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Standby Power Energy Use of Common Household Appliances

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Executive Summary

Various household appliances, such as microwaves, VCR's, DVD players, digital cable boxes, video game consoles, televisions, and other such electronic devices, are almost always connected to a power source and utilizing power to maintain a 'stand-by' mode. This paper reports measurements of standby power energy use in different modes of operation of a variety of common household appliances available on the market in Canada.

The concept of when an appliance is using standby power differs across appliances, so that it is necessary to define the available modes for each appliance. The main focus of this report is on two modes of operation – *off/standby* and *on & idle* – although additional measurements are provided where possible for various other modes that may be available for particular appliances. In many cases, power measurements were found to vary widely across modes of operation for any particular appliance, and different types of appliances were found to have quite different power requirements in the same mode of operation.

The results indicate that home video equipment generally draws the most power in the *off* mode, particularly LCD rear-projection televisions, DLP televisions, and cable boxes, although compact stereos also draw in excess of 5W in this mode. In the *on & idle* mode, the highest average power usage is again observed for televisions, especially plasma, DLP, and LCD televisions. This suggests that the largest return in terms of efforts to reduce standby power consumption could be achieved with televisions, particularly those left in the *on & idle* mode.

Overall, the standby power measurements reported here indicate that – depending of course on household behaviour in terms of the modes in which appliances are "operated" – households could save considerable amounts of energy by disconnecting appliances rather than having them operate in various standby or idle modes. This suggests that it might be useful to provide consumers with (a) better information about the power usage of appliances in various modes, (b) reminders over time about the consequences in terms of energy use concerning the modes in which their appliances are utilized, and (c) a source where they could readily assess the likely power usage of their appliances in various modes of operation.

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1. Introduction

One of the first steps in determining how to reduce energy consumption is to understand how energy is currently being utilized. Various household appliances, such as microwaves, VCR's, DVD players, digital cable boxes, video game consoles, and other such electronic devices, are almost always connected to a power source and utilizing power to maintain a 'stand-by' mode. The primary purpose of this project is to assess the standby power energy use of common household appliances available on the current market in Canada, although in the case of computer equipment, power measurements of superseded models currently in use were also obtained.

Although standby power measurements are often specified in the manufacturer's literature that is provided at the time of purchase, or which may be available through various other sources such as web sites, like fuel consumption ratings on automobiles these specifications only provide a limited amount of information about the actual amount of power (fuel) that will actually be used by consumers in different situations. For example, a DVD player that is connected to a power source but which is not actually in use may draw a certain amount of electricity, but this amount may be substantially different if the DVD player contains a DVD (rather than being empty), even if that DVD is not being played. Furthermore, these differences may vary widely across different models.

In addition to these variations in standby power usage with any particular appliance, most households are likely to utilize a large number of appliances, and are therefore unlikely to be aware of the total amount of standby power that they are consuming. By combining information on average standby power usage of a variety of household appliances in different situations – such as is provided here – with data on which particular appliances are present in a household, such as is available in the 2003 Survey of Household Energy Use, it may be possible to estimate the standby power requirements of a typical household in Canada. With rising energy prices, a sharper focus on energy efficiency issues, and a wider concern about greenhouse gas emissions, this issue has received more prominence recently, including articles in non-technical mainstream

publications.[1] By determining the amount of a typical household's total standby power consumption relative to their total energy consumption, it may be possible to assess whether the issue of standby power usage by consumers warrants greater attention and perhaps greater efforts at education concerning this aspect of energy usage.

The data reported in this study were obtained by measuring the power usage of a number of different appliances in various different modes of operation. Obviously, this requires access to these appliances, and to this end we were graciously provided assistance by a number of appliance retailers, as well as several homeowners. In addition, we were fortunate to be able to measure power usage of office equipment in a number of different working environments.

The plan of rest of paper is as follows. Section 2 describes the methodology that was used to acquire and process the power measurement data. Average power consumption, along with other summary information, is provided in Section 3 for the different appliances in various modes of operation. A general discussion of the results and comparisons across different types of equipment is contained in Section 4, while Section 5 provides a brief overall summary and conclusion. Device measurement protocols, as well as data set variable descriptors, a glossary of acronyms, and details of the power measuring equipment that was used, are contained in appendices.

[1] See "Pulling the plug on standby power", *The Economist*, March 9, 2006.

2. Methodology

This section provides a summary of the process undertaken to gain access to the targeted household equipment, the methodology used to acquire and process the power measurement data, and the rationale for the methods chosen.

2.1 Data Sources

Numerous retail outlets were contacted by phone and then a follow up was completed with a fax or meeting to explain the purpose of the study and the data collection methods. If the retailer agreed to participate in the study, terms of access were agreed upon and any necessary liability agreements put in place. During business hours, every effort was made to minimize any impact on the employees' work, or the customer's experience. In the case of retail outlets, this criterion was met by metering during hours where customer populations were low, typically early morning or afternoons on slow retail days such as Monday or Tuesday. In the case of the computer equipment metered in an office environment, measurements were made after the office was vacated, which usually occurred either early in the morning, during lunch hours, or after regular office hours.

We gratefully acknowledge the participation and assistance of the following Edmonton retailers; Sears Canada, A&B Sound, The University of Alberta Microstore and Dorothy's Appliances. We also extend our appreciation to the Legal Aid Society of Alberta's (LASA) office for granting us access to all their office equipment both before and after a major equipment retrofit.

2.2 Selected Household Equipment

The appliances and equipment were selected in a manner so as to ensure that as many different types and models were measured as possible. The specific types of household appliances and equipment that were measured in this study include:

- **Home Entertainment Equipment**
    - Amplifiers & Receivers
    - CD Clock Radios, Clock Radios, & Radios
    - Compact Audio Systems
    - Digital Set Top (Cable) Boxes
    - Gaming Systems
    - Integrated Home Theatres
    - Portable Stereo Systems
    - Televisions
    - Tuners
    - Turntables
    - VCR/CD/DVDs

- **Office Equipment**
    - Adding Machine
    - Cell Phone Charger
    - Conference Phones, Cordless Phones and Powered Phones
    - Desktop Fan, Fans, and Stand-up Fans
    - Pencil Sharpener
    - Space Heater
    - Stapler

- **Kitchen Equipment**
    - Blenders
    - Breadmakers
    - Can Openers
    - Coffee Grinders & Coffee Machines
    - Indoor Grills
    - Kettles
    - Microwaves
    - Ranges

- Refrigerators
- Deep Fryers, Rice Cookers
- Toasters

- **Computer Equipment**
  - Cathode-Ray Tube (CRT) monitors
  - Desktop Computer
  - Desktop Computer Speakers
  - Fax/Modem
  - Network Hub
  - Label Writer
  - Laptop
  - Liquid Crystal Display (LCD) monitors
  - Printer
  - Scanner

- **Other Equipment**
  - Iron
  - Shaver
  - Toothbrush

Since an appliance or piece of equipment could have several different power modes that are activated by the user throughout the day, it was necessary to capture the power draw of each power mode that might be activated. Many pieces of equipment had only two power modes (*off* and *on*), while others had several (*off, on, on & idle, on & active, minimum settings, medium settings, maximum settings* and *standby*). A description of each power mode for each device type is as follows:

Table 2.1: Power Mode Description for Each Equipment Type

Equipment Type	General Description	Specific Description
Adding Machine	Off	Off
	On & Idle	On
Amplifiers & Receivers	Off	Off
	On & Idle	On
	Automatic/Manual Standby	Standby
Blenders, Juicers, etc.	Off	Off
	On & Active	Blending
Breadmakers	Off	Off
Cable Boxes	Off	Off
	On & Idle	On (No television connection)
	On & Active	On (with television connection)
Can Openers	Off	Off
	On & Active	Activated (No Can)
CD Clock Radio, Clock Radios, & Radios	Off	Off
	On & Idle	On & No Sound
	On & Active	On & Sound
CD/DVD Players	Off	Off (Remote Capable)
	On & Idle 1	On (No Disc)
	On & Idle 2	On (Disc Idle)
	On & Active	On (Disc Playing)
Cell Phone Charger	On & Idle	On
Coffee Grinders, Machines, etc.	Off	Off
	On & Active	Brewing, Grinding, etc.
Compact Audio Systems Portable Stereo Systems	Off	Off
	On & Idle 1	On (No Disc)
	On & Idle 2	On (Disc Idle)
	On & Active	On, Sound, Disc Playing
	Minimum Settings	On & Minimum Sound Level
	Maximum Settings	On & Maximum Sound Level
CRT/LCD Monitors	Off	Off
	On & Idle	Computer Off, Monitor On
	On & Active	Computer On, Monitor On
	Minimum Settings	Minimum(Low Refresh, Low Resolution, Low Contrast, Low Brightness, Black Background)
	Maximum Settings	Maximum (High Refresh, High Resolution, High Contrast, High Brightness, White Background)
	Automatic/Manual Standby 1	Standby

Table 2.1 (continued)

Equipment Type	General Description	Specific Description
Deep Fryers, Rice Cookers and Slow Cookers.	Off	Off
	Minimum Settings	Low Power
	Medium Settings	Medium Power
	Maximum Settings	Maximum Power
Desktop Computer	Off	Off
	On & Idle	No Activity (e.g. No loading)
	Automatic/Manual Standby 1	Standby
	Automatic/Manual Standby 2	Standby
	Hard Off	Hard Off
Desktop Speakers	Off	Off
	On & Idle	On & No Sound
Fax/Modem	Off	Off
	On & Idle	On
Gaming Systemss	Off	Off
	On & Idle	On (No game playing)
	On & Active	On (with game active)
Hubs	On & Idle	On
Indoor Grills	Off	Off
Integrated Home Theater System	Off	Off
	On & Idle	On & No Sound
Irons	Off	Off
	On & Active	Activated
Kettles	Off	Off
	On & Active	Activated
Label Writers	On & Idle	On
	On & Active	Printing
Laptop Computers	Off	Off
	On & Idle	No Activity (e.g. No loading)
	Automatic/Manual Standby 1	Standby
Microwaves	Off	Off
Phones	Off	Off
	On & Idle	On
Printers	Off	Off
	On & Idle	On
	On & Active	Printing
	Automatic/Manual Standby 1	Standby
Ranges	Off	Off
Refrigerators	Off	Off
Scanners	On & Idle	On
Shavers	Off	Off (Recharging)
	On & Idle	Shaving

Table 2.1 (continued)

Equipment Type	General Description	Specific Description
Space Heater	Off	Off
	On & Active	On
Toasters & Toaster Ovens	Off	Off
	On & Active	On & Active
Toothbrushes	Off	Off (Recharging)
Fans	Off	Off
	Minimum Settings	Minimum Setting
	Medium Settings	Medium Setting
	Maximum Settings	Maximum Setting
Staplers	Off	Off
Televisions	Off	Off (Remote Capable)
	On & Idle	On (Settings as found)
	Minimum Settings	Minimum (Low Contrast, Low Brightness)
	Maximum Settings	Maximum (High Contrast, High Brightness)
Tuners	Off	Off
	On & Active	On
Turntable	Off	Off
VCRs	Off	Off
	On & Idle	On

2.3 Measurement Methodology

All energy consumption measurements were taken with the PQL120 power quality logger from AEMC instruments. As detailed in Appendix D, this instrument has a range of 0 W to 2,100 W, with a resolution of 0.1 W. The instrument used in this study was configured to record the following power information (channels) each second:

- Apparent Power (VA)
- Apparent Power Max (VA)
- Apparent Power Min (VA)
- Current RMS (A)
- Current THD (%)
- Frequency (Hz)
- Power (W)
- Power Max (W)
- Power Min (W)

- Total Power Factor
- Volts RMS (V)

The primary measurement for use in this study is the Power (W) measurement. The other channels were recorded to ensure integrity of the data collected, based upon the following relationships:

Current RMS (A) x Volts RMS (V) = Apparent Power (VA)

Power (W) / Total Power Factor = Apparent Power (VA)

Total Harmonic Distortion (THD) is a measure of waveform distortion, such that a THD of 1 = sinusoidal current. If the current is distorted then the meter could provide negative power reads as it attempts to calculate what is happening with the harmonics.

The remaining channels of information, Apparent Power Max (VA), Apparent Power Min (VA), Power Max (W), and Power Min (W), record the minimum and maximum values over the chosen interval and were collected to add breadth to the data set, and provide additional range information for the power measurements.

Each type of equipment had a unique measurement protocol (Appendix A) based on its power utilization pattern. In general, measurement protocols were as follows:

1. Record equipment characteristics
2. With equipment off, plug into power meter
3. Measure power draw for 30 seconds
4. Turn equipment on, wait until observed power draw stabilizes, measure power draw for 30 seconds
5. Enable each possible “power mode” and measure the power draw for 30 seconds in each mode after the observed power draw stabilizes in that mode.
6. Turn off equipment, unplug power meter, and plug device into original outlet
7. Download power data directly to laptop using DataView ® application (Manufacturer provided)

Standard computer assisted data collection files were created in Excel to aid in the efficient and accurate compilation of equipment characteristics. The following information was recorded for each piece of equipment:

- Serial Number
- Location (e.g. Retail Outlet)
- Equipment Type (e.g. CRT Monitor)
- Brand
- Model Name and/or Number
- Manufacturing Date
- Purchasing Price (if available)
- Current Value (if available)
- Measured Size (inches)
- Labeled Size (inches)
- Rated Power (Watts, Volts, Hertz, and Amps)
- Average Power Rating (Watts)
- External Power Supply Description (if present)
- Description

In the case of an unavailable manufacturing date, it was estimated to be within six months of the purchase date (if that was available).

Additional equipment required included:

- RS-232 serial cable.
- RS-232 to USB adapter cable.
- Tape measure.
- Flashlight.
- USB portable memory drive.
- Extension cord

Each power measurement was created as a single file, which was downloaded to a laptop. Downloaded files were named using the following nomenclature:

(*DEVICENUMBER*)_(*MEASUREMENTNUMBER*)_(*SERIALNUMBER*).dvt

For example, the second device measured, on the third power mode will have the filename:

02_03_65674445.dvt

The raw data consists of a collection of single files for each measurement downloaded from the PQL120 power quality logger in a proprietary file format (.dvt), and spreadsheets (.xls) containing equipment characteristic information for each piece of equipment measured.

Using the software that accompanies the PQL120, each individual measurement file is exported into individual comma separated value (CSV) files. These exported files carry the same filename as before, such as: 02_03_65674445.csv

The exported files have the following structure:

Table 2.2: Sample CSV Output

Channel Name	Channel Units	Start Date	Start Time	Duration	Date	Time	Value	Units
Power	W	5/30/2005	1:25:04 PM	30.000 (S)	5/30/2005	1:25:04 PM	10.7	W
Power	W	5/30/2005	1:25:04 PM	30.000 (S)	5/30/2005	1:25:05 PM	10.4	W
Power	W	5/30/2005	1:25:04 PM	30.000 (S)	5/30/2005	1:25:06 PM	10.3	W
Power	W	5/30/2005	1:25:04 PM	30.000 (S)	5/30/2005	1:25:07 PM	10.4	W
Power	W	5/30/2005	1:25:04 PM	30.000 (S)	5/30/2005	1:25:08 PM	10.3	W

For each measurement CSV file, there are 11 separate channel names (as specified at the beginning of this section). Each channel has 30 entries ± 3 (1 entry per second). A parsing program removes repeated header rows, merges the CSV files, and prefixes the *DEVICENUMBER*, *MEASUREMENTNUMBER*, and *SERIALNUMBER* from the corresponding file name to each row. Information not used in the analysis, "start date," "duration," "start time," "date," and "time," was stripped. An example of the resulting CSV file for one channel measurement is shown in Table 2.3:

Table 2.3: Example of CSV File Structure (6 out of 30 values for Device 1, Mode 1)

Device Number	Measurement Number	Serial Number	Channel Name	Channel Units	Time	Value	Units
1	1	XXX-XXX	Power	W	1:25:04 PM	10.7	W
1	1	XXX-XXX	Power	W	1:25:05 PM	10.4	W
1	1	XXX-XXX	Power	W	1:25:06 PM	10.3	W
1	1	XXX-XXX	Power	W	1:25:07 PM	10.4	W
1	1	XXX-XXX	Power	W	1:25:08 PM	10.3	W

Next, the data in the merged CSV file was aggregated into a new file linked by *DEVICENUMBER*, *MEASUREMENTNUMBER*, and *SERIALNUMBER*. For each device number, power mode and channel, a count, mean, median, maximum, minimum, and standard deviation was calculated. The SPSS file was then merged with the characteristic information in the Excel spreadsheets and the following additional variables were created (full details are in Appendix B):

- BrandID -- A numerical code for the recorded brand names
- ModelID -- A numerical code for the recorded model names
- EquipmentCode -- A numerical code for the recorded equipment type names
- EquipmentCategory -- An assigned category (e.g. Office Equipment).
- EquipmentCategoryID -- A numerical code for the assigned equipment category
- GeneralEquipmentType -- An assigned general equipment type name (e.g. Amplifier/Receiver).
- GeneralTypeID -- A numerical code for the assigned general equipment type name
- ManufactureDateBand -- A banding of the manufacturing date
- ModelIDMask -- A numerically assigned value to mask the model names
- NonNegPowerMean -- A conversion of the power mean variable to a variable with no negative values
- NonNegPowerMax -- A conversion of the power max variable to a variable with no negative values
- NonNegPowerMin -- A conversion of the power min variable to a variable with no negative values
- ModelIDMaskStr -- A string conversion of the ModelIDMask variable.

