre Systems

As this is a relatively new appliance range, there is no recent data concerning the number of home theatre systems within households across New Zealand. Currently, the market for home theatres is still relatively small, with many individuals opting to make their own systems using speakers and VCR's/DVD players instead of buying the packages available in stores. Of the 6 home theatres systems measured, 2 had hard off-switches where the appliance could not be turned on using a remote control. The two appliances with hard off switches had a standby power of 0W. The remaining home theatres all had passive standby power readings that were all below 1W. The active standby mode was present in all models tested. The distribution of low power modes in new home theatres can be found in figure 4.23.

Figure 4.23: Distribution of low power modes in new home theatres (2003).



4.13 Consumer Survey

4.13.1 Aims

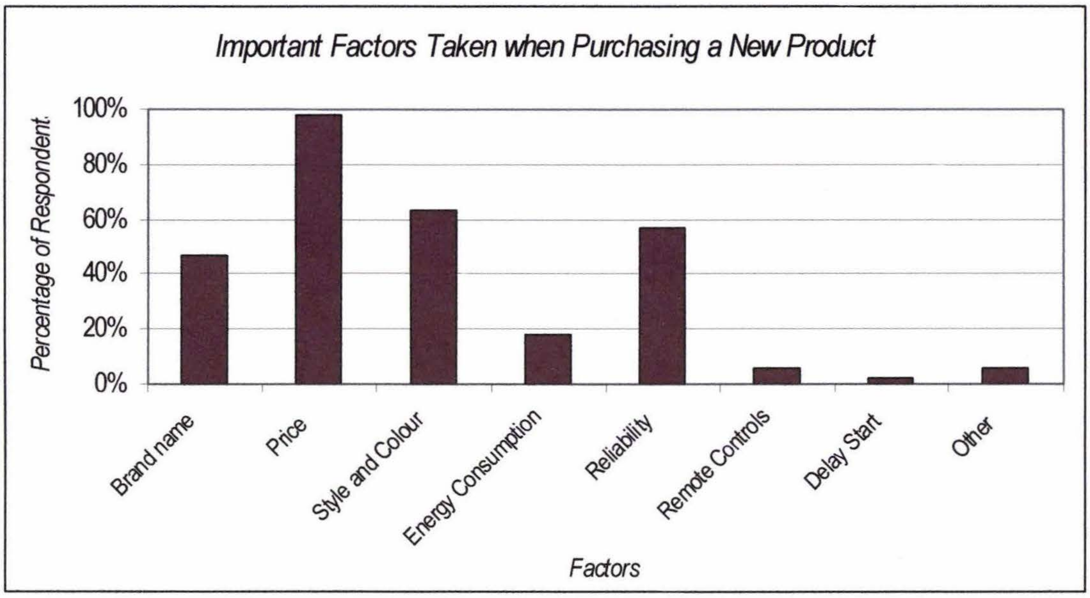
The primary objective of the social survey was to understand consumer behaviour in regard to the purchase of appliances and whether standby power features had an influence on the decision making process. The following areas were investigated through conducting the survey:

- Consumer behaviour in relation to purchasing appliances
- Consumer behaviour in relation to turning appliances off at the mains.
- Consumer behaviour in relation to turning appliances off at the appliance
- Consumer knowledge and reaction toward current energy labelling.
- Consumer knowledge of standby power.

4.13.2 Appliance features

The respondent was asked in question one what the three most important factors a consumer takes into account when purchasing a new product. Possible factors of brand name, price, style and colour, energy consumption, reliability, remote controls and delay start features were suggested to the consumer as well as an 'other' option where the interviewee had the opportunity to suggest anything else that they deemed important. Part of the questionnaire allowed for multiple answers to complete question four (Appendix 1). Figure 4.24 sets out question one results complied from the social survey.

Figure 4.24: Important factors taken into account when purchasing a new product.



The survey was conducted during the electricity crisis of 2003, where power saving was at the fore in the media. However, less then 20% of the respondents considered energy consumption to be important when selecting an appliance for purchase.

4.13.3 Turn off behaviour

The consumers were given a list of household appliances and were asked to state which of these they turned off at the wall when not in use. Consumers were most likely to turn off the cell phone charger, as demonstrated in the results that showed 41% of respondents claimed to turn their cell phones them off. 25% of respondents claimed to turn computers off at the wall when they were not in use and 16% claimed to turn stereos off at the wall.

Appliances that were not turned off at the wall were mainly because of inconvenience to the consumer. Examples of this are microwaves, stereos with clock functions, videos and occasionally ovens. The problem was that it was inconvenient to re-programme the digital clock time as it was time consuming. A summary of responses to appliances turned off at the wall is summarised in Table 4.9.

Table 4.9. Appliances turned off at the wall by consumers when appliance is not in use.

Percentage of Consumers	Appliance
Cellular phone recharger	41.2%
Computers	25%
Washing Machines	23.5%
Clothes Driers	20%
Stereos	16%
Televisions	10%
Microwaves	10%
Video players	8%
DVD players	6%
Ovens	6%
Games Consoles	4%
Dishwashers	0%
Consumers who turned no appliance off at the wall.	31%

A small percentage of consumers stated 'other' in appliances that were turned off at the wall when not in use. These included kettles, bread-makers, hairdryers, electric razors and various types of recharging units such as mini-disc, digi-cam and disc-man.

4.13.4 Energy Labelling

The second objective of the survey was to understand the extent of knowledge of the energy labelling scheme and how helpful the energy labelling was to the consumer. It was found that 69% of consumers surveyed were aware of energy labelling. 31% had never heard of it. They were therefore unable to answer question five as well as question six. In hindsight, question six should have been reworded so that consumers could respond to it.

29 of the 35 consumers who were aware of energy labelling stated that they found it to be helpful in assisting purchase decisions. However, many is it 55% according to question six) stated that this labelling would not be a deciding factor in whether or not an appliance was purchased. 4 of the respondents stated that they did not know how the labelling 'worked'. 6 respondents suggested ways that the labels could be improved. This is noted below:

- Larger sizing of labels. A few consumers made the comment that labels should be printed at a larger size in order to better seize attention.
- More advertising to educate the public about the energy labels. Many consumers stated that a lack of knowledge of the labelling system was due to the lack of advertising available to the consumer. It was felt that more consumer education was necessary in order for the consumer to understand how the labels work.

- Cost of the appliance in dollars, not just kWh. Many of the consumers noted that they did not understand the kWh power consumption value and said that the value would be more useful if it were in an approximate cost per year/day/hour.
- Comparative features displayed on the appliance. Consumers stated that the average kWh value for that particular type of appliance should be placed on the label so that cross-comparisons between appliances were easier to make.
- The labels needed to be extended beyond white-ware type appliances to stereos and other appliances.

4.13.5 Consumer knowledge of Standby Power.

The final objective of the questionnaire was to gauge the knowledge of the surveyed consumer with regard to standby power. In the past one or two years there has been a widening media interest in standby power and the topic has been discussed in many media forums. This may explain the response from this question. 89% of respondents stated that they have heard of standby power and almost all of these respondents could give a quick definition of what standby power is. However throughout these definitions it was obvious that the average consumer was not aware of the full implications of standby power. Many respondents noted that standby power was 'when a small light was on' or when the 'TV was turned off, but able to be turned on with a remote control'. Many were not aware that standby power can be taking place when the appliance has no obvious signs of being on. Only 11% of respondents stated that they had not heard of it.

The survey asked the whether the consumer would take into consideration, before purchasing a product, energy labelling along with its approximate yearly cost. 54% of respondents answered 'yes', while 16% replied 'maybe' with the reasoning that they would consider it a factor if it was a significant amount of money. 30% of consumers surveyed replied 'no' to this question, stating that it would motivate them to turn the appliance off at the wall, but it would not stop them from purchasing the appliance.