3. Results and Discussion

In this section average (mean) power consumption in Watts (W), along with other summary information, is provided for the measurement period for all of the available power modes of each type of appliance.

3.1. Home Entertainment Equipment

Amplifiers & Receivers

An amplifier simply amplifies an input signal before sending the signal to the speakers, and as such it requires an input device, such as a CD player, turntable, or tuner. Receivers incorporate these functions into one unit. A receiver not only receives radio signals, but it also amplifies them so that they can be sent to the speakers. Receivers also perform switching between inputs, which is sometimes considered the job of a preamplifier. High-end audio setups usually break these functions down into separate components, but for consumer-grade usage, a good receiver will have these functions built into one unit.

Table 3.1.1: Amplifiers & Receivers – Power Usage for each Metered Power Mode

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	6	0.1	0.0	0.6	0.6	0.3
On & Idle 1	6	63.6	19.1	233.9	214.8	84.0
Auto/Manual Standby 1	1	0.3				

The amplifiers/receivers measured had two power modes, *off* and *on & idle*. The only true amplifier that was metered had a manual switch for *standby*. Only one receiver model continued to use power while in *off* mode (0.6W). As shown in Table 3.1.1, the *on & idle* power consumption averaged 63.6W. For the single device with a *manual standby mode*, the power usage was 0.3W in that mode. The available manufacturer rated standby consumption ranged from 0.1W to 1.0W. One model consumed more power in the *off (remote ready)* mode than the manufacturer rated standby power consumption. Details of the individual amplifiers and receivers that were measured are contained in Table 3.1.2.

Table 3.1.2: Amplifiers & Receivers – Power Usage by Model Number and Power Mode

Model Number	Mode			Rated Standby Power (W)	Rated Power (W)
	Off (W)	On & Idle 1 (W)	Automatic /Manual Standby 1 (W)		
131 AMP	0.0	19.1	0.3		220
305 REC	0.0	20.9		0.5	190
291 REC	0.0	26.9		1.0	135
287 REC	0.0	37.0		1.0	365
283 REC	0.6	43.7		0.1	350
130 REC	0.0	233.9			13A*

* Manufacturer rated power consumption 13 amps

The only true amplifier that was measured consumed the least power while *on and idle*. This was also the only amplifier/receiver measured in a manual standby mode, where it consumed 0.3W. The receiver that consumed the largest amount of power in the *on & idle* mode was a whole home audio\theatre high definition receiver. It was capable of providing for two home theatres in different rooms or one home theatre and background music in the rest of the house, or a whole-house audio system that allows four people to listen to different sources at the same time. The average power consumption in this category without the large complex system was 29.5 W. The next largest power consumers were receivers with AM/FM tuners that had either large complex front LED displays or active subwoofers that increased power consumption. All of these amplifiers/receivers were current 2005 models that were available in store at major retailers.

Digital Set Top (Cable) Boxes

A digital set top box is a device used in conjunction with a television to provide access to a digital cable service. As the digital cable boxes available to any given area tend to all be of the same model, only three different models were available to be metered. All three set top boxes were metered in the *on & idle* power mode, where mean power consumption was 15.6W, as shown in Table 3.1.3. The two digital cable boxes metered in the *off* power mode had a mean power consumption of 15.5W and were not measured while actively receiving and converting signals to a television. Testing in an environment with proper connectivity may yield different

results. The single box measured in the *on & active* power mode utilized 16.8W while actively connected to a television.

Table 3.1.3: Cable Boxes – Power Usage for all Metered Power Modes

Mode	Number of Mode Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	2	15.5	13.6	17.3	3.7	2.6
On & Idle 1	3	15.6	13.9	17.2	3.4	1.7
On & Active	1	16.8	16.8	16.8	0.0	

Manufacturing specifications for one of these models lists a 35 W power dissipation (power lost to heat production), but power and standby power ratings were not provided. Manufacturing dates for all cable boxes were unavailable. However, as these boxes are the current offerings by the local cable and digital service providers, they are likely no more than two years old.

CD Clock Radios, Clock Radios, & Radios

These devices were first measured with the radio *off* and the digital clock functioning. As shown in Table 3.1.4, for CD Clock Radios, the mean power consumption in the *off* power mode was 1.6W, with the highest power consumption being 2.7W, and the lowest 0.5W. The *off* mode power consumption is most likely due exclusively to the operating digital clock and display features of the clock function. Other power modes were available, such as with the radio on, but these were not metered due to the noise limitations in the office location where many of these devices were metered. The models that consumed the most power in the radio *off* mode had large backlit LCD displays that you could "see from across the kitchen/bedroom even in the dark". The model consuming the least power in the radio *off* mode was also the only model with rated standby power and power consumption included in the product specifications. This model's features included an automatic turn off of CD and radio displays after a few seconds. Power usage measurements in the *off* mode are presented in Table 3.1.5 for each model.

Table 3.1.4: CD Clock Radios – Power Usage for *off* Power Mode

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Radio *off*	5	1.6	0.5	2.7	2.2	1.0

Table 3.1.5: CD Clock Radios – Power Usage by Model Number and Power Mode

Model Number	Off (W)	Rated Standby Power (W)	Rated Power (W)
273	0.5	2.3	14.0
213	1.0		
214	1.2		
278	2.6		
215	2.7		

For clock radios, the mean power consumption in the radio *off* power mode was 0.5W (Table 3.1.6). Three models were also measured in the *on & idle* power mode, the mode with the radio powered on but with the volume at a low level. These models were at least three years old and were very simple models with no alarm, and had no proper method to turn the radio off (setting the volume to zero did not constitute turning the radio off). The mean power consumption for these models was 1.6W. One model was measured in the *on & active* mode (i.e. on with high volume), where it consumed 2.3W of power. Measurements for the individual models are shown in Table 3.1.7

Table 3.1.6: Clock Radios – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	8	0.5	0.0	0.9	0.9	0.3
On & Idle 1	3	1.6	0.5	2.3	1.8	1.0
On & Active	1	2.3				

Table 3.1.7: Clock Radios – Power Usage by Model Number and Power Mode

Model Number	Mode			Rated Power (W)
	Off (W)	On & Idle 1 (W)	On & Active (W)	
152	*	2.0		
216	*	2.3	2.3	
277	*	0.5		
270	0.0			
279	0.2			
209	0.3			
210	0.5			
211	0.5			
212	0.6			
276	0.7			
96	0.9			

* Several clock radio models had no proper method to enable the off power mode.

For radios, the mean power consumption in the *off* power mode was 1.5W (Table 3.1.8). In the *on & idle* power mode, mean consumption was slightly higher at 1.7W. Details for each model are provided in Table 3.1.9.

Table 3.1.8: Radios – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	2	1.5	0.7	2.2	1.6	1.1
On & Idle 1	2	1.7	0.7	2.6	1.9	1.4

Table 3.1.9: Radios – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Idle 1 (W)	
95	0.7	0.7	
269	2.2	2.6	

Both of these radios were older models found in an office environment, and manufacturer specifications were not available.

All CD clock radios, clock radios, and radios had no identifiable manufacturing dates. The CD clock radios and clock radios were in retail establishments and assumed to be 2006 models. One of the CD clock radios, three of the clock radios, and all of the radios were in an office environment and may have been manufactured over the past five years. The clock radios and radios found in retail establishments were assumed to be 2005 models. Clock radios and radios consumed similar amounts of power in both the *off* and *on & idle* modes. Power consumption in the off mode is considerably lower for clock radios and radios compared to CD clock radios, which may be attributed to the larger LCD displays of most CD clock radios.

Gaming Systems

Two different gaming systems were metered, one from 1999 and the other from 2003, although both were from the same manufacturer. The gaming systems were metered while turned off, with the device on and no game playing, and with the device on and a game active, all of which correspond to the *off*, *on & idle*, and *on & active* power modes respectively. The 2003 system utilized more power than the 1999 model in all three power modes, consuming 1.0W while *off* compared to 0.4W in the 1999 model, and consuming 23.3W and 22.5W in the on power modes, compared to 7.6 and 8.6 in the 1999 model. Details are provided in Table 3.1.10.

Power consumption measurements reported here are consistent with recently reported measurements of the standby power consumption of popular gaming systems (DXGaming, 2006). In that study, standby/off power costs, calculated on an annual basis, ranged from $0.26 to $2.63. The *On & Idle* consumption, as measured in the same report, was greater in newer systems, again consistent with our findings. Two new gaming systems are expected on the market by the end of the year and will require further monitoring.

Table 3.1.10: Gaming Systems – Power Usage by Model Number and Power Mode

Model Number	Mode		
	Off (W)	On & Idle (W)	On & Active (W)
406	1.0	23.3	22.5
407	0.4	7.6	8.6

Integrated Home Theatre Systems

Integrated home theatre systems integrate amplifiers, DVD players, or stereo systems into a single "out of the box" system. All power for these devices is routed through one outlet, and power consumption is measured for the integrated unit.

The two home theatre systems that were metered varied considerably in their power consumption. Average power consumption is shown in Table 3.1.11, while the individual measurements are displayed in Table 3.1.12.

Table 3.1.11: Home Theatre Systems – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	2	0.5	0.0	1.0	1.0	0.7
On & Idle 1	2	21.4	5.2	37.6	32.4	22.9

One of the two devices measured zero-watts while powered off, while the other device measured 1.0W of power in this state. Both devices consumed power while *on & idle*, one consuming 37.6W of power. The home theatre system that consumed the least power while *off*, was *Energy Star* rated in the U.S. and Canada. However, that same product consumed considerably more power when *on & idle* than the non-*Energy Star* rated device. This is an interesting finding, insomuch as a consumer making the decision to purchase the product based upon the fact that the product is *Energy Star* rated would probably have the expectation that it utilizes less power overall. This becomes even more important when one considers that it is conceivable that many consumers may leave these types of devices in the *on & idle* power mode, while simply shutting off any inputs.

Table 3.1.12: Home Theatre Systems – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Standby Power (W)	Rated Power (W)
	Off (W)	On & Idle 1 (W)		
288	0.0	37.6	0.4	365
316	1.0	5.2		

Compact Audio Systems

Compact audio systems are integrated units consisting of an amplifier and speakers with one or more functions, including, but not limited to, a radio tuner, tape player, CD player, turntable, and MP3 player. They are known as mini-, mid-, micro-, or shelf- audio systems. Micros are shorter and slimmer than Minis and are designed to fit on a shelf or small space in a bedroom or kitchen. Normally, they have a single cassette deck whereas a mini will have a twin deck and will produce more powerful sound. Both have CD players and stereo radio. One unit was designed to be mounted on a wall or fit on a shelf, while another was a system that included a turntable, 3 CD changer, cassette deck and radio. A powered sub-woofer was also measured as an accessory to these systems. Also included in this section are portable stereos or boom boxes.

The majority of these devices (94%) lacked identifiable manufacturing dates, but most were assumed to have been manufactured within two years of this report. The exceptions were two systems in an appliance sales and repair shop, where the older manufacturing dates were recorded.

All of the 33 compact audio systems measured had two power modes, *off* and *on & idle 1*. The mean power consumption in the *off* mode was 6.2W, while the mean in *on & idle 1* was 13.1W (Table 3.1.13). In addition some of the systems also had an *on & idle 2* power mode or "disc idle" power mode. Eight of the 33 systems were metered in this mode, and the mean power consumption was 10.6W. The same 8 stereo systems were also metered in *minimum settings* and *maximum settings* power modes, which in the case of stereo systems, represents minimum volume and maximum volume respectively. The mean power consumption was 13.1W for *minimum settings*, and 13.5W for *maximum settings*.

Table 3.1.13: All Compact Audio Systems – Power Usage for All Types and Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	33	6.2	0.0	19.9	19.9	7.2
On & Idle 1	33	13.1	1.1	29.6	28.5	8.6
On & Idle 2	8	10.6	3.7	21.3	17.6	5.9
Minimum Settings	8	13.1	6.0	22.8	16.8	5.8
Maximum Settings	8	13.5	6.5	23.4	16.9	6.0

Detailed results for the compact stereo system subset of compact audio systems (which includes compact stereos, mini stereos, and the stereo wall unit) are displayed in Table 3.1.14.

Table 3.1.14: Compact Stereos – Power Usage by Model Number and Power Mode

Model Number	Measurement Mode					Rated Standby Power Consumption (W)	Rated Power Consumption (W)	Rated Amplifier RMS Power Output (W)
	Off (W)	On & Idle 1 (W)	On & Idle 2 (W)	Minimum Settings (W)	Maximum Settings (W)			
189	0.0	4.6				1.5	52	60
326	0.0	11.9	11.7	14.6	14.5		50	85
289	0.0	14.9				0.6	57	36
191	0.0	25.2				1.8	90	40
236	0.0	26.3				0.25	265	250
233	0.5	14.7	14.7	17.8	19.1	0.65	70	50
193	1.3	12.6	12.5	15.4	15.8	1.4	50	40
239*	2.2	3.4						
159	3.7	9.3						20
198	6.2	10.2	10.3	12.8	13.6	0.3	40	18
149	8.3	11.4				0.3	50	36
197	11.0	15.6				0.3	145	170
234	11.3	20.2					110	130
290	13.1	15.7				0.4	135	70
286	14.6	14.5				0.7	260	450
190	15.3	18.4				21.0**	125	180
285	15.9	17.6				0.34	165	180
280	15.9	26.6						160
340	17.5	19.5					88	170
192	18.3	20.2	21.3	22.8	23.4	21.0	125	180
235	19.3	27.7					210	300
281	19.9	29.6						250

*Includes turntable
**0.8 W standby consumption with clock display deactivated

Eleven of the compact stereo units that were metered consumed between 10W-20W while in the *off* power mode, while six consumed less than 1W of power consumption in this same mode (Table 3.1.14). These lower power models had smaller displays that shut off when the audio system was off. For the approximately 50% of the metered compact stereo models that consumed 10W – 20W of power while *off*, there appeared to be very little difference between the *off* power mode and the *on & idle* power mode. There are often flashy graphical routines displayed on the indicators and LCD screens on these units which may account for a significant proportion of the power consumption in the *off* mode. Summary statistics for these compact stereo systems are provided in Table 3.1.15.

Table 3.1.15: Compact Stereo Systems – Power Usage by Power Mode

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	22	8.8	0.0	19.9	19.9	7.5
On & Idle 1	22	16.8	3.4	29.6	26.2	7.2
On & Idle 2	5	14.1	10.3	21.3	11.1	4.3
Minimum Settings	5	16.7	12.8	22.8	10.0	3.8
Maximum Settings	5	17.3	13.6	23.4	9.8	4.0

Portable Stereo Systems

A total of ten portable stereo systems were metered in the *Off* and *On & Idle 1* modes (Table 3.1.16). Three of these systems were metered in the additional *on & idle 2, minimum settings* and *maximum settings* power modes (Table 3.1.17). Power consumption while in the *off* mode averaged 0.9 W, and 3.9 W in the *on & idle* mode.

Table 3.1.16: Portable Stereo Systems – Power Usage for Select Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	10	0.9	0.0	2.2	2.2	0.7
On & Idle 1	10	3.9	1.1	8.1	7.0	2.3

Table 3.1.17: Portable Stereo Systems – Power Usage by Power Mode

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	3	1.4	1.0	2.2	1.2	0.67
On & Idle 1	3	4.3	3.4	5.9	2.5	1.67
On & Idle 2	3	4.8	3.7	5.9	2.2	1.1
Minimum Settings	3	7.1	6.0	8.3	2.3	1.1
Maximum Settings	3	7.3	6.5	8.3	1.7	0.9

Compared to the other stereo systems, portable stereo systems have lower power consumption in all power modes. Unlike the mini and micro stereo systems, portable stereo systems are designed to optionally run from batteries, so on this basis it might be expected that these systems would be designed to be much more energy efficient. The data appear to support this interpretation, with portable stereo systems consuming a mean of only 7.3W even in the *maximum settings* mode, which is less than many mini-stereo systems consumed even while *off*.

The majority of portable stereo models consumed 1.1W of power or less in the off power mode (Table 3.1.18). The devices that had the alternate idle power mode (*on & idle 2*) did not have appreciably different power consumption compared to the *on & idle 1* power mode measured, where the alternate idle power mode represents a "disc idle" mode.

Table 3.1.18: Portable Stereo Systems – Power Usage by Model Number and Power Mode

Model Number	Mode					Rated Standby Power (W)	Rated Power (W)
	Off (W)	On & Idle 1 (W)	On & Idle 2 (W)	Minimum Radio Vol. Settings (W)	Maximum Radio Vol. Settings (W)		
141	0.0	1.1				N/A	N/A
142	0.0	2.3				N/A	N/A
274	0.4	2.2				N/A	N/A
344	0.4	3.4				N/A	16
144	1.0	3.4	4.7	7.1	7.3	N/A	16
272	1.1	2.3				N/A	N/A
143	1.1	3.7	3.7	6.0	6.5	N/A	N/A
271	1.1	8.1				N/A	18
282	1.5	6.7				2.7	32
275	2.2	5.9	5.9	8.3	8.3	N/A	N/A

Only one of these stereos had a manufacturer rated standby power consumption listed in specification sheets. Rated power consumption for this group of audio equipment was also not routinely supplied.

The single sub-woofer that was metered consumed 0.0W while *off* (Table 3.1.19). Power consumption while *on & idle* was 22.6W. The *off* mode was activated only by a "hard off" switch located on the back of the device, and it is likely that many consumers would not manually disable the device on a regular basis, instead choosing to simply deactivate any input into the device (such as an amplifier).

Table 3.1.19: Sub-Woofer – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Idle 1 (W)	
315	0.0	22.6	140

Tuners

The stereo tuner was measured in two power modes, *off* and *on & active*. This device had a mean power consumption of 0.1W when *off*, and 4.2W when *on & active* (Table 3.1.20). While no manufacturing date was available on the tuner, the manufacturing date is estimated as 2005, as the tuner was measured on the floor in a retail outlet.

Table 3.1.20: Tuner – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Active (W)	
325	0.1	4.2	7

Turntables

The single turntable that was available for metering was metered in the *off* mode only where it consumed 0.4W (Table 3.1.21). According to the Recording Industry Association of America, vinyl's percentage of overall sales nearly doubled in 2004, at a time when overall music sales dropped.[2] Their use for home entertainment is clearly not as obsolete as might be assumed.

Table 3.1.21: Turntable – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (W)
	Off (W)	
262	0.4	NA

A survey of technical manuals for 10 models from 4 manufacturers of belt driven, direct drive and direct drive digital turntables suggests that rated power consumption varies from 2W for belt driven models, to between 12W and 16W for direct drive models, and as much as 20W for direct drive digital models. This belt driven turntable was a current 2005 model available on the floor of a major retailer.

Televisions

This selection reports on power consumption measurements for several different types of televisions, including:

- CRT Television
- CRT Television w/ Integrated DVD
- CRT Television w/ Integrated VCR
- CRT Television w/ Integrated DVD & VCR
- DLP Television
- DLP Projection Television
- LCD Rear Projection
- LCD Television
- Plasma Television

[2] "2004 Consumer Profile", The Recording Industry of America, 2004.

Most televisions that were metered and had an identifiable manufacturing date were manufactured in 2004. A significant number of televisions had no identifiable manufacturing date, but the real date of manufacture is most likely within a year of this report (Table 3.1.22).

Table 3.1.22: All Televisions – Distribution by Manufacturing Date

Year of Manufacture	Count	Percent
2004	11	40.7
2005 +	16	59.3

* includes actual and estimated manufacturing dates.

A total of 27 televisions were metered in the *off* and *on & idle* power modes. Seven televisions were metered in the *minimum settings* and *maximum settings* power modes. The *minimum settings* power mode is the state where the television is powered on, and the various display settings, such as contrast and brightness, are set to the minimum possible value. Likewise, the *maximum settings* power mode is the state where the various display settings are set to the maximum possible value. As reported in Table 3.1.23, the average power consumption of televisions while *off* was 4.6W, and while *on & idle* was 110.8W.

Table 3.1.23: All Televisions – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	27	4.6	.0	54.4	54.4	11.8
On & Idle 1	27	110.8	4.1	325.7	321.6	64.8
Minimum Settings	7	131.0	83.6	175.7	92.1	34.4
Maximum Settings	7	172.6	111.9	318.7	206.7	67.9

Fifteen CRT televisions were examined in both *off* and *on & idle* power modes, with a mean power consumption of 1.6W and 91.5W respectively (Table 3.1.24). Most CRT televisions consumed under 4W of power while in the off power mode (Table 3.1.25).

Table 3.1.24: CRT Televisions – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	15	1.6	.0	4.1	4.1	1.4
On & Idle 1	15	91.5	4.1	151.0	146.9	42.9
Minimum Settings	4	122.2	83.6	151.6	68.0	30.1
Maximum Settings	4	139.0	111.9	162.0	50.1	23.2

Of the fifteen CRT televisions metered, sizes ranged from 14" to 34" (Table 3.1.26). The power consumption across sizes does not seem to vary significantly in the *off* power modes, although the 24" and 27" models had the highest mean power consumption in this mode. The active power mode showed an increase in power consumption as size increased, although as the mode was metered with the television settings as-is, variation among user settings may explain the unsteady increase in power consumption with size.

Table 3.1.25: CRT Televisions – Power Usage by Model Number and Power Mode

Characteristics		Mode				Rated Standby Power (W)	Rated Power (W)
Model Number	Screen Size (inches)	Off (W)	On & Idle 1 (W)	Minimum Settings (W)	Maximum Settings (W)		
31	14	1.5	52.7			N/A	80
35	20	2.8	42.0			N/A	105
16	20	1.1	56.6				
317	24	3.1	77.5				
10	27	4.1					
14	27	3.2	81.7				
319	30	0.0	121.0	114.5	127.9	1.00	240
12	32	3.0	76.1				
223	32	0.6	92.8			0.50	180
13	32	1.4	101.5				
153	34	0.1	111.7	83.6	111.9	0.25	
11	34	0.6	143.9				
320	34	0.0	147.7	151.6	154.1	1.00	240
318	34	2.3	151.0	139.3	162.0	3.00	250

Table 3.1.26: CRT Televisions – Power Usage by Labelled Size and Power Mode

Labelled Size (inches)	#	Mode			
		Off (W)	On & Idle 1 (W)	Minimum Settings (W)	Maximum Settings (W)
14	1	1.5	52.7		
20	2	1.9	49.3		
24	1	3.1	77.5		
27	2	3.7	42.9		
30	1	0.0	121.0	114.5	127.9
32	3	1.7	90.1		
34	5	0.6	133.2	124.8	142.7

Two CRT televisions (20" and 19") were examined with built in DVD players, and were metered in both *off* and *on & idle* power modes, with a mean power consumption of 2.7W and 54.9W respectively (Table 3.1.27). In this case, the one inch difference in screen size related to a two fold increase in *on & idle* power consumption.

Table 3.1.27: CRT Televisions/DVD – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	2	2.7	1.8	3.6	1.8	1.3
On & Idle 1	2	54.9	36.4	73.4	37.0	26.2

Two CRT televisions (20" and 27") were examined with a built-in DVD/VCR combination, and were metered in both *off* and *on & idle* power modes, with a mean power consumption of 1.4W and 69.8W respectively (Table 3.1.28). The *off* power consumption was similar for the two sets while the larger screen size set consumed more in the *on & idle* mode.

Table 3.1.28: CRT Televisions/DVD/VCR – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	2	1.4	1.3	1.4	0.1	0.1
On & Idle 1	2	69.8	51.2	88.4	37.2	26.3

A 20" CRT television with a built-in VCR was metered in both *off* and *on & idle* power modes, with a mean power consumption of 1.0W and 64.1W respectively (Table 3.1.29).

Table 3.1.29: CRT Televisions/VCR – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	1	1.0	1.0	1.0	0.0	
On & Idle 1	1	64.1	64.1	64.1	0.0	

Three Digital Light Processing (DLP) televisions were metered in both *off* and *on & idle* power modes, with a mean power consumption of 12.5W and 172.0W respectively (Table 3.1.30). These sets were 42", 44", and 50"in size, with the smallest set consuming the most power in the *off* mode.

Table 3.1.30: DLP Televisions – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	3	12.5	0.1	34.1	34.0	2.2
On & Idle 1	3	172.0	160.7	187.8	27.1	14.2

Two LCD rear projection televisions were metered in *off, on & idle, minimum settings* and *maximum settings* power modes. Measurements are shown in Table 3.1.31. The 42" model had a smaller measured power usage in each setting than the 50" model – which has a POD slot / is cable card ready and is rated at 12.8 W in standby with POD installed or 0.6 W without POD.[3]

Table 3.1.31: LCD Rear Projection Televisions – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)
Off	1	27.2	0	54.4
On & Idle 1	1	167.5	158.8	176.2
Minimum Settings	1	166.8	157.9	175.7
Maximum Settings	1	166.8	157.7	175.8

[3] POD refers to a "point-of-deployment" module, generally referred to as a CableCARD.

A 32” LCD television was metered in both the *off* and *on & idle* power modes, with a mean power consumption of 0.0W and 128.8W respectively (Table 3.1.32). This set was rated at less than 1W in standby and 155W in use.

Table 3.1.32: LCD Televisions – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)
Off	1	0.0	0.0	0.0
On & Idle 1	1	128.8	128.8	128.8

A 42” plasma television was metered in *off, on & idle, minimum settings* and *maximum settings* power modes, with a mean power consumption of 0.0W, 325.7W, 94.3W, and 318.7W respectively (Table 3.1.33). This model was also POD/cable card ready and rated at 0.5W in standby without active POD, 10.9 with installed POD and 332W in use. The range in power consumption between minimum settings and maximum settings was quite large for this model.

Table 3.1.33: Plasma Televisions – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)
Off	1	0.0	0.0	0.0
On & Idle 1	1	325.7	325.7	325.7
Minimum Settings	1	94.3	94.3	94.3
Maximum Settings	1	318.7	318.7	318.7

VCR/CD/DVD

The tables in this sub-section present power measurements relating to the following types of devices:

- Video Cassette Recorders (VCR)
- Compact Disc (CD) Players
- Digital Video Disc (DVD) Players
- VCR/DVD Combination Devices

Manufacturing dates were recorded for those VCRs, CD players, or DVD players where this date was identifiable. Although the majority of these devices lacked any identifiable manufacturing dates, they can most likely be assumed to have been manufactured within a year of this report.

Video Cassette Recorders (VCRs)

While generally an uncommon sight in the retail outlets, three VCRs were metered. For these three VCRs, a mean power consumption of 4.6W was recorded in the *off* power mode, and 6.3W was recorded in the *on & idle* power mode (Table 3.1.34).

Table 3.1.34: VCRs – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	3	4.6	1.3	6.4	5.1	2.9
On & Idle 1	3	6.3	5.1	7.6	2.5	1.2

Two of the three models metered had a power consumption of approximately 6W in the *off* power mode, while the other model consumed only 1.3W in the same mode. The model that consumed the least amount of power while *off*, also consumed the least amount of power while *on & idle* (Table 3.1.35).

Table 3.1.35: VCRs – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Idle 1 (W)	
177	1.3	5.1	9
203	6.1	6.1	13
298	6.4	7.6	16

All of these VCRs were current 2005 models on the floors of major retailers.

CD Players

CD players were also not commonly available on the shelves of retail outlets. The CD player was measured in four power modes, *off*, *on & idle* (no disc), *on & idle 2* (disc idle), and *on & active* (disc playing). This CD player consumed no power while *off*, 4.6W while in both idle modes and 6.6W while *on & active* (Table 3.1.36). This single CD player had an identifiable manufacturing date of 2004.

Table 3.1.36: CD Players – Power Usage by Model Number and Power Mode

Model Number	Mode				Rated Power (W)
	Off (W)	On & Idle 1 (W)	On & Idle 2 (W)	On & Active (W)	
140	0.0	4.6	4.6	6.6	12

DVD Players

Eleven DVD players were metered, all of which were measured in the *off* and *on & idle* modes.

Table 3.1.37: DVD Players – Power Usage for Selected Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	11	0.6	0.0	2.3	2.3	0.7
On & Idle 1	11	6.5	5.7	10.7	10.7	2.8

Five DVD players used no power while turned *off*, while four players utilized between 1W and 2.3W of power. The power consumption while *on & idle* ranged from 5.7W to 10.7W (Table 3.1.37).

Nine DVD players were also measured in the *on & idle 2* (disc idle) and *on & active* (disc playing) mode (Table 3.1.38). As equipment function increased power consumption also increased, with exception of one model where consumption was lower in the active mode than in disc idle mode. Details for each model are presented in Table 3.1.39.

Table 3.1.38: DVD Players (>0W off) – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	9	0.7	0.0	2.3	1.2	0.8
On & Idle 1	9	7.5	5.7	10.7	5.0	1.9
On & Idle 2	9	8.3	5.6	13.1	7.5	2.4
On & Active	9	9.2	6.8	12.2	5.4	1.7

Table 3.1.39: DVD Players – Power Usage by Model Number and Power Mode

Model Number	Mode				Rated Power (W)
	Off (W)	On & Idle 1 (W)	On & Idle 2 (W)	On & Active (W)	
167	0.0	5.7			25
169	1.1	5.7			9
168	1.1	5.7	5.6	6.8	8
172	0.0	6.1	5.9	7.9	10
173	0.0	6.5	6.5	8.7	11
341	1.0	6.0	8.0	8.6	11
342	0.8	8.0	8.7	9.6	12
295	2.3	6.8	9.0	8.8	11
185	0.0	9.9	9.3	10.7	14
170	0.0	10.7	13.1	12.2	15

Seven of the DVD players metered were manufactured in 2005, while three and one were manufactured in 2004 and 2003, respectively (Table 3.1.40).

Table 3.1.39: DVD Players– Power Usage by Manufacturing Date and Power Mode

Year of Manufacture	#	Mode				
		Off (W)	On & Idle 1 (W)	On & Idle 2 (W)	On & Active (W)	Automatic/Manual Standby 1 (W)
2003	1	0.4	0.0	12.1	11.4	12.8
2004	3	0.4	8.8	9.3	9.9	
2005+	7	0.7	6.4	7.6	8.7	

3.2. Office Equipment

Adding Machines

The devices categorized as adding machines are essentially calculators, with the addition of a receipt printer and an AC adapter. Three different brands and six different models were measured. The mean power consumption while *off* was 2.0W, and the mean power consumption while *on & idle* was 2.7W.

Only one model consumed 0W while in the *off* power mode, two models consumed less than 1W while in the *off* power mode, while the other three models consumed greater than 3W of power while in the *off* power mode (Table 3.2.1).

Table 3.2.1: Adding Machines – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	6	2.0	0.0	3.7	3.7	1.7
On & Idle	6	2.7	0.8	3.8	3.0	1.4

Four of the six models consumed almost identical amounts of power in both power modes (Table 3.2.2). The two models, 178 and 202, which reported lower energy consumption relative to the other models, had external power supplies in the form of an AC/DC converter. No manufacturing dates were available from any of the adding machines, and as all models were metered in an office location, they may have been over five years old.

Table 3.2.2: Adding Machines – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Idle 1 (W)	
252	0.0	3.6	
178	0.4	1.1	1.8
202	0.8	0.8	
253	3.2	3.2	
179	3.7	3.8	
180	3.7	3.7	

Telephones

Six devices were metered in the telephones category, of which there were four different device types:

- Cell Phone Charger
- Conference Phone
- Cordless Phone
- Powered Phone

Three cell phone chargers were metered (Table 3.2.3), although in one case the cell phone itself was unavailable and could not be attached in order to test the *on & active* power mode. This cell phone charger model was also the only model to consume power in the *off* power mode, consuming 3.0W of power. The power mode was labeled *on & idle* as there is no method (other than physical disconnection from an electrical outlet) by which to switch the device into the *off* power mode. The two models that were tested with a cell phone attached metered 5.2W and 2.9W in that power mode. Differences in power consumption with the cell phone attached may be attributed primarily to differences in the size of the battery being charged, and the level to which the battery was currently charged, both of which are unknown.

Table 3.2.3: Cell Phone Chargers – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	On & Idle (W)	On & Active (W)	
400	0.0	5.2	
401	0.0	2.9	
154	3.0		6.0*

* External Power Supply Rating

A conference phone is a phone designed for meetings or conferences, so it has as components several speakers as well as microphone(s) to receive input from a group of people, but does not have a handset. A single conference phone was metered (Table 3.2.4), and was found to consume 3.8W while in the *off* power mode, and 6.4W while in the *on & idle* power mode. The

on & idle power mode was simply enabling the phone with the dial-tone emitting from the speaker, and may not accurately represent actual power consumption while the phone is in use.