4.14 Manufacturers' Opinions

The two interviewees, Mr Bill Currie and Mr Richard Butler from Fisher and Paykel Whiteware acknowledged the fact that it would be difficult to initiate any real change in the design of products until there was some sort of legislation to make low standby power a legal requirement in electrical appliances. This is due to the myriad of factors that need to be taken into account when designing a product and the cost to the company to incorporate features that are not either demanded by the consumer or a legal requirement of the appliance itself. Their response provided the basic understanding that unless the consumer lobbied for new technologies to reduced standby power usage, there was no push for change on a manufacturing and employing staff with expertise to carry out changes would cost considerable amounts that would be acknowledged as unimportant to the consumer. It was also discussed that the onus was on the customer to lobby for changes, rather than placing sole responsibility on manufacturing companies to implement new policies concerning the reduction of standby power usage. Other manufacturers like Sony and Panasonic, however, continue to design and manufacture appliances with low standby power without any legislation in place. Incorporating low standby power in new appliances may increase in importance as market leaders set a new benchmark for manufacture and design

5.0 Discussion

5.1 Appliances

5.1.1 High Standby Appliance Groups

In all the products tested it was found that in each group there were appliances with both high and low standby power consumption levels. This indicates that the technology to reduce standby power is currently available and is ready to be taken advantage of by the manufacturers of appliances with higher standby readings. In many appliance groups, such as stereos, there is a significant difference in standby power consumption between brands. For example the Sony brand consistently had standby readings of under 1W. In comparison, the Aiwa brand 'eco-mode' had a standby power consumption ranging from 10W to 38W. Although many of the stereo systems looked similar in appearance and features, there was a vast difference in standby power consumption. This may also be indicative of the overseas reaction to standby power.

In the United States the Executive Order 13221 (Bush, 2001), required any appliance bought by government agencies to have standby readings of 1W or below. In Japan the "Top Runner" programme (1999) provides mandatory standards for manufacturers to reduce standby power in appliances. Some manufacturers have put more into research than others into reducing both active and standby power in order to meet the requirements of standby power legislation and voluntary labelling schemes.

The one appliance group that is suspected of having very high standby power is the set-top box. Popular overseas, the New Zealand equivalent of a set-top box is a sky decoder or the sky digital decoder. Studies in America have shown that the digital satellite receiver box is increasing in popularity and it is beginning to experience rapid sales growth. Current measurements suggest that these standby losses range from 11.3 to 18.4 watts. The main concern with this product is that there is virtually no difference between the on-mode and the standby mode (Meier and Huber, 1999). Due to difficulties in locating set-top boxes and time constraints, the standby power consumed by set-top box was unable to be measured. In retrospect, measurements for such appliances would have been advantageous. As this appliance becomes more popular, more research by EECA on its standby power consumption needs to be directed into developing and testing this appliance as its popularity increases in New Zealand.

5.2 Consumer Behaviour

Behavioural Survey Limitations

Some of the survey questions such as question four were ambiguous and inaccurate (see question four, Appendix 1). There was no distinction made between those who did not own an appliance and therefore could not provide a positive response and those who owned one, but did not turn it off. It is therefore considered that in hindsight the negative response to this question could be affected by the inaccuracy of the wording and has lead to results which are not fully reliable. The results however, do provide us with an interesting illustration of consumer turnoff behaviour and challenges further, more accurate research to be undertaken in regards to question four.

A further problem with the questionnaire was in regards to question 5. If the consumer did not know what standby power was, they would not be unable to properly assess their answer to question six, which asks if the consumer would take into account standby power when it came to purchasing a product. Therefore, question six may have not been truly representative of a thoroughly, thought out response and thus could be inaccurate. In retrospect, question five biased the response to question six and should have been asked in a different manner that took into account those who were unaware of what standby power was. Advice should have been sought from more avenues than solely the Fisher and Paykel interviewees.

5.2.1 Standby Power Awareness

The results of the survey undertaken indicate that 30% of New Zealanders keep all appliances plugged in at all times. The remaining 70% of consumers unplug anything from one appliance to unplugging all appliances when not in use.

Looking from a wider prospective, the question remains: whose responsibility is it to reduce standby power usage within New Zealand? Is it up to the consumer, if up to 70% keep the majority of appliances plugged in and turned on at all times; or is it up to the manufacturer to lower power consumption of products?

As a result of this research one may conclude that the answer may lie in giving both parties a portion of responsibility. This research has shown that 89% of surveyed people had an understanding of standby power, yet did not know the full extent of its importance. Nor do they know which product groups have significant standby power usage, and how much power appliances use on standby. Hence, unless there is some sort of standby power awareness scheme to educate consumers; they will remain ignorant to the extent of the problem. An advertising campaign with regards to standby power and energy labelling may be the start to increasing awareness.

Consumers could be educated though previously successful and tested campaigns like drink driving and speeding that have used TV, newspapers and documentary mediums to raise public awareness. Funds need to be directed either from the governmental sector or at the manufacturer and consumer end (for example, price raises) toward further investigations and manufacturing developments to the tested appliances that reduce standby power usage. Further investigations conducted through correct statistical methods need to be taken to collate some accurate data that can be presented to the public to stimulate consumer initiated change. These investigations need to be specific to New Zealand so that the average consumer understands and has at least a fundamental understanding of the effects of standby power usage.

5.2.2 Energy Labelling

A significant issue that needs to be addressed is the energy labelling currently in place in New Zealand. 69% of consumers surveyed were aware of energy labelling, but 31% had never heard of it. 57% of consumers found the labelling to be helpful in assisting purchases, however many stated that this labelling would not be a deciding factor in whether or not an appliance was purchased or not. 43% of consumers surveyed found that the labels were not helpful and a small number of respondents stated that they did not understand what the label was trying to communicate.

It seems that the current labelling system which deals with energy efficiency in electrical terms, such as "kWh", may be too complicated for the average New Zealander to comprehend. Simplification is needed and consumer orientated literature and media needs to take place to promote better understanding. Many of the comments made by respondents indicate that it would be better to give an average monetary value to energy consumption, as it seems more relevant and is easier to understand. 98% of those surveyed stated that price is an important factor when purchasing a new appliance; and it follows logically that these consumers should be given an after-sales estimate of how much this appliance will cost to run. This may give the consumer a clearer understanding of the product's energy efficiency and encourage a more educated decision when purchasing appliances. A positive side-effect of educating consumers in this way is that it may increase competition between manufacturers to lower both active and standby power in new appliances, in order to compete with other manufacturers.

5.3 Implications for the Standby Power Definition

The current definition of standby power in section 1.0 (IEC, 2001) has its problems because different appliances have differing standby modes. For example, the standby power for a television is off-mode. However only 10% of people surveyed in this study turn televisions off using the off-switch. This means 90% leave the television in passive-standby mode. Therefore, if a television manufacturer had to design a product to meet a requirement for standby power, they could create a television with low power consumption in the off-mode.

However, the more frequently utilized passive-standby, by not being covered by regulations and legalisation that limit its standby power levels actually negates the changes made to the TV. Therefore it would be advisable to make changes to the mode the population actually leaves an appliance in. This would require extensive research and may be a good topic for study at PhD or Post graduate level. A change in the standby power definition is also required as the current definition can be manipulated so that manufacturers can promote irresponsible design.

5.4 Legislation

Legislation needs to be implemented within New Zealand to encourage manufacturers to reduce standby power consumption in new appliances. This will help to bring new technology up to standard with countries such as the USA, Europe, Australia, Japan and China who are taking internal steps to reduce standby power. Legislation in other countries has shown that mandatory legislation is hard to monitor. The number of government officials needed to undertake the work required to make sure each manufacturer is following the rules is large, and training staff is costly (International Energy Agency, 2001). In New Zealand it could be feasible to introduce mandatory legislation, if one takes into account the small number of actual manufacturing companies. However, a campaign educating the consumer on energy labelling and the cost of standby power teamed with a voluntary manufacturers' scheme to lower standby power in conjunction with the energy star label scheme could be a successful start to addressing a national problem. Many past studies have called for a worldwide standby power labelling scheme. This worldwide scheme is seen as being necessary as many products such as driers designed in New Zealand are being manufactured and sold overseas

6.0 Conclusion

To date, New Zealand has not considered standby power to be of real importance. While many first world countries are introducing legislation and are making active movements toward reducing standby power in new appliances, New Zealand has yet to take action. There is a growing awareness of standby power in New Zealand and the topic has gained some media coverage. However, from this study it is apparent that although 89% of surveyed consumers were aware of standby power, the consumer was unaware of the extent to which standby power has accumulated through appliances. There is also a general lack of public awareness surrounding the amount of power standby modes consume nationally per year (Meier and Lebot, 2002). In the midst of a power crisis (at the time of writing, June, 2003), New Zealand has the capability to reduce power consumption by 10%, which is the fraction of total residential electricity use that standby power consumes in New Zealand. This would have to be implemented by turning all appliances off standby. Unfortunately the lack of consumer education in regard to the extent of standby power in households inhibits this saving from being made.