Table 3.2.4: Conference Phones – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Idle (W)	
301	3.8	6.4	

Three cordless phone sets were metered (Table 3.2.5), without the cordless phone attached, with the cordless phone attached, and with the cordless phone activated and in use, all of which correspond to the *off*, *on & idle*, and *on & active* power modes respectively. However, one of the cordless phones was metered only in the *on & idle* mode due to the necessity of not interrupting the functioning of an operating office telephone. The two cordless phones metered in the *off* power mode utilized 1.3W and 1.2W, while these two phones utilized 2.5W and 1.4W while activated. The three cordless phones utilized 2.5W, 3.6W, and 2.8W for an average consumption of 3.0W while in the *on & idle* power mode. As with the cell phone chargers, variation in power usage among the two modes in which the phone is attached may be attributable to variation in the battery sizes and battery charge levels of the cordless phones, both of which are unknown.

Table 3.2.5: Cordless Phones – Power Usage by Model Number and Power Mode

Model Number	Mode			Rated Power (W)
	Off (W)	On & Idle (W)	On & Active (W)	
404	1.3	2.5	2.5	
405	1.2	3.6	1.4	
224		2.8		12*

* External Power Supply Rating

There were only two powered phone models metered, although several different devices of the same model were metered. The most frequently metered model had a mean power consumption of 1.6W of power while in the *off* power mode, and 1.9W of power while in the *on & idle* power mode. The *on & idle* power mode involved simply enabling the phone with the dial-tone

emitting from the speaker, and may not accurately represent actual power consumption while the phone is in use. Details are presented in Table 3.2.6.

Table 3.2.6: Powered Phones – Power Usage by Model Number and Power Mode

Model Number	Number of Measurements	Mode		Rated Power (W)
		Off (W)	On & Idle 1 (W)	
349	1		1.8	
350	5	1.6	1.9	

Fans

Seven devices were metered in the fans category, of which there were three different device types:

- Desktop Fan
- Standard Fan
- Stand-up Fan

Across all device types, the mean power consumption was 0W while in the *off* power mode, 32.4W while in the *minimum settings* power mode, 41.4W while in the *medium settings* power mode, and 49.3W while in the *maximum settings* power mode (Table 3.2.7).

Table 3.2.7: Fans – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	6	0.0	0.0	0.0	0.0	0.0
Minimum Settings	6	33.4	12.6	60.0	47.4	15.9
Medium Settings	6	41.4	17.5	69.2	51.7	17.9
Maximum Settings	6	49.3	33.6	77.1	43.5	15.9

Six different models were metered (Table 3.2.8), all of which consumed 0W of power while in the *off* power mode, indicating that the switch was a hard off switch. None of the models tested had a remote control, although there are fans available that come with remote controls. It should

be expected that these newer remote control models might consume some power while in the *off* power mode.

Table 3.2.8: Fans – Power Usage by Model Number and Power Mode

Model Number	Mode				Rated Power (W)
	Off (W)	Minimum Settings (W)	Medium Settings (W)	Maximum Settings (W)	
94	0.0	12.6	17.5		
166	0.0	22.2		33.6	
206	0.0	26.4	31.7	39.3	
30	0.0	28.3	33.8	39.3	
196	0.0	42.2	47.9	53.4	
163	0.0	60.0	69.2	77.1	

Only one of the fans had a recordable manufacturing date, which was 2001.

Space Heaters

A single space heater was metered (Table 3.2.9), and was found to consume 0.2W of power while in the *off* power mode, and 1228.7W of power while in the *on & active* power mode. The model metered had a small digital display, which was active in all power modes. The 0.2W of power is likely explained by this display. The model itself is a ceramic compact heater with thermostat and oscillation control. There was no available manufacturing date.

Table 3.2.9: Space Heaters – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Active (W)	
207	0.2	1228.7	1500

Pencil Sharpeners

Three pencil sharpeners were metered, only one of which consumed power (2.2W) while in the *off* power mode (Table 3.2.10). The pencil sharpeners were activated by inserting a pencil which must then activate a sensor. This sensor must be on at all times to properly function, and this sensor could explain the *off* mode power consumption, although the model which consumed power in this mode was the only model with an external power supply, which constantly consumes power regardless of device use.

Table 3.2.10: Pencil Sharpeners – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (W)
	Off (W)	
237	0.0	
260	0.0	
355	2.2	15*

* External Power Supply Rating

Staplers

Two electric staplers were metered (Table 3.2.11), and these were found to consume 1.7W and 1.3W of power while in the *off* power mode. The stapler was activated by inserting a piece of paper which must then activate a sensor. This sensor must be on at all times to properly function, and this sensor could explain the *off* mode power consumption, although both staplers utilized external power supplies which constantly consume power as well.

Table 3.2.11: Staplers – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (W)
	Off (W)	
93	1.7	29*
356	1.3	

* External Power Supply Rating

3.3. Kitchen Equipment

Blenders, Juicers, etc.

There were several different device types in this category, all having the function of blending, mixing or processing. The device types, according to the manufacturer's labels, are:

- Blender
- Smoothie Maker
- Stand Mixer
- Juice Extractor
- Food Processor
- Combination Juicer, Blender, and Grinder

Twenty-two devices in this category were measured (Table 3.3.1), almost all of which consumed either a very low amount of power while *off*, or consumed none at all. The power mode *on & active* was measured only twice, as there was no appropriate protocol for measuring up to ten different power modes, and also due to time and noise constraints.

Table 3.3.1: Blenders, Juicers, Etc – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	22	0.1	0.0	1.1	1.1	0.3
On & Active	2	52.8	25.0	80.6	55.5	39.3

Of the twenty-two devices measured, only three consumed power while in the *off* power mode, consuming 0.6W, 0.7W, and 1.1W, respectively (Table 3.3.2). Two of these models, which are actually the same model but were separated as the model names included a colour indicator, featured a touch-pad with an indicator light that may explain power consumption in the *off* mode. The other model which consumed power while *off* does not have an indicator light, although according to product documentation the model features a "Count-Up™ timer with continuous beep," though the operation of the timer in the *off* power mode is not known.

Table 3.3.2: Blenders, Juicers, Etc – Power Usage by Model Number and Power Mode

Model Number	Model Description	Mode		Rated Power (W)
		Off (W)	On & Active (W)	
5	Blender	0.0	25.0	350
27	Blender	0.0		450
57	Smoothie Maker	0.0		550
68**	Blender	0.7		
69**	Blender	1.1		
70	Stand Mixer	0.0		325
72	Blender	0.0		500
78	Blender	0.0		375
351	Stand Mixer	0.0		400
89	Blender	0.0		450
117	Juice Extractor	0.0		200
134	Blender	0.0		380
136	Juicer	0.0		850
138	Blender	0.0	80.6	350
139	Blender	0.6		600
147	Food Processor	0.0		60
151	Food Processor	0.0		500
165	Food Processor	0.0		
218	Juice Extractor	0.0		400
303	Blender	0.0		500
312	Juicer/Blender/Grinder	0.0		
334	Blender	0.0		450

** Same Model, Different Colour

With the exception of two blenders, all of these blenders/mixers/juicers/processors were current 2005 models on the floors of major retailers. Those that consumed energy in the *off* mode had lighted displays or LED timer displays.

Breadmakers

Two breadmakers were measured in the *off* power mode. Both devices had a digital clock display, which explains the *off* mean power consumption of 1.5W (Table 3.3.3).

Table 3.3.3: Breadmakers – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	2	1.5	1.2	1.9	0.7	0.5

One of the devices measured 1.9W of power while *off*, while the other device measured 1.2W of power in this mode (Table 3.3.4).

Table 3.3.4: Breadmakers – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (W)
	Off (W)	
132	1.9	660
219	1.2	550

All of these breadmakers were metered in a repair shop, and had unidentifiable manufacturing dates.

Can Openers

Five different can openers were measured, with a mean power consumption of 0.3W while turned *off*. A single device was measured while *on & active*, consuming 54.8W (Table 3.3.5).

Table 3.3.5: Can Openers – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	5	0.3	0.0	1.4	1.4	0.6
On & Active	1	54.8	54.8	54.8	0.0	

Four out of the five devices measured consumed no power while in the *off* power mode, while a single device consumed 1.4W while in the *off* power mode (Table 3.3.6). The model which consumed *off* power was a cordless can opener, and the power consumption may be explained by recharging or maintaining the charge of the battery.

Table 3.3.6: Can Openers – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Active (W)	
99	0.0		NA
100	0.0		NA
103	1.4		NA
113	0.0		NA
258	0.0	54.8	NA

Most of these can openers were current 2005 models on the floors of major retailers. A single model was found in a repair shop with no identifiable manufacturing date.

Coffee Grinders, Coffee Machines, etc.

There were several different device types in this category, all having the objective of brewing coffee or grinding coffee. The device types, according to the manufacturers labels, are:

- Coffee Machine
- Coffee Maker
- Coffee Grinder
- Coffee Mill
- Espresso Machine
- Combination Coffee Brewer and Coffee Grinder

Twenty-three devices in this category were measured in the power mode *off*, while three other devices were measured in the *on & active* mode. The findings are summarized in Table 3.3.7. The *on & active* mode was not measured for most devices due to the obvious constraints of enabling coffee production in a retail outlet on new equipment. The *off* power consumption is most likely explained by the presence of digital clocks and timers common in modern coffee machines.

Table 3.3.7: Coffee Grinders, Machines, etc – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	23	0.6	0.0	1.7	1.7	0.6
On & Active	3	369.5	71.7	685.5	613.8	307.3

The coffee grinder did not consume power while *off* (Table 3.3.8).

Table 3.3.8: Coffee Grinders – Power Usage for *off* Power Mode

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	1	0.0	0.0	0.0	0.0	

The power consumption of the two combination coffee grinders and coffee brewers was 0.6W and 0.7W (Table 3.3.9).

Table 3.3.9: Coffee Grinders & Brewers – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (W)
	Off (W)	
145	0.6	1000
157	0.7	

The mean power consumption for coffee machines in the *off* power mode was 0.9W (Table 3.3.10).

Table 3.3.10: Coffee Machines – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	15	0.8	0.0	1.7	1.7	0.7
On & Active	3	369.5	71.7	685.5	613.8	307.3

Of the fifteen coffee machines measured, only five metered 0W of power consumption in the *off* power mode. The remaining eight coffee machines consumed between 0.6W to 1.7W of power while in the *off* power mode (Table 3.3.11). The apparent reason for power consumption in the *off* mode is the presence of a digital clock display.

Table 3.3.11: Coffee Machines – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power W)
	Off (W)	On & Active (W)	
28	1.7		975
52	1.2		1110
55	0.0	351.3	900
59	0.0		
65	1.1		1150
104	0.0		900
112	0.0		625
146	1.4		900
158	1.6		
160	0.6		
161	1.2		
162	1.0		
188	1.6		900
199	0.0	71.7	1025

The coffee mill that was measured consumed 0.0W of power while *off*.

Indoor Grills

A single device described as an indoor grill was measured, although only in the *off* power mode for practical reasons. Power consumption was 0W while in the *off* power mode. A quick examination at the retail location indicated that none of the indoor grills operated *off* power mode digital clocks, and it was uncertain which grills turned on simply by plugging into the wall. Due to this uncertainty, it was not possible to measure a large sample of indoor grills without safety concerns.

Kettles

Five different kettles were measured, all of which consumed 0W of power while in the *off* power mode. A single model was measured while powered *on* (Table 3.3.12).

Table 3.3.12: Kettles – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Active (W)	
56	0.0		1500
106	0.0		1500
115	0.0		1500
124	0.0		1500
314	0.0	820.8	1200

Microwaves

Nineteen different microwaves were metered in the *off* power mode. No other power modes were metered due to the impracticality of operating a microwave in the retail environment. Mean power consumption while *off* was 1.9W (Table 3.3.13).

Table 3.3.13: Microwaves – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	19	1.9	0.4	3.3	2.9	0.8

Only two microwaves metered had a power consumption level below 1W. The highest power consumption level in the *off* mode was 3.3W, with a second highest power consumption of 2.9W (Table 3.3.14). Power consumption in the *off* mode is a function of digital clock display. None of the microwaves had identifiable or accessible manufacturing dates, although all of the microwaves were metered in a retail outlet and could reasonably be assumed to be 2005 models.

Table 3.3.14: Microwaves – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (W)
	Off (W)	
19	1.4	1200
20	1.5	1100
21	2.9	
22	1.3	1200
23	1.5	1200
24	0.4	
25	1.5	1100
26	2.1	1100
118	3.3	1000
119	2.0	700
120	2.1	1000
121	2.1	1500
122	2.3	
123	2.7	1100
247	2.7	1200
248	0.4	800
249	2.0	1200
250	2.8	
300	1.9	1000

Ranges

Twelve different ranges were metered in the *off* power mode. No other power modes could be metered in the retail setting. Mean power consumption while *off* was 1.2W (Table 3.3.15).

Table 3.3.15: Ranges – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	12	1.2	0.0	5.0	5.0	1.4

Only one range that was metered had a power consumption of 0.0W in the *off* mode. Six of the ranges metered consumed less than 1W of power, while one model consumed a high of 5.0W. The second highest level of power consumption was 2.0W (Table 3.3.16). Most power consumption appears related to digital clock display. The 5.0W model was the only model of its

brand metered, and relative to the other models had a quite elaborate digital display, as shown in Figure 1.

Figure 1: Model 343 Digital Display

Table 3.3.16: Ranges – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (kWh/yr)
	Off (W)	
75	0.5	478
76	1.9	484
79	0.6	443
80	0.4	443
82	0.0	452
83	0.4	456
84	1.8	439
85	0.5	449
88	1.2	442
90	2.0	419
92	0.4	540
343	5.0	

Refrigerators

In the retail outlet where their power consumption was metered, refrigerators had their cooling processes disabled, while the internal lights remained operational for retail display purposes. The metered refrigerators consumed from 0.0 W to 111.4 W of power on initial measurement and the variation was attributable to internal fans and other disabled internal devices that were (in some cases) reactivated when the equipment was unplugged and then plugged into the power meter. As such the metered measurements in a retail setting were not considered to be an accurate reflection of the power consumption of these appliances in a functioning household. Measurement details are provided in Table 3.3.17.

Table 3.3.17: Refrigerators – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (kWh/yr)
	Off (W)	
39	0.0	559
77	4.1	583
86	105.8	417
87	111.4	482
91	9.0	476
232	107.2	493

Deep Fryers, Rice Cookers, and Slow Cookers

Eleven various cookers and fryers were metered in the *off* power mode, while a single device was measured at a variety of power settings (Table 3.3.18). These devices were similar to the indoor grills considered previously, and had the same problems with metering. Some devices had switches, so could remain plugged in while *off* and not consume any power, while several devices would immediately start cooking once plugged in.

Table 3.3.18: Deep Fryers, Rice and Slow Cookers – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	11	211.8	0.0	1098.9	1098.9	437.5
Minimum Settings	1	83.5	83.5	83.5		
Medium Settings	1	122.6	122.6	122.6		
Maximum Settings	1	201.8	201.8	201.8		

The rice cooker consumed 41.6W of power and began cooking immediately. There are other rice cookers on the market that have hold/warm functions but these could not be measured in a retail setting.

Table 3.3.19: Deep Fryers, Rice and Slow Cookers – Power Usage by Model Number and Power Mode

Model Description	Model Number	Mode				Rated Power (W)
		Off (W)	Min. Settings (W)	Med. Settings (W)	Max. Settings (W)	
Rice Cooker	50	41.6				710
Deep Fryer	9	0.0				1500
Deep Fryer	111	1090.3				1500
Deep Fryer	148	1098.9				1500
Slow Cooker	45		97.3			110 - 190
Slow Cooker	49	0.0				290
Slow Cooker	51	0.8				250
Slow Cooker	74	0.0				170 - 270
Slow Cooker	102	0.9				370
Slow Cooker	220	0.0	83.5	122.6	201.8	225
Slow Cooker	299	0.0				100

The first deep fryer that was metered consumed 0W of power while switched *off*. The other deep fryers began consuming power immediately upon being plugged in to a power source.

Two of the slow cookers that were metered consumed power while in the *off* power mode, one consuming 0.8W of power, and the other consuming 0.9W of power (Table 3.3.19). One slow cooker began cooking immediately upon being plugged in to a power source. A single slow cooker was metered in *minimum, medium, and maximum settings*. As expected, power consumption increased with the higher settings.