The possible future directions for New Zealand as a result of this study are as follows:

- Legislation should be put into place in New Zealand to encourage manufacturers to reduce standby power consumption of new appliances. Mandatory legislation may be possible to police, taking into account the small number of manufacturers in New Zealand. A campaign educating the consumer on energy labelling and the cost of standby power teamed with a voluntary manufacturers' scheme to lower standby power consumption in conjunction with education on the worldwide energy star label would be effective. Previous studies have called for a worldwide standby power labelling scheme.
- More research should be conducted into the standby consumption of the commercial and industrial sectors within New Zealand.
- Improvements in energy labelling could result from consumer education and awareness campaign with regard to energy labelling, the simplification of energy labels and the inclusion of standby power costs in these labels.

7.0 Bibliography

Aebischer, B., and A. Huser. 2000. *Networking in private households. Impacts on electricity consumption*. Report for the Swiss Federal Office of Energy, Berne.

Aulenback, A., A. Fung, A. Ferguson, and V. I. Ugursal. 2001. *Stand-by Power Requirements for Household Appliances*. Dalhousie University, Canadian Residential Energy End-use Data and Analysis Centre, Halifax CREEDAC-2001-05-04. May.

Babbie, Earl R. The Practice of Social Research. Wadsworth Publishing Company, 1998.

Bertoldi, P. et al (2002). Standby Power Use: How big is the problem? What Policies and Technical Solutions Can Address it? Presented at American Council for an Energy Efficient Econcomy (ACEEE) 2002 Summer Study.

Bush, George W. 2001. *Executive Order 13221: Energy Efficient Standby Power Devices*. July 31. http://www. whitehouse.gov/news/ releases/2001/07/20010731-10.html.

Cremer, C. and U. Boede. 2001. "Off Mode Power Consumption: The Most Hidden Part of Standby Power Losses – An Analysis of German Households." Presented at 2001 ECEEE Summer Study, Mandelieu, France.

DeGroote, W. (2001). "Wasted Electricity During Night and Weekends in five Office Buildings". Third International Workshop on standby Power, Tokyo, Energy Conservation Centre of Japan.

DTE.1997. *For All the Energy you'll ever Need*. August 2002. http://dteenergy.com/bussiness/manufacturing/powerfactor.isp

EECA. 1999. *Energy Use in New Zealand Households, Report on the Year Three Analysis for the Household Energy End Use Project (HEEP)*. Wellington, New Zealand: Energy Efficiency and Conservation Authority. June.

Energy Star. 2000. *What is Energy Star. September 2001.* http://www.energystart.gov/index

European Commission. 2001. *The EU Stand-by initiative, the European Actions to Improve Energy Efficiency of Electrical Equipment while either off or in Standby.* http://energyefficiency.jrc.cec.eu.int/html/standby_initiative.htm

Harrington, L. 2002. *Australian House Tour.* January. http://www.energyefficient.com.au/standby.

Harrington L. and P. Kleverlaan. 2001. *Quantification of Residential Standby Power Consumption in Australia: Results of Recent Survey Work.* Australian Greenhouse Office, Canberra. May.

Horowitz, N. (2002). Power Supplies: A Hidden Opportunity for Energy Savings. National Resources Defence Council. San Francisco, CA.

IEA (International Energy Agency). 2001. *Things That Go Blip in the Night: Standby Power and How to Limit It.* Paris, France.

Lin, J., A. Meier, J. Liu, and T. Li. 2002. "First Measurements of Standby Power in Chinese Homes." Submitted to *Energy for Sustainable Development.*

Lebot, B. Meier, A. and Anglade, A. Global Implications of Standby Power Use. The proceedings of ACEEE summer Study on Energy Efficiency in Buildings. Asilomar, California, June 2000.

Lge Electronics.2001. *Story of Lge: Home Networking*. 25 May 2001. http://www.Lge.com/experince/homenetworking.isp

Meier, A. (1987). Saving the "Other" Energy in Homes. Energy Auditor & Retrofitter. 4: 13-19

Meier, A. and B. Lebot. 2002. "The 1 Watt Initiative: Cutting the World's Standby Losses." presented at Energy Globe 2002, Wels, Austria.

Menti, U. 1999. *Standby-Consumption in office buildings*. Report for the Swiss Federal Office of Energy, Berne.

Meyer & Schaltegger AG. 1999. *Bestimmung des Energieverbrauchs von Unterhaltungselectronikgeraeten, Buerogeraeten und Automaten in der Schweiz*. St. Gallen, Switzerland. March.

Molinder, O. 1997. "Study on Miscellaneous Standby Power Consumption of House Equipment (light-audio-white goods)." In *Proceedings of First International Conference on Energy Efficiency in Household Appliances*, Florence, Italy.

Nakagami, H., A. Tanaka, C. Murakoshi, and B. Litt. 1997. "Standby Electricity Consumption in Japanese Houses." Presented at First International Conference on Energy Efficiency in Household Appliances, Florence, Italy.

Nakagami, C., H. Ohashi, A. Tanaka, H. Nakagami. 2001. "Energy consumption measurement survey for commercial buildings in Japan - The existence of stand-by electricity." In *2001 Summer Study Proceedings, European council for an energy efficient economy*, 2:29-31.

Ohashi, H., Tanaka, A., Nakagami, H. 2001. "Stand-by Electricity in household appliances in Japan" (in Japanese). In *Proceedings of the 17 th Conference on Energy, Economy and Environment, 2001*. Tokyo.

Rainer, L., A. Meier, and S. Greenberg. 1996. "Leaking Electricity in Homes." In *Proceedings of the 1996 American Council for an Energy Efficient Ecocnomy (ACEEE) Summer Study on Energy Efficiency in Buildings*, Pacific Grove CA.

Rath, U., M. Hartmann, A. Praeffke, and C. Mordziol. 1997. *Klimaschutz durch Minderung von Leerlaufverlusten bei Elektrogeräten*. Umweltbundesamt, Berlin Forschungsbericht 20408541 UBA-FB 97-071.

Ross, J. P. and A. Meier. 2000. "Whole-House Measurements of Standby Power Consumption," presented at Second International Conference on Energy Efficiency in Household Appliances, Naples, Italy, 2000.

Siderius, H.-P. 1995. *Household Consumption of Electricity in the Netherlands*. Van Holsteijn en Kemna, Delft (Netherlands). November.

Sidler, O. 2000. *Campagne de Mesures sur le Fonctionnement en Veille des Appareils Domestiques*. ADEME, Sophia-Antipolis, France. Report No. 99.07.092. January.

Statistics New Zealand. 2002. Household Economic Survey: Households with Amenities by Tenure of Dwelling 1998-2002.

Tanides, C. G., G. S. Dutt, and M. S. Brugnoni. 2000. "Characterisation and energy savings potential of video appliances in the Argentine residential sector." *Energy for Sustainable Development*, 14: 42-50.

Warner, J., J. Lin, A. Meier, J. Liu, and T. Li. 2002. "Measurements of Residential Standby Power Use in China." Under preparation for submission to *Energy*.

Webber, C.A., J.A. Roberson, et al. (2001). Field surveys of Office Equipment Operating Patterns. Berkeley CA, Lawrence Berkeley National Laboratory

Yokogawa Electrical Corporation.1995. *Cost Effective Digital Sampling Power Analyser*. September 2003. http://www.dqm.co.uk

Appendix 8.0

8.1.1 Appliance Behavioural Survey

Hello. My name is Inge Flinte and I am a post-graduate student from Massey University researching consumer behaviour in relation to domestic appliances and standby power. This survey will take only a few minutes to complete. Please complete all questions that are relevant to you.

1) Out of the factors listed below please select the three most important factors you take into account when choosing an electrical appliance?

- Brand Name
- Price
- Style and Colour
- Energy Consumption
- Reliability
- Remote Controls
- Delay start features
- Other (please state)

2) Are you aware of the star-rating energy labelling scheme?
If yes, go to 3
If no, go to 4

3) Do you find the energy labels helpful when making a purchase? Do you think that these labels could be improved in any way?

4) Which of the appliances listed below do you usually unplug or turn-off at the wall when they are not in use? Please state not applicable if you do not own appliance.

- Microwave
- Computer
- Television
- Video
- Cell phone charger
- Oven
- Stereos
- Dishwasher
- Washing machine
- Clothes Drier
- DVD player
- Games Console
- Other (Please State)

5) Have you heard of standby power? If yes, please explain what you understand standby power to be? If no, please state no.

6) Standby power is the power consumed by an electrical appliance when it is not fulfilling its primary function (i.e. the standby power of a TV is when it is turned off, but can still be turned on via a remote control device, the standby power of a microwave is when the microwave is not in use, but performing a secondary function such as powering a clock or keypad). If the standby power consumption of an appliance and

its approximate yearly cost was clearly shown on the energy label would this factor into your decision when buying the appliance?

8.1.2
Results of Social Survey

Brand name	Price	Style and Colour	Energy Consumption	Reliability	Remote Controls	Delay Start Features	Other
31	64	41	11	37	4	1	4
66	66	66	66	66	66	51	51
47.06%	98.04%	62.75%	17.65%	56.86%	5.88%	1.96%	5.88%

Question One

Question Two

Yes	68.63%
No	31.37%

Question Three

Yes	57%
No	43%

Question Four

Microwave	Computers	Television	Video	Cell-Phone Charger	Oven	Stereos
9.80%	25%	9.80%	7.80%	41.20%	5.90%	16%

Dishwasher	Washing Machine	Clothes Drier	DVD Player	Games Console	None
0%	23.50%	19.60%	5.90%	3.40%	31%

Question Five

Yes	90%
No	10%

Question Six

Yes	55%
No	29%
Maybe	16%

Appendix 8.2

8.2.1 Results of Appliance Survey

Washing Machine (n = 18)

Standby Power: Off mode (W) (n = 18)

Median	3.48
Lower Quartile	0.03
Maximum	4.70
Minimum	0.01
Upper Quartile	3.93

Standby Power: Active Standby mode (W) (n = 16)

Median	4.14
Lower Quartile	4.03
Maximum	17.00
Minimum	1.99
Upper Quartile	5.41

Dishwashers (n = 29)

Standby Power: Off mode (W)

Median	1.49
Lower Quartile	1.43
Maximum	2.37
Minimum	0.03
Upper Quartile	1.56

Standby Power: Active Standby mode (W)

Median	2.12
Lower Quartile	1.64
Maximum	2.79
Minimum	1.57
Upper Quartile	2.70

Clothes Dryers (n = 13)

Standby Power: Off mode (W)

Median	0.03
Lower Quartile	0.03
Maximum	2.47
Minimum	0.03
Upper Quartile	0.30

Ranges and Ovens (n = 7)

Standby Power: Off mode (W)

Median	11.56
Lower Quartile	6.74
Maximum	43.40
Minimum	0.71
Upper Quartile	22.79

Television (n = 50)

Standby Power: Off mode (W)

Median	0.03
Lower Quartile	0.03
Maximum	0.11
Minimum	0.03
Upper Quartile	0.04
Mean	0.04

Standby Power: Passive Standby Mode (W)

Median	4.33
Lower Quartile	1.04
Maximum	14.03
Minimum	0.08
Upper Quartile	7.58

Home Theatres (n = 6)

Standby Power: Passive Standby Mode (W)

Median	0.63
Lower Quartile	0.60
Maximum	0.70
Minimum	0.57
Upper Quartile	0.65
Mean	0.63

Standby Power: Active Standby Mode (W)

Median	32.77
Lower Quartile	10.97
Maximum	42.20
Minimum	2.06
Upper Quartile	37.80

Stereos (n = 51)

Standby Power: Passive Standby Mode (W)

Median	0.85
Lower Quartile	0.59
Maximum	37.90
Minimum	0.29
Upper Quartile	8.26

Mean	5.26

Standby Power: Active Standby Mode (W)

Median	19.33
Lower Quartile	14.22
Maximum	52.20
Minimum	10.06
Upper Quartile	28.53

Video Cassette Players (n = 18)

Standby Power: Passive Standby Mode (W)

Median	4.02
Lower Quartile	2.67
Maximum	7.35
Minimum	1.64
Upper Quartile	4.15

Standby Power: Active Standby Mode (W)

Median	7.58
Lower Quartile	7.29
Maximum	10.13
Minimum	6.28
Upper Quartile	9.00

Microwaves (n = 28)

Standby Power: Passive Standby Mode (W)

Mean	2.56
Median	2.30
Minimum	0.07
Maximum	7.55
Upper Quartile	2.75
Lower Quartile	1.68

Appendix 8.2.2

Results of Measurement Survey in Raw Data
(In order with results section)

Washing Machines	**Off Active Power**	**Off-Power factor**	**Off-Crest Factor**	**Passive Active Power**	**Passive Power Factor**	**Passive-Crest Factor**	**Active Active Power**	**Active-Power Factor**	**Active-Crest Factor**
Fisher and Paykel Intuitive Eco IW811 8.0 kg $1699	4.82	0.39	3.34	n/a	n/a	n/a	5.73	0.42	3.42
Fisher and Paykel Intuitive Eco IW700 $1599.95	4.50	0.38	3.59	n/a	n/a	n/a	5.29	0.40	3.51
Fisher and Paykel Intuitive Eco IW511 $1349.95	4.72	0.39	3.63	n/a	n/a	n/a	5.41	0.41	3.30
Fisher and Paykel Excellence GW711 $1399.95	3.51	0.34	3.20	n/a	n/a	n/a	4.13	0.37	3.25
Fisher and Paykel Excellence GW611 $1099.95	3.75	0.35	3.18	n/a	n/a	17.00	4.29	0.37	3.38
Fisher and Paykel Excellence GW511 $999.95	3.56	0.34	3.11	n/a	n/a	n/a	4.06	0.36	3.06
Fisher and Payel Pride MW511 5.5kg $799.95	3.56	0.34	2.98	n/a	n/a	n/a	4.14	0.36	3.22
Haier 5kg front loading washing machine XQ950HN800TX $799	0.01	0.02	1.42	n/a	OW	0	17.00	0.96	1.72
Samsung 5kg Electronic Washing Machine SW50ASP $699	1.91	0.34	2.03	n/a	>1W	0	3.09	0.60	1.78
Simpson 6kg Electonic Washing Machine 36S605K $899	0.03	0.94	oF	n/a	>2W	1.00	2.27	0.52	1.95
Simpson espirit 750 7.5kg Heavy Duty 22S750K $949 MANUAL WASHER	0.03	0.94	oF	n/a	>3W	2.00	n/a	n/a	n/a
Simposn encore 806 8.0kg heavy duty 22S806K $1299.99	0.03	0.93	oF	n/a	>4W	1.00	2.00	0.42	1.95
Simpson 5.5kg washing machine espirit 550 365550K $779 MANUAL NO ELECTRONICS	0.03	0.94	oF	n/a	>5W	6.00	n/a	n/a	n/a
Hoover 6kg Washing Machine 600MB $799.99 Manual NO ELECTRONICS	0.03	0.94	oF	n/a	>6W	5.00	n/a	n/a	n/a
Haier 5kg electronic washing machine $699 XQJ50-31A	0.01	0.01	1.42	n/a	>7W	0	2.15	0.21	1.35
Fisher and Paykel Pride Smart drive autowasher Pride 5.5 MW511	3.45	0.34	3.42	n/a	>8W	0	4.04	0.37	3.41
Fisher and Paykel Intuitive 5.5kg IW511	4.70	0.40	0.18	n/a	>9W	0	5.60	0.43	3.14
Fisher and Paykel Smart Drive Excellence 5.5/GW511	3.54	0.36	2.88	n/a	>10W	0	4.03	0.36	3.35
Fisher and Paykel Front loader Autowasher FW1800	0.03	0.90	oF	n/a	>11W	1.00	10.51	0.94	1.55
Fisher and Paykel Intuitive 7kg Autowasher IW711	4.49	0.39	3.29	n/a	>12W	1.00	5.33	0.41	3.25