Toasters and Toaster Ovens

Nineteen toasters and toaster ovens were metered in the *off* power mode. In the repair shop it was possible to meter two models in the *on & active* power mode. Mean power consumption while power *off* was 0.2W, while the mean power consumption for the operating toasters was 826.0W (Table 3.3.20).

Table 3.3.20: Toasters and Toaster Ovens – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	19	0.2	0.0	2.3	2.3	0.6
On & Active	2	826.0	814.4	837.6	23.2	16.4

Except for a single toaster, all toasters that were metered consumed 0W of power while turned *off*, (Table 3.3.21). This toaster was one of the two toasters measured at the repair shop location, and it is most likely that this toaster was faulty, as there did not appear any reasonable explanation for *off* power mode consumption in toasters.

Table 3.3.21: Toasters – Power Usage by Model Number and Power Mode

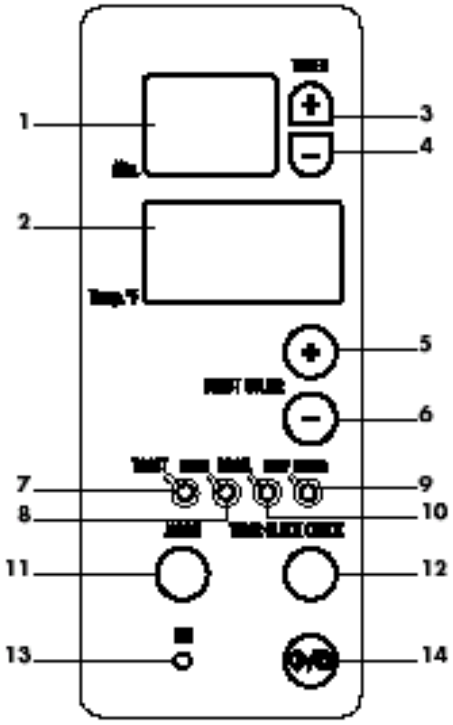
Model Number	Mode		Rated Power (W)
	Off (W)	On & Active (W)	
34	0.0	814.4	900
38	0.0		1000
40	0.0		750
41	0.0		780
42	0.0		780
105	0.0		450
107	0.0		1500
110	0.0		750
352	2.3	837.6	950
323	0.0		1500
324	0.0		1500
336	0.0		850
337	0.0		1400
338	0.0		800

Toaster ovens consumed 0.0W of power while *off*, with the exception of a single toaster oven, which consumed 0.9W of power while *off* (Table 3.3.22). This single device is the only device described as a "digital toaster oven," which featured an elaborate control panel, as shown below in Figure 2.

Table 3.3.22: Toaster Ovens – Power Usage for All Metered Power Modes

Model Number	Mode	Rated Power (W)
	Off (W)	
46	0.0	1440
47	0.0	1500
109	0.0	1200
335	0.0	1500
339	0.9	1200

Figure 2: Model 339 Digital Toaster Oven Control Panel



1 Timer display
2 Temperature/toasting level display
3-4 TIMER +/- buttons (time)
5-6 TOAST COLOR +/- buttons (temperature/toast)
7 TOAST indicator light
8 BAKE indicator light
9 KEEP WARM indicator light
10 BROIL indicator light
11 MODE button
12 TEMP. QUICK CHECK button
13 Indicator light ON
14 Start/Stop button

3.4. Computer Equipment

Computer Monitors

For computer monitors, the *off* power mode is the mode in which both the computer and the monitor are powered off. The *on & idle* power mode is when the monitor is turned on, but the computer is left off. This mode has some interesting quirks, as many older monitors appeared to load up a "burn-in" mode when no signal was initially received from the video input. The *on & active* setting refers to the situation where both the monitor and the computer are turned on, and all monitor settings are as found.

The *minimum settings* power mode is activated by configuring the monitor to operate with the set of lowest possible attributes. Within the operating system, the lowest possible refresh rate, lowest possible resolution, and a black background were selected. From the monitor panel, the lowest possible contrast and lowest possible brightness settings were also selected.

The *maximum settings* power mode is activated by configuring the monitor to operate with a set of highest possible attributes. Within the operating system, the highest possible refresh rate, highest possible resolution, and a white background were selected. From the monitor panel, the highest possible contrast and highest possible brightness setting were also selected.

The standby power modes were activated by either selecting "turn off monitor" from the power options within the operating system, selecting "standby," or selecting "hibernate." The original protocols called for all different standby modes to be selected and recorded, however, it became apparent that this was redundant, and only one of the methods to access any of the standby modes need be selected for a single monitor.

It was not possible to access all the power modes for all the monitors. In many cases, there was limited access to the operating system, in which case only the *off, on & idle,* and *standby* modes were accessible. Several monitors of the same model were metered in order to determine the extent of any variation within a model type and as further meter data verification.

Thirty-one CRT monitors were metered in the *off* power mode, with a mean power consumption of 1.4W (Table 3.4.1). Twenty-two monitors were metered in the *on & idle* power mode, with a mean power consumption of 21.4W. 33 monitors were metered in the *on & active* power mode, with a mean power consumption of 62.6W. 13 monitors were metered in the *minimum settings* and *maximum settings* power mode, with a mean power consumption of 48.6W and 73.6W, respectively. 25 monitors were metered in at least one standby power mode, with a mean power consumption of 3.3W.

Table 3.4.1: CRT Monitors – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	31	1.4	0.0	4.4	4.4	1.5
On & Idle 1	22	21.4	0.0	71.8	71.8	27.6
On & Active	33	62.6	51.1	78.1	27.0	7.6
Minimum Settings	13	48.6	40.8	58.4	17.6	5.0
Maximum Settings	13	73.6	66.7	97.4	30.8	8.8
Automatic/Manual Standby 1	25	3.3	0.0	7.4	7.4	2.1
Automatic/Manual Standby 2	1	2.7	2.7	2.7	0.0	
Manual Standby 1	5	0.8	0.0	2.6	2.6	1.1

Of the fifteen different CRT monitor models metered (Table 3.4.2), 5 consumed 0W of power while in the *off* power mode. Four models consumed a significant amount of power in the *on & idle* power mode, the mode in which the monitor is powered on, but the computer remains off. This high power consumption is explained by the "burn-in" feature on some monitors, which fail to engage into a standby mode unless there has already been a signal input from the computer.

Table 3.4.2: CRT Monitors – Power Usage by Model Number and Power Mode

Model Number	#	Mode							
		Off (W)	On & Idle 1 (W)	On & Active (W)	Minimum Settings (W)	Maximum Settings (W)	Automatic Manual Standby 1 (W)	Automatic Manual Standby 2 (W)	Manual Standby 1 (W)
33	2	0.0	4.1	73.5	52.2	97.4	4.2		
101	1	2.8		57.6	45.7	67.0	3.0		
126	1			51.2	42.2	68.1	2.8	2.7	2.6
129	1	0.0	52.5	61.4			3.5		
135	4	0.2	70.8	73.3	56.9	83.3	4.8		
176	2	0.0	0.7	59.0	49.8	70.5			0.7
195	2	0.1	0.3	67.3	58.4	80.7			0.0
240	1	0.0	2.8	55.6			2.7		
306	1	2.2		65.6					
307	1	3.3		64.1					
313	3	2.7	2.7	59.5	46.4	69.7	3.4		
329	7	0.9	1.5	57.6			1.5		
330	1	0.0		75.8			.0		
332	1	2.6	46.3	56.5	48.8	67.5	5.2		
333	5	3.8	45.0	60.5	46.1	70.6	4.7		

Of the thirty-three CRT monitors metered, only one was labelled as a 19" monitor, while the remaining thirty-two monitors were all 17" (Table 3.4.3). The 19" monitor did consume more power in the *on & active* power mode than the average of the 17" monitors in the same power mode, as might be expected. The 19" monitor also consumed 0W of power in the *off* power mode, as well as in the *standby* power mode. The average power consumption among the 17" monitors was 1.4W in the *off* power mode, and 3.5W in the *standby* power mode.

Table 3.4.3: CRT Monitors – Power Usage by Labelled Size and Power Mode

Labelled Size	#	Mode							
		Off	On & Idle 1	On & Active	Minimum Settings	Maximum Settings	Automatic/ Manual Standby 1	Automatic/ Manual Standby 2	Manual Standby 1
17"	32	1.4	21.4	62.2	48.6	73.6	3.5	2.7	.8
19"	1	0.0		75.8			0.0		

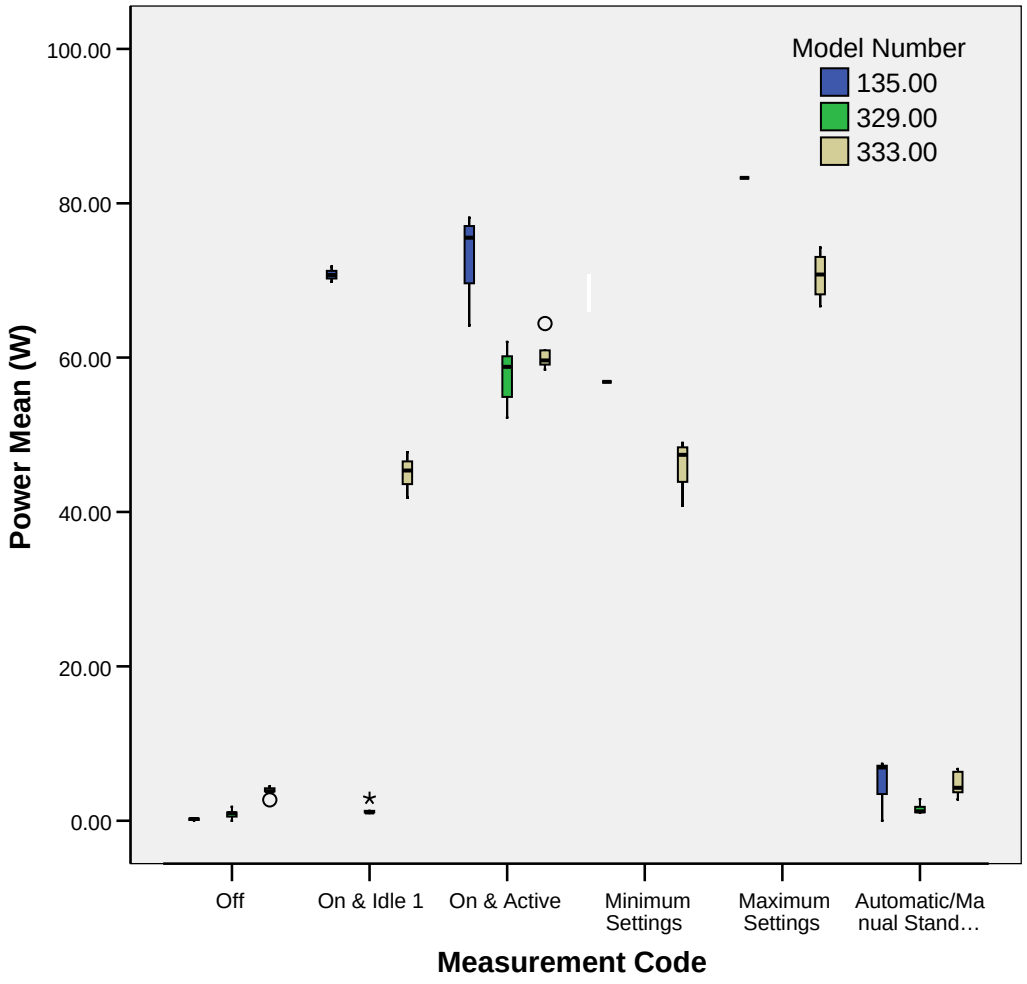
Of the thirty-three CRT monitors metered, only one did not have an identifiable manufacturing date. Mean o*ff* power mode consumption in the 1999 model was 2.6W, compared to 0.5W in the 2004 models. The most significant change between power consumption over the dates of manufacture is the sharp decline of power consumption in the *on & idle* power mode between 2001 and 2002. This power mode was the "burn-in" setting for older monitors, and was most likely discarded by manufacturers in 2002. Power use in the active power mode settings (*on & active, minimum settings, maximum settings*), appear to be fairly steady across manufacturing dates, indicating no apparent energy efficiency improvements in basic CRT display technology. Summary measurements by year of manufacture are presented in Table 3.4.4.

Table 3.4.4: CRT Monitors – Power Usage by Manufacturing Date and Power Mode

Year of Manufacture	#	Mode							
		Off	**On & Idle 1**	**On & Active**	**Minimum Settings**	**Maximum Settings**	**Automatic/ Manual Standby 1**	**Automatic/ Manual Standby 2**	**Manual Standby 1**
1999	1	2.6	46.3	56.5	48.8	67.5	5.2		
2000	6	2.5	34.8	64.2	47.0	78.3	4.3		
2001	7	1.0	66.2	69.3	52.9	75.0	4.9		
2002	7	1.5	1.1	58.9	42.2	68.1	1.5	2.7	2.6
2003	7	.6	2.0	59.1	52.4	75.9	3.1		.0
2004	4	.5	1.1	63.7	48.2	69.4	1.0		.7

For three of the models, several different units were metered to check for variation among them, and as a check on the metering equipment. As shown in Figure 3, variation among measurements of the same model type (only two models were measured in the *maximum* and *minimum* settings) was most significant in the *on & active* power mode. However, this power mode records the power levels with the monitor settings "as-is", so some or all of the variation may be due to unknown variations within the users' monitor settings. There was much less variation in the *idle* or *off* power modes.

Figure 3: CRT Monitors – Power Usage by Power Mode for Select Models



As summarized in Table 3.4.5, seventeen LCD monitors were metered in the *off* power mode, with a mean power consumption of 0.7W. Twelve LCD monitors were metered in the *on & idle* power mode, with a mean power consumption of 0.7W. Seventeen LCD monitors were metered in the *on & active* power mode, with a mean power consumption of 33.6W. Six of these monitors were metered in the *minimum settings* and *maximum settings* power mode, with a mean power consumption of 26.5W and 46.2W, respectively. Thirteen monitors were metered in at least one standby power mode, with a mean power consumption of 0.8W. Measurement details by model are presented in Table 3.4.6.

Table 3.4.5: LCD Monitors – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	17	0.7	0.0	2.3	2.3	0.7
On & Idle 1	12	0.7	0.0	2.7	2.7	0.9
On & Active	17	33.6	20.0	114.0	94.0	21.3
Minimum Settings	6	26.5	17.6	47.6	30.0	10.9
Maximum Settings	6	46.2	29.2	113.8	84.6	33.2
Automatic/Manual Standby 1	13	0.8	0.0	3.0	3.0	0.8
Automatic/Manual Standby 2	4	0.8	0.0	2.9	2.9	1.4
Automatic Standby 3	3	0.9	0.0	2.5	2.5	1.3
Manual Standby 1	4	1.1	0.0	2.6	2.6	1.2

Table 3.4.6: LCD Monitors – Power Usage by Model Number and Power Mode

Model Number	#	Mode								
		Off (W)	On & Idle 1 (W)	On & Active (W)	Minimum Settings (W)	Maximum Settings (W)	Automatic Manual Standby 1 (W)	Automatic Manual Standby 2 (W)	Automatic Standby 3 (W)	Manual Standby 1 (W)
4	2	0.8	0.8	27.1			1.4			
6	2	0.4	0.4	27.7			0.3			
7	1	0.7		36.1						
8	1	0.8		29.4			0.9			
32	1	0.8		29.2	21.1	29.2	1.1			
97	1	0.0	0.0	21.1			0.0			
125	1	1.6	1.4	114.0	47.6	113.8				1.2
128	1	1.7	1.8	39.0						
225	1	0.0	0.0	29.7	17.6	29.2	0.5	0.4	0.3	0.4
241	1	2.3	2.7	33.5	20.8	34.4	3.0	2.9	2.5	2.6
266	1	0.0	0.0	26.0	23.9	35.0	0.0	0.0		0.0
267	1	0.0	0.0	33.3	28.1	35.6	0.0	0.0	0.0	
310	1	0.2		24.1			0.3			
311	1	0.1	0.6	26.5			0.6			
331	1	1.6		20.0			1.5			

Of the seventeen LCD monitors metered, one was 15", eleven were 17", 4 were 19" and a single monitor was 30" (Table 3.4.7). The 30" monitor did consume more power in the *on & active*

power mode than the average of the other monitors in the same power mode, as might be expected. The 30" monitor also consumed 1.6W of power in the *off* power mode, compared to 0.7W and 0.2W for the 17" and 19" models, respectively. It should be noted that the 15" monitor which also consumed 1.6W of power in the *off* mode, also had a manufacturing date much earlier than the other models metered (2003), which may be a possible explanation for its higher power consumption. Power consumption in the *on & active*, *minimum settings*, and *maximum settings* power modes appear directly correlated to LCD screen size, with active power consumption increasing as size increases.