NB: All results are rounded to 2 decimal places

Clothes Dryers	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive-Power Factor	Passive-Crest Factor	Active-Active Power	Active - Power Factor	Active Crest Factor
Fisher and Paykel AD55 $599.95 (manual)	0.03	0.94	oF	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel EP56 $729.95 (electronic)	2.47	0.81	1.85	n/a	n/a	n/a	3.97	0.87	1.92
Fisher and Paykel ED55 $699.95 (electronic panel)	2.44	0.85	1.94	n/a	n/a	n/a	3.70	0.88	1.96
Fisher and Paykel AD39 $449.95 (manual)	0.30	0.93	oF	n/a	n/a	n/a	n/a	n/a	n/a
Simpson 5kg electronic dryer sirocco 555 39S555K $629	0.03	0.92	oF	n/a	n/a	n/a	1.63	0.58	1.78
Simpson sirocco 500 dryer 39S500K 4.5 kg	0.03	0.92	oF	n/a	n/a	n/a	n/a	n/a	n/a
Simpson sirocco 455 dryer 39S455K 4 kg	0.03	0.92	oF	n/a	n/a	n/a	n/a	n/a	n/a
Simpson sirocco 450 4.5kg manual dryer $459.99 39P450K	0.03	0.93	oF	n/a	n/a	n/a	n/a	n/a	n/a
Simpson sirocco 350 Manual dryer $399.99	0.03	0.92	oF	n/a	n/a	n/a	n/a	n/a	n/a
Hoover 3.5kg manual dryer $419.99 3525DB	0.03	0.93	oF	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel autosensing dryer ED56	2.39	0.81	1.84	3.95 Delay start	0.87 delay start	1.90 delay start	3.75	3.75	1.93
Fisher and Paykel Manual dryer AD55	0.03	0.91	oF	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel Manual Dryer AD39	0.03	0.94	oF	n/a	n/a	n/a	n/a	n/a	n/a

Dishwashers	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive Active Power	Passive-Power Factor	Passive-Crest Factor	Active-Active Power	Active-Power Factor	Active-Crest Factor
Simpson Manual Dishwasher WQP12BFE	0.03	0.91	oF	n/a	n/a	n/a	n/a	n/a	n/a
Haier dishwasher WQP12BFE $999.99	0.03	0.06	3.03	n/a	n/a	n/a	2.10	0.57	2.37
Westinghouse dishwasher (electronic) SB905WH $999.99	0.85	0.40	2.04	n/a	n/a	n/a	1.82	0.70	1.49
Dishlex electronic dishwasher DX300WA Global 300 $1199.99	2.37	0.65	1.96	n/a	n/a	n/a	2.54	0.69	1.89
Haier dishwasher WQP12AFM2 $699	0.12	0.01	1.42	n/a	n/a	n/a	2.15	0.21	1.35
Fisher and Paykel Nautilus 920 dishwasher	1.60	0.77	2.70	n/a	n/a	n/a	2.70	0.82	2.60
Fisher and Paykel Nautilus 920 dishwasher	1.55	0.78	2.60	n/a	n/a	n/a	2.70	0.83	2.60
Fisher and Paykel Nautilus 920 dishwasher	1.60	0.81	3.40	n/a	n/a	n/a	2.79	0.84	2.98
Fisher and Paykel Nautilus 920 dishwasher	1.49	0.81	3.20	n/a	n/a	n/a	2.70	0.83	2.80
Fisher and Paykel Nautilus 920 dishwasher	1.58	0.80	3.40	n/a	n/a	n/a	2.73	0.84	2.90
Fisher and Paykel Nautilus 920 dishwasher	1.56	0.79	3.80	n/a	n/a	n/a	2.74	0.83	3.34
Fisher and Paykel Nemo 820 dishwasher	1.49	0.76	2.80	n/a	n/a	n/a	1.68	0.77	3.00
Fisher and Paykel Nemo 820 dishwasher	1.43	0.76	3.17	n/a	n/a	n/a	1.62	0.78	3.00
Fisher and Paykel Nemo 820 dishwasher	1.49	0.78	3.19	n/a	n/a	n/a	1.63	0.80	2.96
Fisher and Paykel Nemo 820 dishwasher	1.45	0.78	3.23	n/a	n/a	n/a	1.60	0.79	3.70
Fisher and Paykel Nemo 820 dishwasher	1.47	0.79	3.40	n/a	n/a	n/a	1.57	0.79	3.66
Fisher and Paykel Nemo 820 dishwasher	1.47	0.78	3.90	n/a	n/a	n/a	1.64	0.79	4.20
Fisher and Paykel Dishdrawer	2.90	0.12	6.99	n/a	n/a	n/a	5.10	0.14	6.39

Ovens and Ranges	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive-Power Factor	Passive Crest Factor	Active-Active Power	Active-Power Factor	Active-Crest Factor
Fisher and Paykel Titan 545 American	9.26	0.30	2.26	n/a	n/a	n/a	71.20	0.94	1.49
Fisher and Paykel Essence BI601ED	43.40	0.69	1.58	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel Prema BI601E	21.29	0.87	1.58	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel Essences BI601X	4.22	0.63	3.25	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel Prema BI601E	27.29	0.86	1.49	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel Astro E BI601QASE	7.58	0.86	1.49	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel Astro Tower BI601QASE2	13.85	0.59	1.52	n/a	n/a	n/a	n/a	n/a	n/a
Fisher and Paykel Pepper RA6102MEWC range	0.71	0.18	1.50	n/a	n/a	n/a	n/a	n/a	n/a

Microwaves	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive-Power Factor	Passive-Crest Factor	Active-Active Power	Active-Power Factor	Active-Crest Factor
Samsung MID33CE Clock $299.95	n/a	n/a	n/a	2.86	0.74	1.74	n/a	n/a	n/a
Panasonic NNS952 Clock $479.95	n/a	n/a	n/a	2.70	0.03	1.43	n/a	n/a	n/a
DeLongi Microwave Clock $1399.95	n/a	n/a	n/a	0.99	0.29	2.71	n/a	n/a	n/a
Samsung sensor Clock MID34NCE $299.95	n/a	n/a	n/a	3.13	0.81	1.67	n/a	n/a	n/a
Panasonic Clock NN-T791SF $879.95	n/a	n/a	n/a	2.30	0.03	1.44	n/a	n/a	n/a
Samsung Clock MID83 $399.95	n/a	n/a	n/a	6.77	0.57	2.31	n/a	n/a	n/a
Panasonic Clock NN-S562WF $429.95	n/a	n/a	n/a	2.30	0.03	1.43	n/a	n/a	n/a
Samsung Clock MI98SCI $499.9	n/a	n/a	n/a	7.55	0.57	2.24	n/a	n/a	n/a
Panasonic NO Clock NN-MX20 $199.95	n/a	n/a	n/a	0.15	0.08	1.50	n/a	n/a	n/a
Panasonic Clock NN-S552WF $339.95	n/a	n/a	n/a	2.30	0.03	1.44	n/a	n/a	n/a
Panasonic Clock NN-S451WF $329.95	n/a	n/a	n/a	2.40	0.03	1.44	n/a	n/a	n/a
Haier 24 litre microwave HR7803D $299.99 clock	n/a	n/a	n/a	3.13	0.68	1.64	n/a	n/a	n/a
LG microwave MS192A 19 litre 800 Watts NO CLOCK	n/a	n/a	n/a	0.07	0.04	1.39	n/a	n/a	n/a
Tiffany Microwave MWO17A NO CLOCK	n/a	n/a	n/a	0.15	0.02	1.37	n/a	n/a	n/a
Sharp microwave Carousel 210D No clock	n/a	n/a	n/a	1.67	0.51	2.10	n/a	n/a	n/a
Sharp microwave Carousel R240E Clock	n/a	n/a	n/a	1.36	0.63	1.92	n/a	n/a	n/a
LG microwave M5194A Clock	n/a	n/a	n/a	2.80	0.63	2.42	n/a	n/a	n/a
Panasonic Microwave NN-S540 clock	n/a	n/a	n/a	2.40	0.03	1.41	n/a	n/a	n/a
Sharp Carousel R230F Clock	n/a	n/a	n/a	1.35	0.64	1.92	n/a	n/a	n/a
Sharp Carousel R340F Clock	n/a	n/a	n/a	1.95	0.80	1.48	n/a	n/a	n/a
LG Microwave LGMS314 Clock	n/a	n/a	n/a	1.71	0.65	1.90	n/a	n/a	n/a
Panasonic NN-S560W Clock	n/a	n/a	n/a	2.40	0.03	1.39	n/a	n/a	n/a
Sharp Carousel 'Sensor' R390D 'Touch screen'	n/a	n/a	n/a	6.23	0.83	1.68	n/a	n/a	n/a
Sharp Carousel R380E clock	n/a	n/a	n/a	4.03	0.70	1.72	n/a	n/a	n/a
LG Microwave MS305GL clock	n/a	n/a	n/a	2.62	0.62	2.37	n/a	n/a	n/a
Panasonic Microwave NN-S751 Clock	n/a	n/a	n/a	2.40	0.03	1.38	n/a	n/a	n/a
Panasonic T790 Clock	n/a	n/a	n/a	2.20	0.03	1.39	n/a	n/a	n/a
Sharp Carousel clock	n/a	n/a	n/a	1.98	0.79	1.53	n/a	n/a	n/a

Televisions	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive- Power Factor	Passive-Crest Factor
Panasonic TX-68P82Z Quintrix F 32"	0.03	0.67	oF	14.03	0.76	3.15
RCA 28WR22 Widescreen $999.95 32"	0.03	0.82	oF	0.74	0.11	1.43
Philips 32PW9556 Widescreen $3799.95 32"	0.04	0.88	oF	0.36	0.05	1.45
Thomson 32VK4SE $2499.95 32"	0.03	0.90	oF	1.73	0.31	4.21
Philips 32PW6516 Widescreen $2999.95 32"	0.07	0.01	1.45	2.54	0.30	1.77
Samsung WS32Z4HF $3999.95 32"	0.03	0.93	oF	2.15	0.24	2.44
RCA 28DG17E $999.95 28"	0.03	0.88	oF	4.92	0.63	4.39
JVC AV25L53 $1299 25"	0.03	0.92	oF	4.43	0.41	3.61
Panasonic TX-60P82Z $1299 25"	0.03	0.70	oF	10.26	0.67	3.30
Philips 25PT2152 $899 28"	0.03	0.93	oF	0.87	0.05	2.49
Panasonic TX-60P82Z $1299 25"	0.09	0.01	1.44	2.58	0.15	5.66
Philips 32PW8807 $ 3999.95 32"	0.03	0.91	oF	0.97	0.11	1.56
Sony Widescreen CTV EH32 $3999.95 32" EStar	0.03	0.92	oF	0.36	0.12	1.57
Philips Platinum Widescreen 32PW9576$4699.95	0.03	0.92	oF	1.00	0.12	1.51
JVC Big screen CTV AV29WS $1799.95 29"	0.03	0.95	oF	4.43	0.41	3.88
Toshiba big screen 29A3TA $1099.95 29"	0.06	0.02	1.50	6.32	0.64	3.66
Toshiba 29AZ502 $1699.95 29"	0.06	0.02	1.52	5.23	0.43	3.04
Philips 29T9420 29" $3299.95 29"	0.03	0.93	oF	1.07	0.13	2.23
Sony DR29 $3799.95 29" energy star	0.11	0.01	1.60	0.73	0.04	1.52
Panasonic TX68P250 $2799.95 29"	0.10	0.01	1.49	2.62	0.15	5.93
Thomson 29DF45EA $2499.95 29"	0.03	0.95	oF	1.79	0.32	4.00
Toshiba 21A3 CTV $1599.95 CTV	0.06	0.02	1.52	12.59	0.59	3.51
Philips 21PT2252 $749.95 21"	0.03	0.93	oF	0.72	0.08	2.14
Panasonic TX51PS722 $799.95 21"	0.03	0.93	oF	7.64	0.50	3.63
Philips 21PT2303 $799.95 21"	0.03	0.93	oF	0.08	0.09	2.27
JVC AV-21W53 $849.95 21"	0.03	0.95	oF	4.39	0.40	3.80
Sony PG21 21" $649.95	0.09	0.06	1.52	8.18	0.57	3.79
RCA 21DG170 $599.95 21"	0.03	0.93	oF	4.33	0.67	4.48

Televisions continued	Off Active Power	Off Power Factor	Off Crest Factor	Passive Active Power	Passive Power Factor	Passive Crest factor
Panasonic TC21515M $649.95 21"	0.03	0.94	oF	7.51	0.50	3.64
JVC AV-21Q3 $649.95 21"	0.03	0.94	oF	5.78	0.59	3.56
Samsung CB20RI $499.95 21"	0.05	0.01	1.53	9.88	0.67	3.45
Philips 15PT2302 $499.95 15"	0.03	0.94	oF	2.03	0.26	3.48
Panasonic TC36M10 $579.95 15"	0.03	0.94	oF	6.14	0.51	4.37
Sony PG14 $579.95 15"	0.09	0.06	1.49	9.32	0.63	3.53
JVC AV-14A3 $399.95 14"	0.03	0.94	oF	5.91	0.59	3.54
Samsung CB14R1 $399.95 14"	0.05	0.01	1.51	7.00	0.55	3.50
RCA 34CMV $369.95 14"	0.03	0.95	oF	3.91	0.69	4.06
Philips 29PT6361 $2099 29"	0.03	0.87	oF	2.32	0.26	3.26
Philips 29PT8419 29"	0.03	0.89	oF	0.78	0.10	1.86
Philips 32PW8807$3599 32"	0.03	0.88	oF	0.88	0.10	2.93
RCA Widescreen 32WR22EA $1999	0.03	0.88	oF	3.91	0.31	7.98
Panasonic TX-76PW50A $3799 32"	0.10	0.01	1.66	2.60	0.15	6.23
LG RT21FA31X $799 21"	0.03	0.86	oF	9.58	0.58	4.17
LG CT29M30EX $1199 29"	0.03	0.85	oF	9.36	0.50	3.77
LG RT29FA30RX $1699 29"	0.03	0.86	oF	12.99	0.53	3.30
LG RT29FA31PX $2499 29"	0.03	0.85	oF	12.91	0.54	3.45
LG Turbos search CF21T3IKX $649	0.03	0.86	oF	7.00	0.53	3.90
Jenson $599 29"	0.03	0.77	oF	12.80	0.57	3.78
Philips Tube television 25" $1099	0.03	0.88	oF	0.81	0.09	3.93
Sony Tube television 25" $1299	0.11	0.01	1.44	0.65	0.03	1.41
LG Television 25" $969	0.03	0.87	oF	8.32	0.47	4.27