Table 3.4.7: LCD Monitors – Power Usage by Labelled Size and Power Mode

Size (inches)	#	Mode								
		Off (W)	On & Idle 1 (W)	On & Active (W)	Minimum Settings (W)	Maximum Settings (W)	Automatic Manual Standby 1 (W)	Automatic Manual Standby 2 (W)	Automatic Standby 3 (W)	Manual Standby 1 (W)
15	1	1.6		20.0			1.5			
17	11	0.7	0.8	28.7	19.8	30.9	0.9	1.6	1.4	1.5
19	4	0.2	0.2	30.5	26.0	35.3	0.2	0.0	0.0	0.0
30	1	1.6	1.4	114.0	47.6	113.8				1.2

Of the seventeen LCD monitors metered, three did not have an identifiable manufacturing date. There were no LCD monitors manufactured prior to 2003. It is difficult based on this short period to evaluate what changes to LCD energy efficiency are taking place over time (Table 3.4.8).

Table 3.4.8: LCD Monitors – Power Usage by Manufacturing Date and Power Mode

Year of Manufacture	#	Mode						
		Off (W)	On & Idle 1 (W)	On & Active (W)	Maximum Settings	Automatic Manual Standby 1 (W)	Automatic Manual Standby 2 (W)	Automatic Standby 3
2003	2			20.0				0.0
2004	7	0.7	0.6	24.1		0.2		
2005 +	5		0.8		113.8	0.9	0.4	

Desktop Computers

For desktop computers, the *off* power mode represents the power mode in which the computer is switched off using the power button on the front of the case. There is often a secondary power switch, or "hard off" switch, located on the back of the desktop computer, which is used to activate the *hard off* power mode. The *on & idle* power mode is the mode in which the computer has been switched on, has completed booting the operating system and is not visibly executing any functions other than a simple "login screen."

The standby power modes were activated by either selecting "standby" or "hibernate" from the power options within the operating system. The original protocols called for all different standby modes to be selected and recorded, however, it became apparent that this was redundant, and only one of the methods to access any of the standby modes needed be selected for a single computer.

It is expected that the power consumption while the computer is being utilized would be a useful metric to record, but due to the number of components to activate (CPU, HDD, CDROM, Graphics Card, etc), and the difficulty in having proper access to activate these in a consistent manner (e.g. installation of a "stress test" utility), it was impossible to include this mode in the measurements. However, some active power consumption metering experiments have been done, albeit in popular online technical articles, which have found that going from an *on & idle* power mode to an *on & active* power mode can increase the power consumption from 60W to 100W in modern desktops (Schmid and Roos, 2005). Also it was reported that AMD units (a competitor to Intel that makes compatible CPUs) appear to be much more energy-efficient than Intel CPUs, when viewing the metric as "performance/W," or "FLOPS/W".[4] Such a metric may become more prevalent as the major chip manufacturers have indicated future releases of performance-related efficiency metrics.

Thirty-seven desktop computers were metered in the *off* and *on & idle* power modes, with a mean power consumption of 3.5W and 85.9W respectively (Table 3.4.9). Thirty-six desktop

[4]FLOPS refer to "floating-point operations per second", a common speed rating benchmark for microprocessors.

computers were metered in at least one *standby* power mode, with a mean power consumption of 44.5W.

Table 3.4.9: Desktop Computers – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	37	3.5	0.9	8.6	7.7	1.8
On & Idle 1	37	85.9	51.9	107.8	55.9	15.5
Automatic/Manual Standby 1	36	44.5	2.1	90.6	88.5	21.4
Automatic/Manual Standby 2	4	4.3	1.3	9.5	8.2	3.6
Manual Standby 1	4	32.6	2.2	75.1	72.9	36.4
Hard Off	4	0.1	0.0	0.2	0.2	0.1

Most of the metered computers were "custom" builds, which made it difficult to retrieve model specific information such as hard drive size, speed, video card specifications and rated power. Model-specific power measurements are presented in Table 3.4.10.

Table 3.4.10: Desktop Computers – Power Usage by Model Number and Power Mode

Model Number	#	Mode						Rated Power (W)
		Off (W)	On & Idle 1 (W)	Automatic Manual Standby 1 (W)	Automatic Manual Standby 2 (W)	Manual Standby 1 (W)	Hard Off (W)	
155	32	3.7	87.3	46.0	9.5		0.1	
164	1	1.4	60.5			2.5		
251	1	2.0	65.2	4.2				
254	1	.9	82.5	2.1	1.3	2.2		
284	1	2.9	104.9	74.8	2.7	75.1		
345	1	4.6	70.4	50.9	3.9	50.8		

Seven computers had a non-identifiable CPU speed, while thirty computers had a identifiable CPU speed, ranging from 600 MHz to 3200 MHz. As shown in Table 3.4.11, the two lowest *on & idle* power consumption levels also corresponded to the two lowest CPU speeds, although general correlations between power consumption in the *on & idle* power mode and CPU speed are difficult to identify. A similar condition exists with the *off* power mode mean power

consumption with, for example, the slowest computer reporting the highest power consumption in this mode. It is likely that this model is also a much older computer than the other models, and that power consumption is highly dependent on other variables (such as the size of the power supply).

Table 3.4.11: Desktop Computers – Power Usage by CPU Speed and Power Mode

CPU Speed (MHz)	#	Mode				
		Off	On & Idle 1	Automatic/Manual Standby 1	Automatic/Manual Standby 2	Hard Off
600	1	7.9	51.9	35.1		
800	1	2.8	53.4	41.4		
950	1	2.7	88.0	38.7		
1250	1	3.6	80.6	43.0		
1300	11	2.3	95.3	38.7		0.2
1666	1	3.8	88.0	4.9		
1700	1	5.0	100.5	33.4		
1800	1	4.4	82.8	26.7		
2400	2	4.7	86.3	52.0		0.0
2600	4	5.6	81.9	43.8	9.5	0.0
2800	4	3.6	90.3	75.8		0.0
3000	1	4.7	99.0	90.6		
3200	1	5.2	93.8	72.7		

Manufacturing dates for the desktop computers were almost entirely unavailable. Only two of the computers metered had manufacturing dates that could be reliably estimated to be 2005, due to the fact that it was known they were recently purchased.

In light of this difficulty, the Basic Input/Output System (BIOS) dates for the computers were also recorded to provide an additional method of approximating the manufacturing date. However, the reliability of this method is suspect, as many BIOS dates change when the BIOS is updated. In addition, several of the computers that were metered may have had internal components that were manufactured later than the motherboard.

Desktop Speakers

A total of fifteen desktop speakers were measured in two power modes, *off* and *on & idle*. In the *off* power mode, the mean power consumption was 0.9W. The *on & idle* power consumption averaged 2.5W (Table 3.4.12).

Table 3.4.12: Desktop Speakers – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	15	0.9	0.0	2.7	2.7	0.7
On & Idle	15	2.5	0.0	5.9	5.9	1.6

A total of eleven different models of desktop speakers were measured (Table 3.4.13). Most models consumed between 0.5W and 1.5W of power while in the *off* power mode, although a single model consumed 0.0W of power while in the *off* power mode.

Table 3.4.13: Desktop Speakers – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W RMS)
	Off (W)	On & Idle (W)	
37	0.8	2.0	10
181	1.1	4.6	
200	1.1	2.3	
261	0.8	2.0	
292	0.5	1.5	
293	0.9	3.5	10
302	0.1	0.2	
346	1.6	2.1	
347	2.7	5.9	
348	0.0	0.0	
351	0.8	1.4	

Manufacturing dates for desktop speakers are almost entirely unavailable; only one model was recorded as having a manufacturing date of 2005, and that was estimated based on being present on the retail floor. All other models were located in an office space, and were likely up to five years old.

Fax/Modems

Fax/modems are peripheral devices with their own power supply that can be attached to a desktop computer. These devices are becoming increasingly uncommon, as most modern computer systems have built-in fax/modems running on the internal power supply. A total of five peripheral fax/modems were metered in two power modes, *off* and *on & idle*. In the *off* power mode, the mean power consumption was 1.3W. The *on & idle* power consumption averaged 3.8W (Table 3.4.14).

Table 3.4.14: Fax/Modems – Power Usage for All Metered Power Modes

Mode	Number of Measurements	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	5	1.3	0.9	1.9	1.0	0.4
On & Idle	5	3.8	2.5	5.7	3.2	1.2

Three different models of fax/modems were metered (Table 3.4.15). Power consumption ranged from a mean of 1.0W to 1.9W. The *on & idle* power consumption was regarded as a standby-mode because these devices are typically left on around the clock to ensure receipt of fax documents.

Table 3.4.15: Fax/Modems – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power
	Off (W)	On & Idle (W)	
186	1.4	3.7	na
187	1.0	3.1	na
304	1.9	5.7	na

Manufacturing dates for all fax/modems were unavailable. All devices were located in an office space, and could be up to five years old.

Hubs

Computer networking hubs are increasingly common in households with more than one computer. These devices have no *off* power mode and are constantly consuming power. A small home office type 4-port hub was metered at 2.5W while turned on. This power measurement is indicative of *on & idle* or standby power consumption. On and active power consumption would require that the hub be actively transferring data when the measurement was taken. The manufacturing date for the hub is unknown, but is likely manufactured within the last five years.

Label Writers

These devices are small printers that produce adhesive labels. Three such devices were metered (Table 3.4.16), with a mean power consumption of 2.6W while in the *on & idle* power mode. A single device was metered while printing labels and consumed 3.8W of power. Without disconnecting them from a power source, there was no method that could be used to shut the devices completely *off*.

Table 3.4.16: Label Writers – Power Usage for All Metered Power Modes

Mode	Number of Devices Measured	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
On & Idle	3	2.6	1.8	3.6	1.8	0.9
On & Active	1	3.8	3.8	3.8	0.0	

In total two different models of label writers were measured. One model consumed 2.3W of power, while the other model consumed 2.7W of power (Table 3.4.17).

Table 3.4.17: Label Writers – Power Usage by Model Number and Power Mode

Model Number	#	Mode		Rated Power (W)
		On & Idle 1 (W)	On & Active (W)	
48	1	2.3		
226	2	2.7	3.8	

Manufacturing dates were unavailable for all label writers. All devices were located in an office space, and could be up to five years old.

Laptop Computers

The metered laptop computers had two power modes, *off* and *on & idle*. Two of the four laptop computers were metered in additional *standby* power modes. In the *off* power mode, the mean power consumption was 3.3W. The *on & idle* power consumption averaged 18.7W. The two additional standby modes averaged 4.3W for an automatic and 2.2W for a manual standby mode (Table 3.4.18).

Table 3.4.18: Laptop Computers – Power Usage for All Metered Power Modes

Mode	Number of Devices Measured	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	4	3.3	2.2	4.5	2.3	1.2
On & Idle	4	18.7	16.0	21.5	5.5	2.7
Automatic/Manual Standby	2	4.3	4.3	4.4	0.1	0.1
Manual Standby	2	2.2	2.0	2.3	0.3	0.2

Three different models of laptop computers were measured (Table 3.4.19). The power consumption between models in the *off* power mode ranged from a mean of 2.2W to a mean of 4.3W. It is important to note in this table that there appears to be no significant difference between switching the laptop computer into the *off* power mode, and switching the laptop computer into a standby power mode. It is reasonable to assume that both modes would use the same amount of power in other models.

Table 3.4.19: Laptop Computers – Power Usage by Model Number and Power Mode

Model Number	#	Measurement Code				Rated Power (W)
		Off (W)	On & Idle (W)	Automatic/Manual Standby (W)	Manual Standby (W)	
208	1	2.2	16.0		2.0	
246	2	4.3	20.9	4.3		
259	1	2.2	16.8		2.3	

Printers

Twenty eight printers were metered in the *off* power mode with a mean power consumption of 5.1W (Table 3.4.20). Thirty six printers were metered in the *on & idle* power mode, with a mean power consumption of 36.8W. Thirty one printers were metered in the *on & active* power mode, with a mean power consumption of 195.7W. Seven of the printers were metered in a standby power mode, with a mean power consumption of 15.6W.

Table 3.4.20: Printers – Power Usage for All Metered Power Modes

Mode	Number of Devices Measured	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	28	5.1	0.0	98.3	98.3	20.0
On & Idle	36	36.8	2.8	108.8	106.0	36.9
On & Active	31	195.7	10.5	381.9	371.4	68.4
Automatic/Manual Standby	7	15.6	4.0	32.8	28.9	10.8

Twenty two different printer models were metered in various power modes (Table 3.4.21). The two models which were not metered in the *off* power mode did not have any obvious method with which to switch the printer off (other than physical disconnection from a power source), and were powered on constantly. Many models consumed less than 1W of power while in the *off* power mode, although two models consumed large amounts of power, 42.6W and 98.3W, while in the *off* power mode. The *on & idle* power mode may in many cases be considered a standby mode (printer not printing, awaiting input), and yet this mode consumes significantly high amounts of power in several models. Power consumption in the standby power mode was

typically less than the power consumption in the *on & idle* power mode, although in some cases the power consumption remained almost the same.

Table 3.4.21: Printers – Power Usage by Model Number and Power Mode

Model Number	Mode				Rated Power (W)
	Off (W)	On & Idle (W)	On & Active (W)	Automatic Manual Standby (W)	
127	0.0				1500
2		3.9	207.9	4.0	170
309	0.0	4.5	10.5		15
3		5.0	174.7		285
308	0.0	5.2			19
227	0.0	5.9	102.4		340
229	0.0	6.7	304.3	6.9	426
265	0.0	7.4	177.9	7.5	394
43	0.0	7.6	170.4		625
228	0.0	9.9	197.6		400
53	0.0	19.0			330
230	0.6	20.7	251.5	20.9	450
137	0.0	26.2			
174	0.0	38.3	178.7		250
71	0.7	44.5			350
150	42.6	48.6	381.9	32.8	470
60	0.8	48.7	213.1	12.7	800/790*
244	0.0	69.0			
63	0.0	80.6	195.9		375
62	0.0	82.8	268.3		375
64	0.0	82.8	150.0		420
231	98.3	96.7	332.9	24.9	

* Different Ratings for Copying / Printing

Printers had the most well recorded manufacturing dates compared to other devices. Only four of the devices had no identifiable manufacturing date. No printers manufactured after 2000 had greater than 1W standby power consumption, and although 2005 models had fairly low *on & idle* power consumption, trends based exclusively on manufacturing dates are hard to define. The two printers that consumed high amounts of power while *off* were 1999 and 2000 models. Power usage by year of manufacture are presented in Table 3.4.22.

Table 3.4.22: Printers – Power Usage by Manufacturing Date and Power Mode

Year of Manufacture	#	Mode			
		Off	On & Idle 1	On & Active	Automatic/Manual Standby 1
< 1999	3	49.2	42.7	278.4	24.9
1999	4	0.0	7.6	186.8	
2000	3	42.6	18.5	281.7	18.4
2001	4	0.0	13.4	175.7	
2002	2	0.0	46.4	233.0	
2003	3	0.0	80.0	197.9	
2004	9	0.0	57.6	176.6	7.2
2005 +	5	0.2	14.3	125.1	12.7

Scanners

A single scanner was metered in the *on & idle* power mode, with power consumption of 8.6W. There was no method to switch the scanner into the *off* power mode.

3.5. Other Household Items

Irons

Two irons were measured in two different power modes: *off*, and *on & active*. The mean power consumption while *off* was 0.0W, indicating that the power switch was a hard-off power switch, with no standby power consumption. *On & active* power consumption had a mean of 1021.9W (Table 3.5.1). Details for each model are presented in Table 3.5.2.

Table 3.5.1: Irons – Power Usage for All Metered Power Modes

Mode	Number of Devices Measured	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	2	0.0	0.0	0.0	0.0	0.0
On & Active	2	1021.9	945.7	1098.0	152.4	107.7

Table 3.5.2: Irons – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Active (W)	
268	0.0	945.7	1200
327	0.0	1098.0	1300

Shavers

Electric shavers were measured in the power mode *off* and *on & idle*. The mean consumption in the *off* mode was 2.7W, and the mean consumption in the *on & idle* mode was 1.7W (Table 3.5.3). The *off* mode power consumption is likely explained by the re-charging or maintaining of the charge of the shaver battery.

Table 3.5.3: Shavers – Power Usage for All Metered Power Modes

Mode	Number of Devices Measured	Mean (W)	Minimum (W)	Maximum (W)	Range (W)	Standard Deviation
Off	3	2.7	0.0	7.9	7.9	4.5
On & Idle 1	2	1.7	1.1	2.3	1.1	0.8

Power consumption in the *off* mode ranged from 0.0W to 7.9W. One possible explanation is that it is likely that the shaver consuming 0.2W of power had a full battery, while the shaver consuming 7.9W of power had a low and charging, or improperly functioning battery. Details of power usage for each model are presented in Table 3.5.4.