Video Casette Recorders (VCRs)	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive-Power Factor	Passive-Crest Factor	Active-Active Power	Active-Power Factor	Active-Crest Factor
Sony VHS SLV-EZ725 $479.95	n/a	n/a	n/a	3.56	0.44	4.33	9.00	0.50	3.71
Sony VHS SLV-EZ121 $329.95	n/a	n/a	n/a	2.47	0.38	4.69	7.45	0.49	3.91
Panasonic SJ230 $299.95	n/a	n/a	n/a	4.1	0.46	4.18	7.58	0.47	4.59
Philips VR330 $299.95	n/a	n/a	n/a	4.59	0.42	5.17	6.28	0.42	5.12
Philips VR620 $399.95	n/a	n/a	n/a	7.35	0.47	4.13	9.69	0.48	4.06
Samsung SV250X $259.95	n/a	n/a	n/a	2.67	0.41	4.01	7.53	0.49	3.86
JVC HRJ695 $499.95	n/a	n/a	n/a	1.9	0.35	3.81	7.17	0.51	0.36
Philips VHS VR730 $449.95	n/a	n/a	n/a	4.66	0.41	6.16	7.54	0.45	6.46
Samsung VHS SV-650X $499.95	n/a	n/a	n/a	3.66	0.45	4.01	9.06	0.51	3.68
LG VHS player CC47OTW $349	n/a	n/a	n/a	2.19	0.36	4.47	7.07	0.49	3.67
Philips Hi-Fi Video Recorder VR620 $399	n/a	n/a	n/a	4.15	0.42	4.64	10.13	0.49	3.91
Sharp VHS-VCA301 $319	n/a	n/a	n/a	1.64	0.37	5.89	7.29	0.50	3.72
Panasonic VHS NV-FJ630 $479	n/a	n/a	n/a	4.02	0.46	4.04	8.91	0.51	3.88
Panasonic VHS NV-SJ430 $399	n/a	n/a	n/a	4.11	0.46	4.03	8.19	0.51	3.96
Panasonic VHS NV-SJ230 $329	n/a	n/a	n/a	4.14	0.47	3.99	7.75	0.51	3.81
Samsung SV-641X $379	n/a	n/a	n/a	3.22	0.41	3.80	9.88	0.54	3.21
Philips VHS VR330 $279	n/a	n/a	n/a	4.54	0.48	4.09	6.35	0.50	4.09

Digital Versatile Discs (DVDs)	Off Active Power	Off Power Factor	Off Crest Factor	Passive Active Power	Passive Power Factor	Passive Crest Factor	Active Active Power	Active Power Factor	Active Crest Factor
Toshiba DVD player SD-2500 $549.95	n/a	n/a	n/a	1.73	0.32	5.16	12.99	0.52	3.95
Panasonic DVD-RV32 $499.95	n/a	n/a	n/a	2.85	0.43	4.05	9.04	0.52	4.09
Sony DVD-N305 $499.95	n/a	n/a	n/a	0.19	0.11	2.10	9.93	0.52	3.87
Philips DVD616K $349.95	n/a	n/a	n/a	0.53	0.11	1.84	13.25	0.57	3.51
Samsung Multi DVD player DVD-S124 $449.95	n/a	n/a	n/a	2.98	0.43	3.68	12.23	0.53	3.82
Philips DVDQ35 $599.95	n/a	n/a	n/a	0.56	0.12	1.81	11.40	0.56	3.34
Panasonic DVDXV10 $799.95	n/a	n/a	n/a	2.20	0.37	3.83	8.02	0.46	4.72
Lenoxx DHT800 $699	n/a	n/a	n/a	0.03	0.71	oF	36.84	0.85	2.09
RCA DVD player DRA5008 $379	0.03	0.03	oF	10.93	0.50	4.36	n/a	n/a	n/a
Sony DVD player $599	0.06	0.03	1.43	0.39	0.11	2.36	n/a	n/a	n/a
Samsung DVD/CD/MP3+VCR player $799	n/a	n/a	n/a	4.64	0.47	4.15	18.43	0.58	3.12
LG DVD/CD player DV472IP $449	n/a	n/a	n/a	2.28	0.33	4.24	10.66	0.53	3.41
Panasonic DVD-RV31	n/a	n/a	n/a	2.20	0.40	3.82	7.21	0.53	3.18
Phillips DVD player DVD616 $399	0.54	0.12	1.90	n/a	n/a	n/a	12.05	0.57	3.23
Sharp DVD player DV40X $499	n/a	n/a	n/a	5.08	0.43	4.13	14.41	0.52	4.09
Sony DAV-C450 Compact AV system $1499.95 Energy Star	0.31	0.61	oF	n/a	n/a	n/a	1.54	0.31	4.26

Stereos - portable no remote	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive-Power Factor	Passive-Crest Factor	Active-Active Power	Active-Power Factor	Active-Crest Factor	Demo-Active Power	Demo Power Factor	Demo Crest Factor
Panasonic RXD17 radio/cassette/cd $199	4.54	0.23	2.00	n/a	n/a	n/a	6.36	0.65	1.56	n/a	n/a	n/
Sony CFO-S100 CD/radio/cassette	3.78	0.27	2.06	n/a	n/a	n/a	5.98	0.70	1.72	n/a	n/a	n/
Philips AZ1003 $149.95	5.15	0.25	2.16	n/a	n/a	n/a	7.16	0.69	1.82	n/a	n/a	n/
Philips AZ1080 $199.95	5.17	0.25	2.08	n/a	n/a	n/a	6.13	0.61	1.58	n/a	n/a	n/
Philips CD/radio player AZ3010 $169.95	n/a	n/a	n/a	8.42	0.27	1.96	11.66	0.67	1.89	n/a	n/a	n/
Philips MP3 - CD playback AZ1155 $369.95	4.54	0.28	2.01	n/a	n/a	n/a	6.13	0.68	1.79	n/a	n/a	n/

Stereos- portable with remote	Off Active Power	Off Power factor	Off-Crest Factor	Passive Active Power	Passive-Power Factor	Passive-Crest Factor	Active-Active Power	Active Power Factor	Active-Crest Factor	Demo-Active Power	Demo-Power Factor	Demo-Crest Factor
Sharp XL-30 Micro Component system $299	n/a	≤ 1W	0	0.97	0.50	1.95	10.06	0.75	1.75	n/a	n/a	n/a
Sharp XL60W Micro Component System $439	n/a	≤ 2W	0	0.88	0.54	1.80	14.31	0.65	1.65	n/a	n/a	n/a
Sharp XL-1000 Compact Audio System $449	n/a	≤ 3W	0	0.91	0.58	1.67	12.96	0.76	1.73	n/a	n/a	n/a
Panasonic SA0PM25 CD stereo system $599	n/a	≤ 4W	1	0.78	0.56	1.70	14.53	0.69	1.73	n/a	n/a	n/a
Aiwa XR0M150 Micro System	n/a	≤ 5W	2	9.02	0.44	2.06	12.31	0.56	1.85	n/a	n/a	n/a
Kenwood Micro hi-fi component system $499	n/a	≤ 6W	2	0.29	0.33	1.91	18.13	0.75	1.77	n/a	n/a	n/a
Sony CMT-EP303 Micro Hi Fi component system $399 Energy Star	n/a	n/a	n/a	0.45	0.89	1.74	12.61	0.65	1.51	n/a	n/a	n/a
Sony CMT-CP101 Micro Hi Fi Component System $599 Energy Star	n/a	n/a	n/a	0.34	0.85	1.97	17.20	0.70	1.63	n/a	n/a	n/a
Panasonic SA-PM17 Micro CD stereo system SA-PM17	n/a	n/a	n/a	0.74	0.55	1.52	16.24	0.50	1.70	n/a	n/a	n/a
Panasonic CD Stereo System SA-PM27 $699	n/a	n/a	n/a	0.72	0.55	1.51	16.31	0.53	1.63	n/a	n/a	n/a
Panasonic CD Stereo System SA-PM07	n/a	n/a	n/a	0.62	0.64	1.71	11.17	0.70	1.73	n/a	n/a	n/a
Sony Mini system MHCDP800AV $1299	n/a	Off-mode	0	0.72	0.57	1.78	52.20	0.81	2.01	0.67	0.44	1.95
Sony Mini system MHCS7AV $1499	n/a	Passive Standby mode	43	0.66	0.44	1.95	43.60	0.79	2.00	0.72	0.58	1.77
Aiwa Mini System NSX-T99 $1099	n/a	Active Standby mode	43	37.90	0.51	1.69	49.60	0.61	1.50	39.50	0.50	1.70
Sharp Mini Stereo CDXP120A $299	n/a	Demo mode	18	5.94	0.31	2.61	13.94	0.58	1.65	6.06	0.31	2.07
Sony Mini Hi-Fi System MHC-DX50 $849	n/a	n/a	n/a	0.58	0.47	1.63	32.90	0.74	1.96	23.79	0.67	1.48
Sony Mini Hi-Fi MHC-RG88 $1299 Energy Star	n/a	0W	0	0.58	0.47	1.60	43.00	0.74	2.26	20.99	0.61	1.37
Sharp Audio tower system CDCH1000 $799	n/a	≤ 1W	26	0.89	0.89	1.85	35.76	0.79	2.05	26.90	0.73	1.92
Pioneer Compact mini component A790 $899	n/a	≤ 2W	3	0.81	0.71	1.65	27.43	0.66	1.70	26.84	0.65	1.69
Panasonic Mini system CS-AK44 $599	n/a	≤ 3W	1	0.49	0.77	1.61	31.52	0.63	1.77	25.04	0.57	1.60
Sony Mini system MHCRG22 $549 Energy Star	n/a	≤ 4W	1	0.60	0.45	2.01	21.62	0.58	1.66	16.33	0.49	1.84
Sony Mini system MHC-RG55 $629 Energy Star	n/a	5 -10W	5	0.55	0.51	1.60	28.41	0.64	1.79	18.53	0.50	1.59
Sony Mini system MHC-RG66 $749 Energy Star	n/a	11-15W	4	0.55	0.53	1.53	30.40	0.62	1.83	19.65	0.49	1.51

Stereos with Portable Remotes continued	Off Active Power	Off Power Factor	Off Crest Factor	Passive Active Power	Passive Power Factor	Passive Crest Factor	Active Active Power	Active Power Factor	Active Crest Factor	Demo Active Factor	Demo Power Factor	Demo Crest Factor
Pioneer Mini system A-390 $699	n/a	16-20 W	1	0.81	0.76	1.53	23.89	0.67	1.84	23.41	0.68	1.78
Panasonic SA-AK600 $699	n/a	21-25W	2	1.13	0.69	1.94	36.00	0.71	2.06	24.79	0.63	1.85
Aiwa NSX-R30 $399	n/a	≥ 26	1	14.81	0.68	1.51	18.34	0.73	1.78	15.22	0.61	1.50
Panasonic Mini system SCAK200 $499	n/a	n/a	n/a	0.67	0.41	1.91	20.13	0.82	1.99	16.75	0.79	1.92
Samsung MAX-ZB450 Mini system $399	n/a	n/a	n/a	10.85	0.67	1.69	18.92	0.78	1.99	11.09	0.67	1.68
Aiwa Midi system Z-L720 $999	n/a	n/a	n/a	25.91	0.60	1.53	28.90	0.65	1.69	27.47	0.63	1.62
JVC Lifestyle system VS-DT6 $699	n/a	n/a	n/a	3.24	0.60	1.67	12.82	0.79	1.90	n/a	n/a	n/a
JVC ULX-L30 Micro System $499	n/a	n/a	n/a	1.72	0.60	2.09	22.43	0.79	1.95	n/a	n/a	n/a
JVC VX-L30 Micro system $349 clock	n/a	n/a	n/a	0.59	0.34	1.94	12.03	0.66	1.62	n/a	n/a	n/a
Sony CMT-EP303 Micro Hi Fi component system $399 Energy Star clock	n/a	n/a	n/a	0.41	0.90	1.71	12.00	0.76	1.66	n/a	n/a	n/a
Panasonic SCPM17 Micro System $499.95	n/a	n/a	n/a	0.80	0.54	1.59	18.07	0.56	1.84	13.70	0.46	2.04
Phillips MC200 Micro System $379.95	n/a	n/a	n/a	2.26	0.25	2.01	11.04	0.68	1.98	n/a	n/a	n/a
Panasonic SA-AK600 Mini System $599.95	n/a	n/a	n/a	1.04	0.73	1.90	36.42	0.77	2.13	23.48	0.71	1.87
Sony MHCRG22 Mini system $549.95 Energy Star	n/a	n/a	n/a	0.60	0.45	2.01	22.26	0.70	2.15	14.10	0.59	1.71
Aiwa NSX-RSO Digital Audio System $399.95	n/a	n/a	n/a	15.38	0.60	1.75	17.86	0.65	1.63	15.74	0.61	1.73
Aiwa Digital Audio System NSX-SZ500 $549.95	n/a	n/a	n/a	20.44	0.66	1.51	21.64	0.68	1.54	20.98	0.67	1.53
Aiwa SZ-700 Mini System $649.95	n/a	n/a	n/a	21.69	0.69	1.61	23.32	0.71	1.69	22.88	0.71	1.69
Aiwa NSX-R10 Mini System $649.95	n/a	n/a	n/a	9.12	0.81	1.92	12.46	0.82	2.00	9.43	0.82	1.93
Samsung MZX-2B550 $499.95	n/a	n/a	n/a	14.18	0.41	2.13	24.68	0.63	1.70	19.40	0.52	1.94
Samsung MAX-ZB450 $399.95	n/a	n/a	n/a	11.62	0.60	1.61	19.74	0.74	1.93	11.97	0.61	1.62
Aiwa XR-EM20 $299.95	n/a	n/a	n/a	8.01	0.40	2.29	15.15	0.61	2.18	n/a	n/a	n/a

Computers and Monitors	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive-Power Factor	Passive-Crest Factor	Active-Active Power	Active-Power Factor	Active-Crest Factor
Hyundai Monitor 17" C17RO702	3.98	0.43	2.91	4.16	0.44	2.84	4.17	0.41	3.3
Hyndai I Tower 2500	4.17	0.42	4.33	n/a	n/a	n/a	37.80	0.64	2.6
Hyndai I Tower 2500ST	4.41	0.43	4.32	n/a	n/a	n/a	42.70	0.64	2.6
PC Company 17" Monitor	4.51	0.45	4.32	n/a	n/a	n/a	4.25	0.44	3.5
PC Company Special Edition 2000	1.93	0.12	1.71	n/a	n/a	n/a	2.08	0.12	1.8
PC Company Innovator 2200+	3.39	0.25	2.02	n/a	n/a	n/a	3.58	0.26	2.2
Discovery and bundle The PC Company	1.89	0.11	1.37	n/a	n/a	n/a	n/a	n/a	n/
Compaq Preario 6522	2.54	0.26	3.40	n/a	n/a	n/a	4.04	0.33	3.8
Compaq MV5500 15" Monitor	3.91	0.35	2.77	n/a	n/a	n/a	4.07	0.37	2.5
Compaq Preario Computer 6622 Hot Key Start	n/a	n/a	n/a	3.03	0.29	3.41	n/a	n/a	n/
Compaq Notebook Preario 700 721AU $2899	n/a	n/a	n/a	2.07	0.26	2.98	n/a	n/a	n/
HP Pavilion 713A	3.73	0.19	2.31	n/a	n/a	n/a	4.36	0.23	2.3
HP 15" Monitor	0.84	0.14	1.49	n/a	n/a	n/a	5.06	0.45	2.9
CTX Colour Monitor	0.30	0.08	1.38	n/a	n/a	n/a	4.00	0.44	3.6
Artec AMD Athlon 1900+ 512 MD Ram 60.0 GB Hard Drive	5.84	0.35	3.23	n/a	n/a	n/a	69.30	0.60	2.8

Home Theatres	Off-Active Power	Off-Power factor	Off-Crest Factor	Passive-Active Power	Passive- Power Factor	Passive-Crest Factor	Active-Active Power	Active-Power Factor	Active-Crest Factor
Sony Home Theatre System DAV5500 $1599 Energy Star	0.03	0.93	oF	n/a	n/a	n/a	2.06	0.38	3.4
Panasonic Home Theatre DVDSCH77SA $1399	n/a	n/a	n/a	0.57	0.43	1.97	42.20	0.79	2.0
Panasonic Home Theatre SCDM3 $1299	n/a	n/a	n/a	0.70	0.49	2.02	33.60	0.70	1.8
Sony Home Theatre DAV450 $1499 Energy Star	0.03	0.93	oF	n/a	n/a	n/a	3.98	0.45	3.6
Panasonic DVD Home Theatre System DT100 $1799.95	n/a	n/a	n/a	0.64	0.52	1.67	31.95	0.81	1.7
Panasonic Home Theatre System SCHT70 $1499.95	n/a	n/a	n/a	0.61	0.50	2.09	39.20	0.79	2.0