Table 3.5.4: Shavers – Power Usage by Model Number and Power Mode

Model Number	Mode		Rated Power (W)
	Off (W)	On & Idle 1 (W)	
242	0.2	1.1	2.0
256	0.0	2.3	4.0
257	7.9		

Toothbrushes

Two electric toothbrushes charging units were measured, in the *off* power mode, which is essentially the only available power mode. The two models consumed 2.0W and 0.3W (Table 3.5.5).

Table 3.5.5: Toothbrushes – Power Usage by Model Number and Power Mode

Model Number	Mode	Rated Power (W)
	Off (W)	
255	2.0	1.0
403	0.3	NA

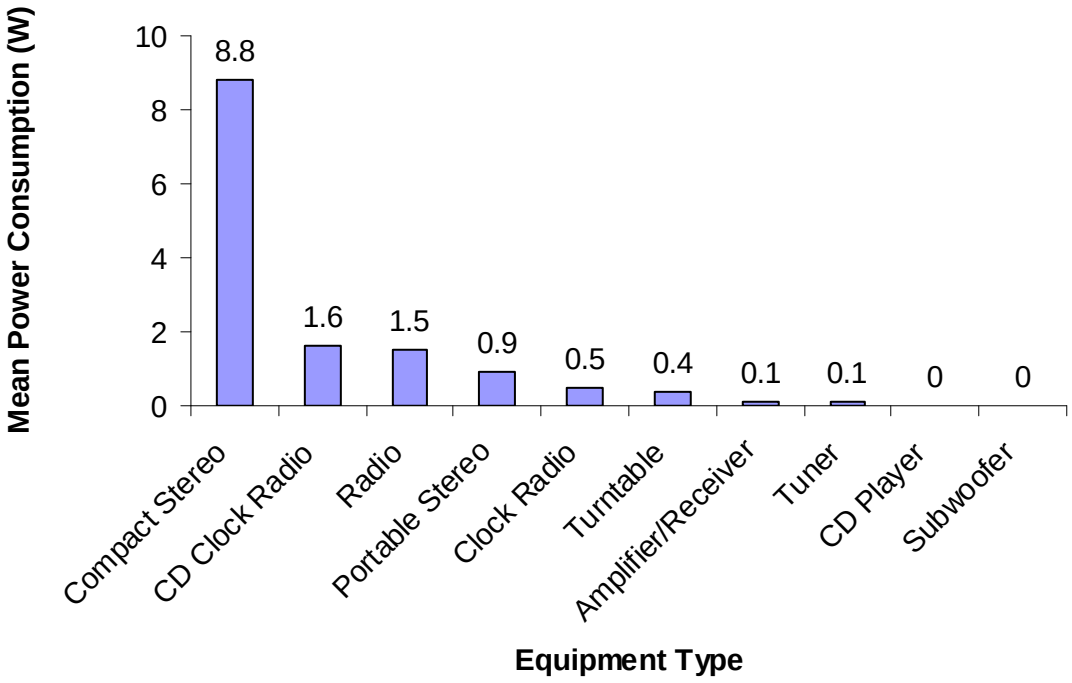
4. Summary and Comparisons

In this section, a brief summary of the results detailed in the previous section is provided, along with some comparisons of the power usage of different types of appliances.

4.1. Home Entertainment Equipment

In view of their different functions, and to avoid over-crowding of the diagrams presented here, for presentation purposes we separate home entertainment equipment into two broad groups – audio equipment and video equipment. Figure 4 displays average power consumption of various types of home audio equipment in the *standby/off* mode, while Figure 5 displays similar power usage information in the *on & idle* mode.

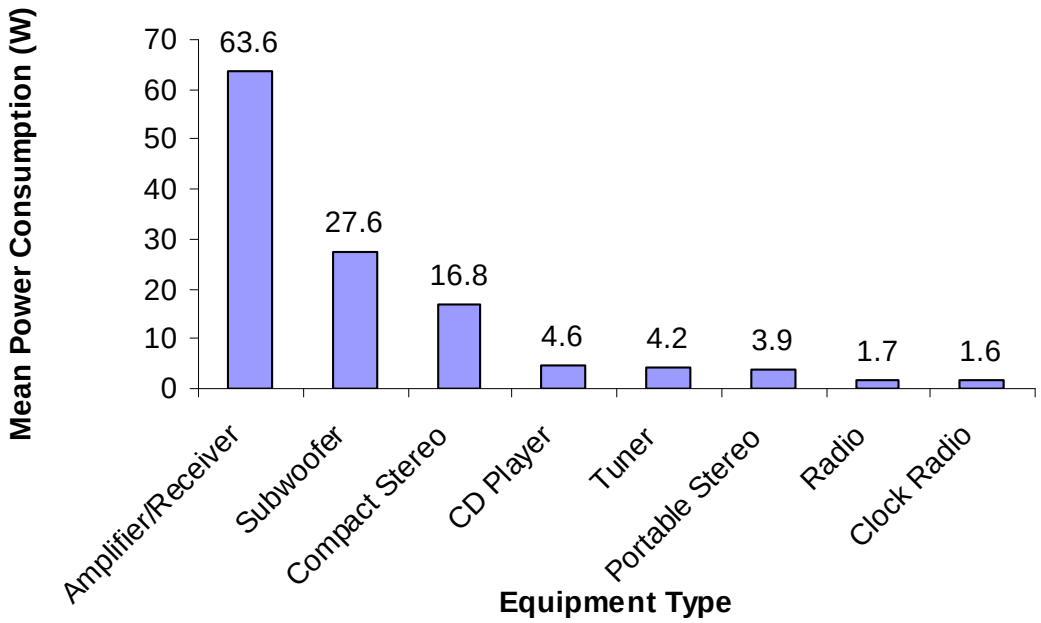
Figure 4: Home Audio Equipment - Average Power Consumption in *Standby/Off* Mode



As Figure 4 shows, in the *standby/off* mode, most home audio equipment consumes less than 2W of power except for Compact Stereo units which, with an average of 8.8W, consume the most power of all the home audio equipment that was metered. The range of power usage values in this mode for Compact Stereo systems is quite large (0.0W to 19.9W), indicating that – at least

for some models – there would appear to be considerable scope for improvements in their efficiency. A large part of this consumption is attributable to display features that remain active when the device is not in use. The other types of home audio equipment also follow a similar pattern, with a positive correlation between high power consumption and large, complex, "always on" display features.

Figure 5: Home Audio Equipment - Average Power Consumption in *On& Idle* Mode



*CD clock radios and Turntables were not measured in this mode

In the *on & idle* mode, compact stereo systems consume less than component amplifier/receivers. In this case the inclusion of a large home theatre receiver/amplifier inflated the consumption average. Excluding this unit, the average power consumption in this mode for amplifier/receivers is 29.5W, which is similar to the average for the one subwoofer that was measured, but is still almost twice the average for compact stereo units. Of course the extent to which higher power usage in this mode is a concern depends on consumer usage patterns with this equipment. If, for example, amplifiers and receivers are left on and idle for extended periods of time, or if compact stereos are routinely left in this mode when a disk has completed playing, the relatively high power usage could translate into considerable amounts of energy use.

Figure 6 displays average power consumption of various types of home audio equipment in the *standby/off* mode, while Figure 7 displays similar power usage information in the *on & idle* mode. In the standby/off mode, rear projection LCD televisions use by far the most power on average, almost twice as much as a cable box. Apart from DLP televisions, all other home video equipment that was metered was found to use less than 5W on average in this mode.

Figure 6: Home Video Equipment – Average Power Consumption in *Off* Mode

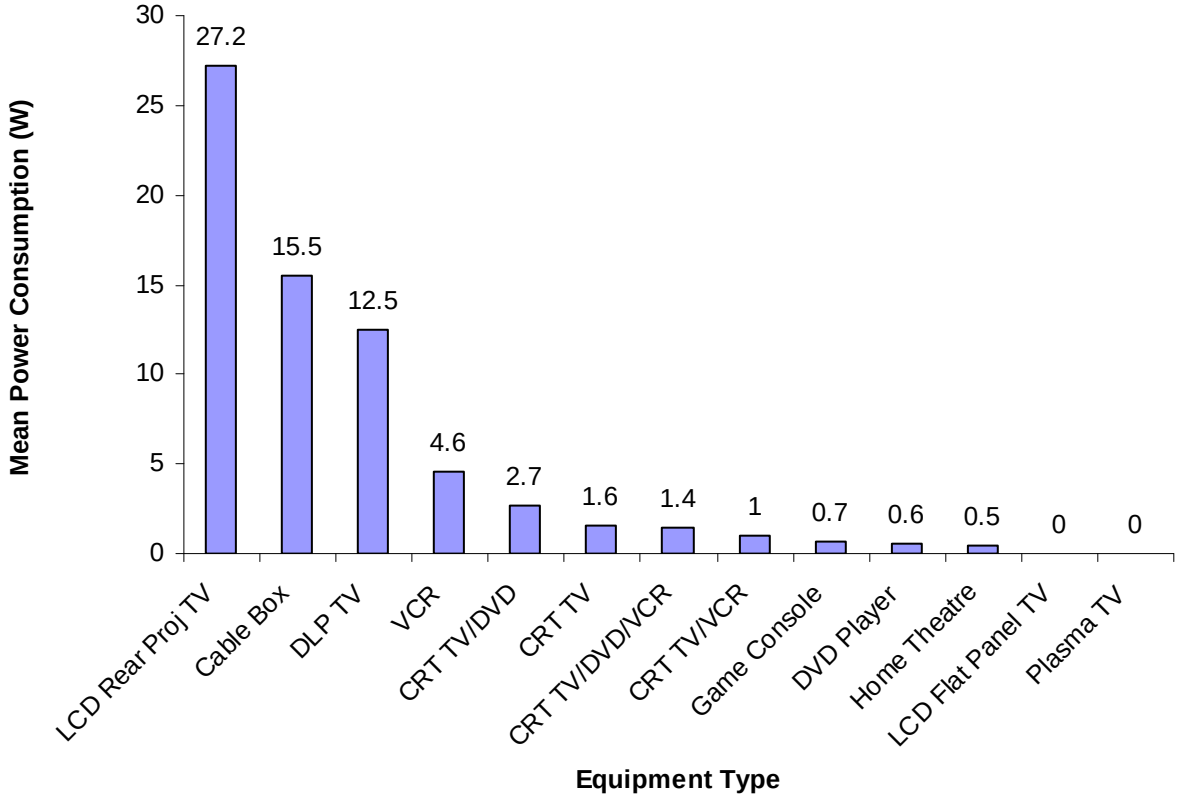
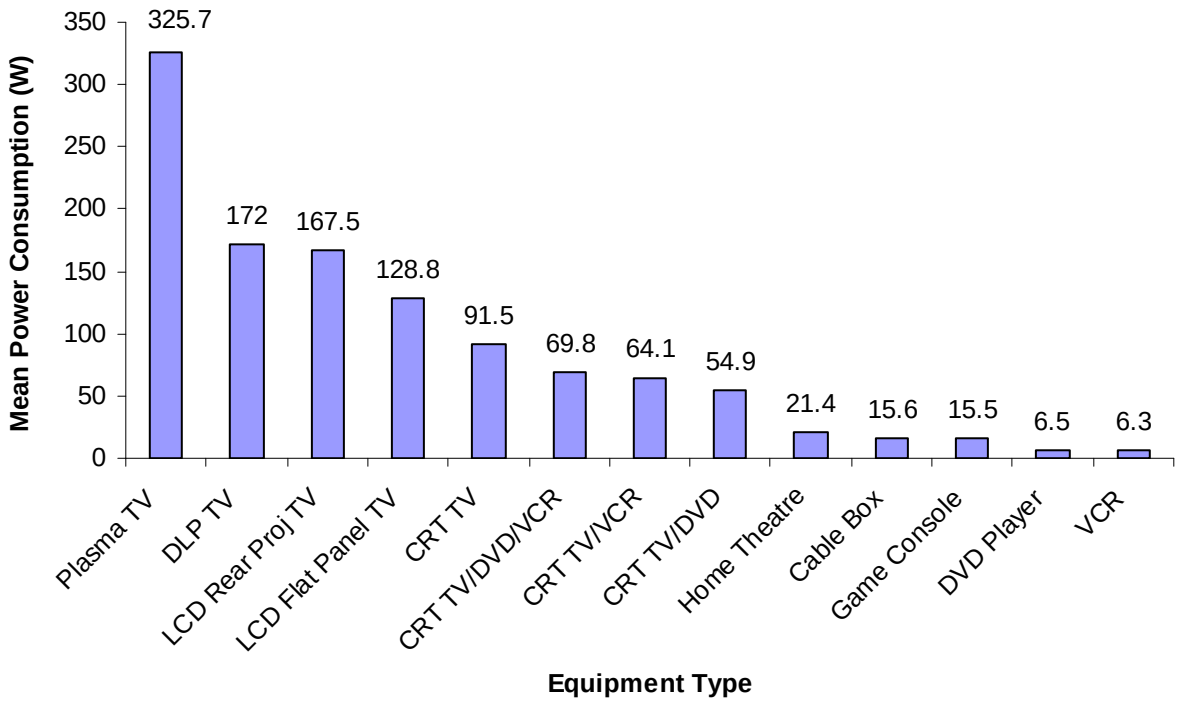


Figure 7: Home Video Equipment – Average Power Consumption in *On & Idle* Mode

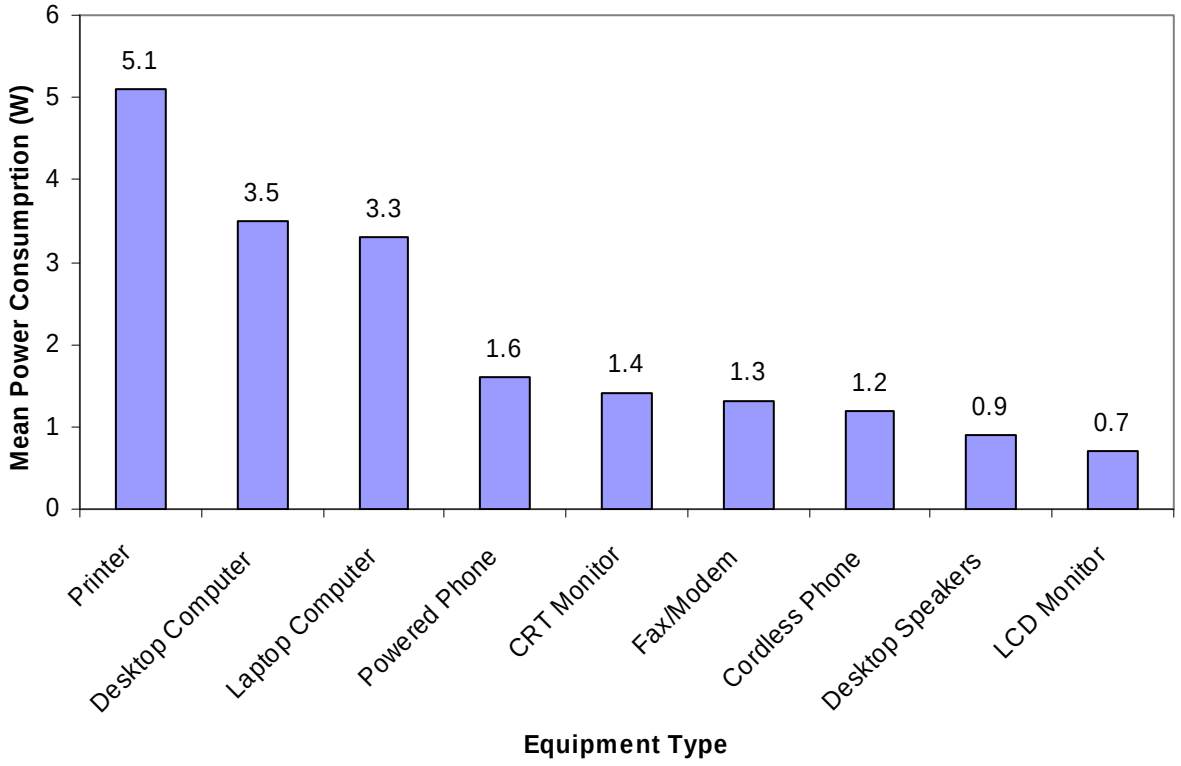


Average power usage in the *on & idle* mode for home video equipment is largest by far for plasma televisions, although it must be noted that this measurement is based on a single plasma set. DLP televisions and LCD rear projection televisions draw approximately 170W on average, while LCD flat panel televisions also use in excess of 128W on average. Clearly, the increasing penetration of plasma, LCD, and DLP televisions has considerable implications for standby power use, particularly if these sets are left in the *on & idle* mode. CRT televisions in combination with one or more of a DVD or VCR use between 50 and 70W on average, while stand-alone CRT televisions draw a larger 91.5W on average. DVD players and VCRs on average used approximately 6.5W in the *on & idle* mode, while all other measured video equipment used between 15W and 25W on average.

4.2. Computers and Selected Home Office Equipment

In terms of home office equipment, computers and associated peripherals generally have the largest power requirements. Figure 8 displays average power consumption of computing and other office equipment in the *standby/off* mode, while Figure 9 displays similar power usage information in the *on & idle* mode.

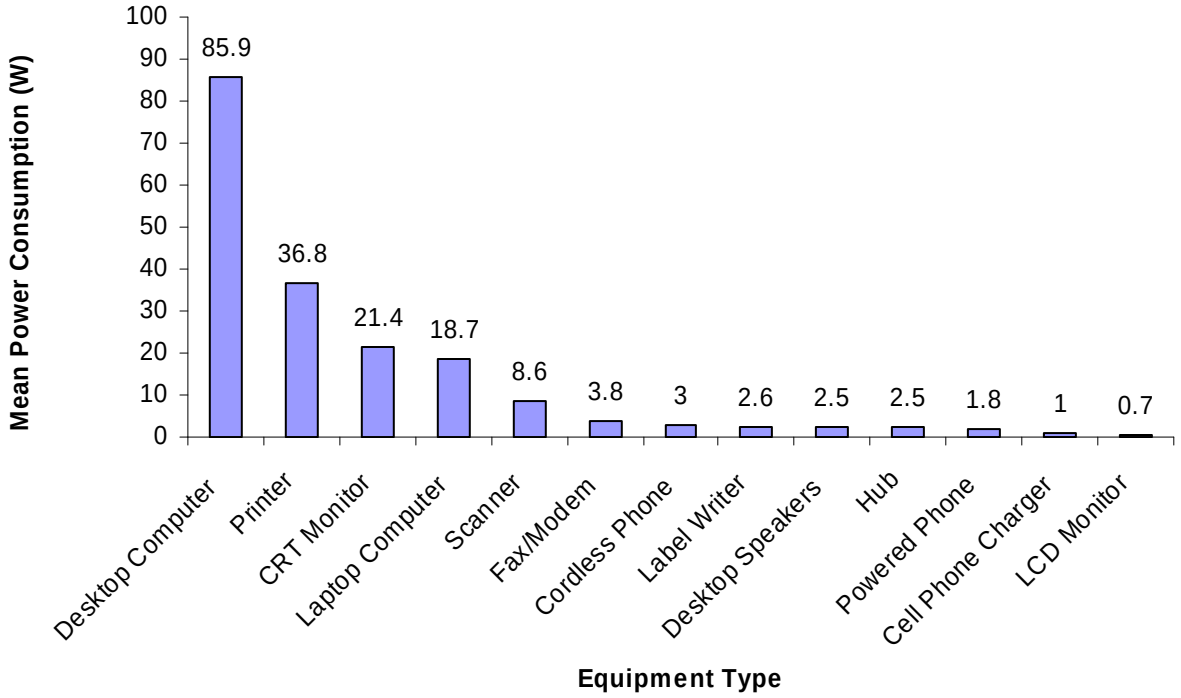
Figure 8: Computers and Selected Home Office Equipment – Average Power Consumption in *Off* Mode



As can be seen from Figure 8, in the *standby/off* mode, printers use the most power, followed by desktop and laptop computers, which have similar power requirements. Note, however, that the power requirements for printers in this mode have decreased noticeably over time, and if the metered sample is restricted to printers manufactured in the last five years (2001 and later), the average power requirements for printers in this mode drops to an extremely small 0.04W.

When computers and other office equipment are *on & idle*, average power consumption (Figure 9) is highest by far for desktop computers, followed by printers, which use about 40% as much power on average, and then CRT monitors and laptop computers which use less than one-quarter of the power of desktop computers in this mode. Interestingly, and in contrast to the case in the *standby/off* mode, printers manufactured since 2000 have a slightly higher average power consumption in this mode, of 42.5W.

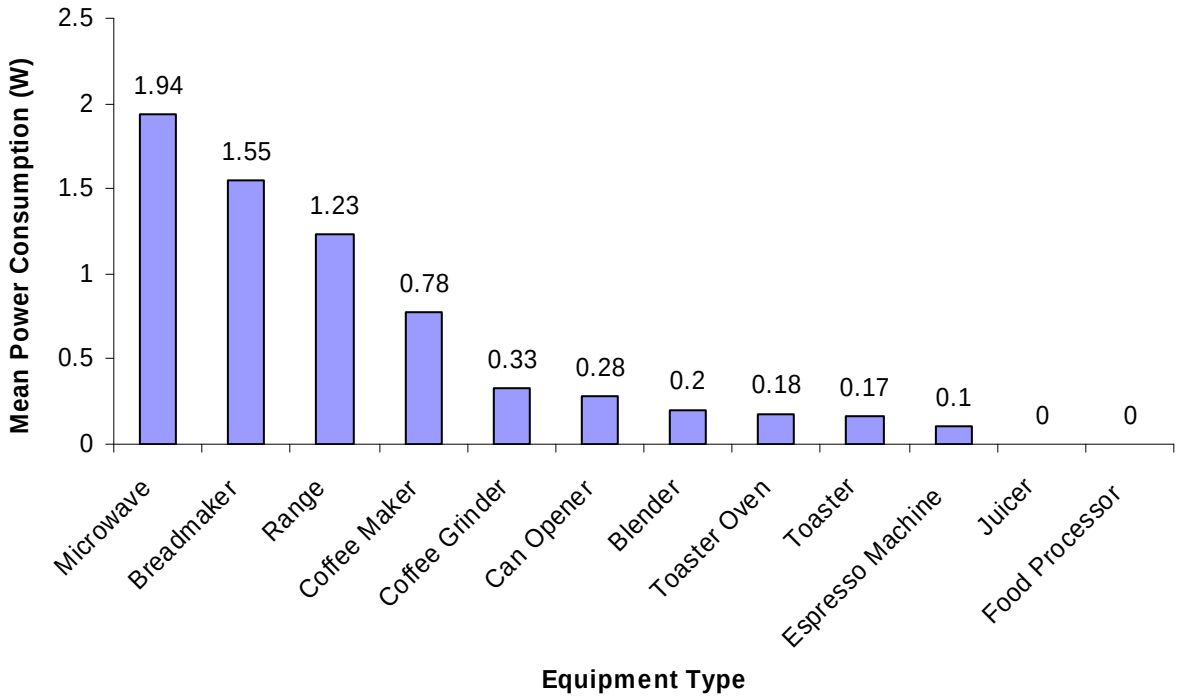
Figure 9: Computers and Selected Home Office Equipment – Average Power Consumption in *On & Idle* Mode



4.3. Kitchen Equipment

For kitchen equipment, there is generally no well-defined *on & idle* mode, so that standby power considerations are analyzed here in the *standby/off* mode. In most cases the power requirements in these cases are due to clocks and other digital displays that have been incorporated in the equipment. As shown in Figure 10, all average power requirements are below 2W. Although appliances such as breadmakers have relatively large power usage in this mode, it is probably unlikely that they would be left connected to the power when not in use, unlike microwaves, ranges and perhaps coffee makers. The comparison group here excludes refrigerators due to the difficulty in defining when they are in the *off* mode as well as other measurement issues discussed earlier. With these caveats, and as reported in Table 3.3.17, refrigerators were found to draw between 0W and 111.4W.

Figure 10: Kitchen Equipment – Average Power Consumption in *Off* Mode



* Coffee Grinders here include coffee grinders, coffee mills, and combined grinder/brewers.

** Refrigerators are omitted due to measurement issues discussed earlier (see Table 3.3.17 and accompanying text).

4.4. Comparisons among Equipment with Similar Power Requirements

Finally, in this section we present some comparisons across equipment categories of the power requirements of different appliances. In view of the large number of appliances that were metered in the various modes, in each figure the comparisons are restricted to appliances that have average power requirements that fall in a similar range. Figures 11 – 13 pertain to appliances in the *standby/off* mode, while Figures 12 – 15 contain similar information for appliances in the *on & idle* mode.

Figure 11: Average Power Consumption in *Off* Mode for Equipment Consuming Less than 1W on Average in the *Off* Mode

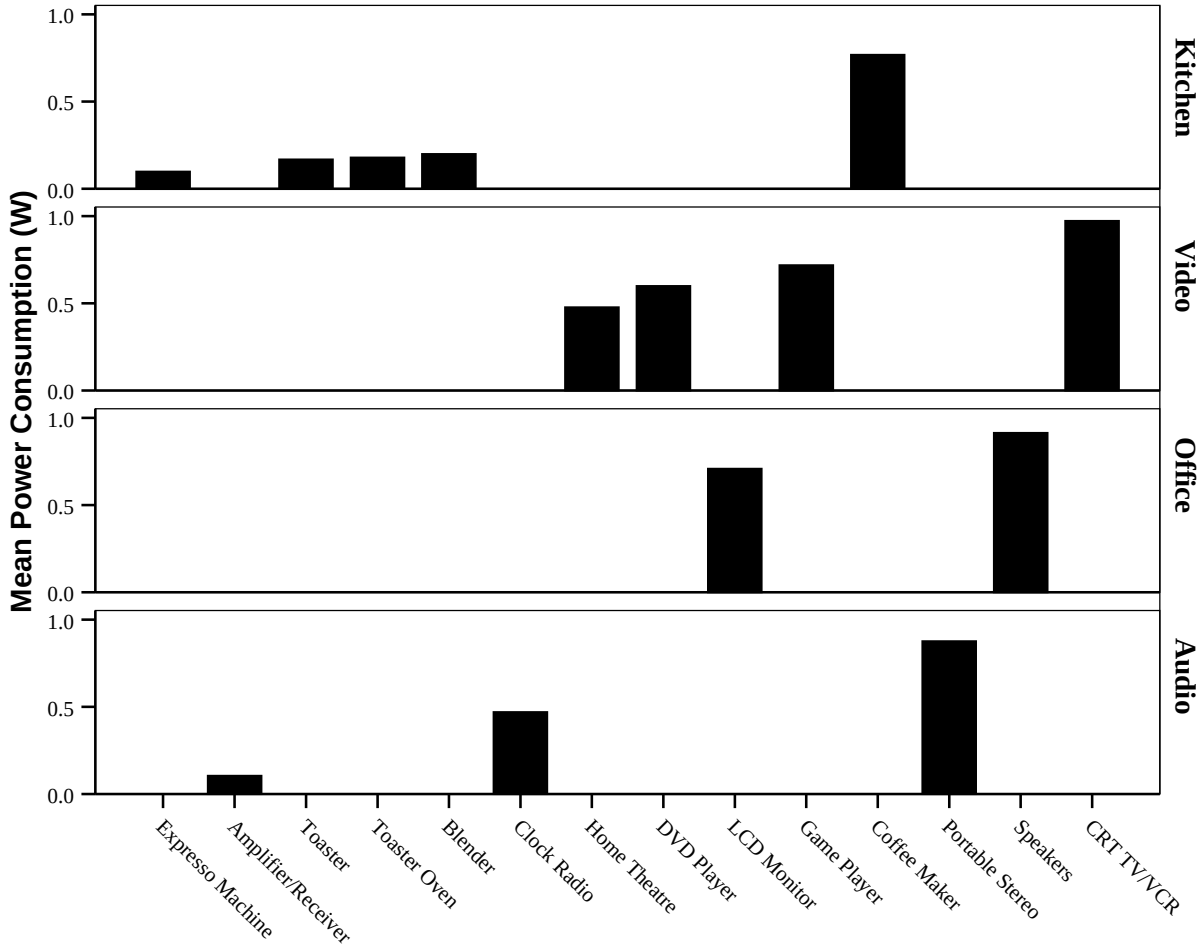
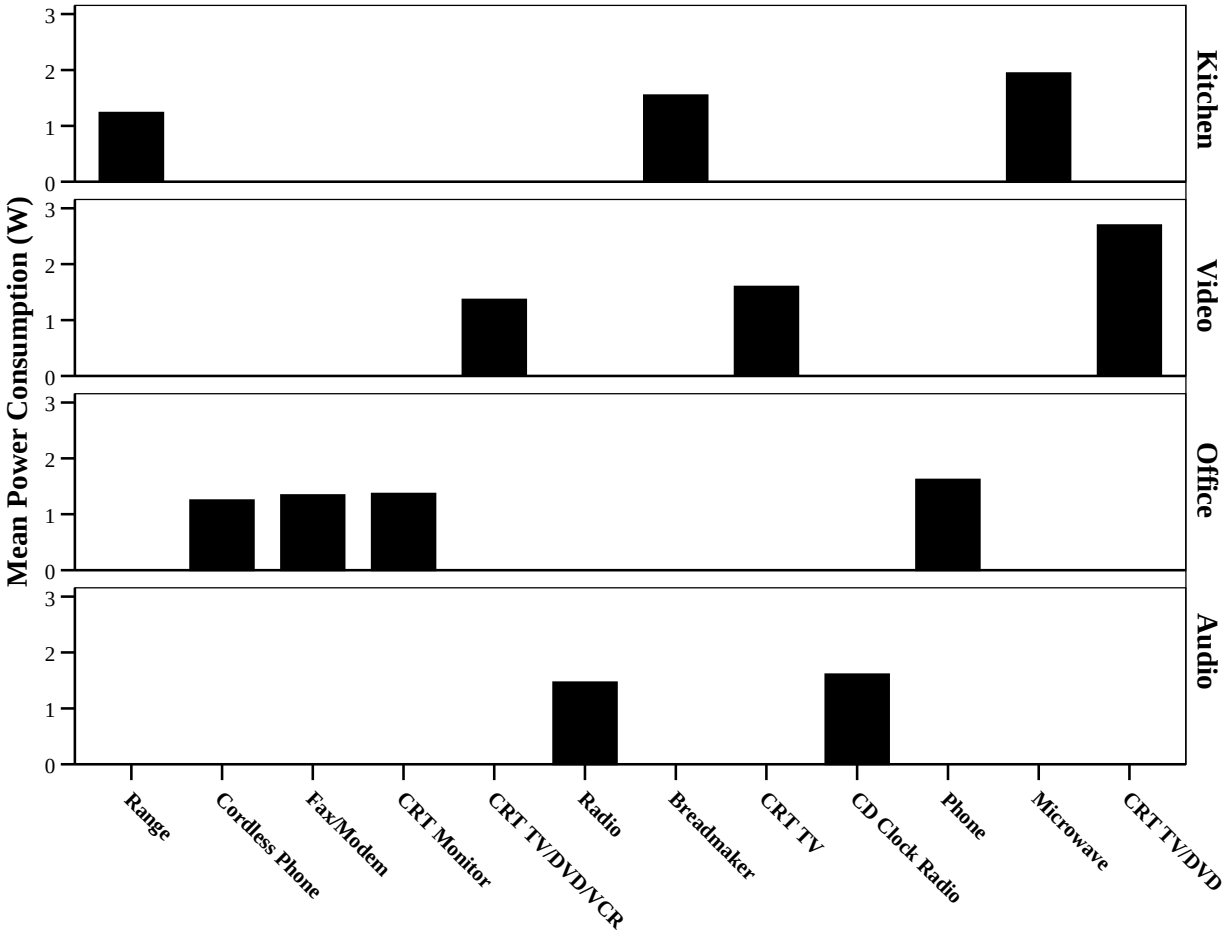


Figure 11 shows the average power usage in the *off* mode for appliances that on average draw less than 1W of power. Here the largest power users on average are the CRT TV/VCR, computer (desktop) speakers, portable stereos, and coffee makers. Within this group of appliance, six of the nine largest power using appliances are in the home entertainment category (video and audio).

Figure 12 shows similar information for appliances using between 1W and 3W of power in the off mode. Within this grouping, the largest power using appliances are CRT TV/DVDs and microwaves. Equipment from all categories – kitchen, office, video, and audio – is well represented in this grouping.

Figure 12: Average Power Consumption in *Off* Mode for Equipment Consuming Between 1W and 3W on Average in the *Off* Mode



Appliances having the largest power usage in the *off* mode, between 3W and 30W, are displayed in Figure 13. Within this grouping the largest power using appliances are again video equipment, specifically LCD rear-projection televisions, cable boxes, and DLP televisions. Compact stereos are the next largest power user, along with printers (but again, printers would not be included in this grouping if older models were excluded).

Figure 13: Average Power Consumption in *Off* Mode for Equipment Consuming Between 3W and 30W on Average in the *Off* Mode

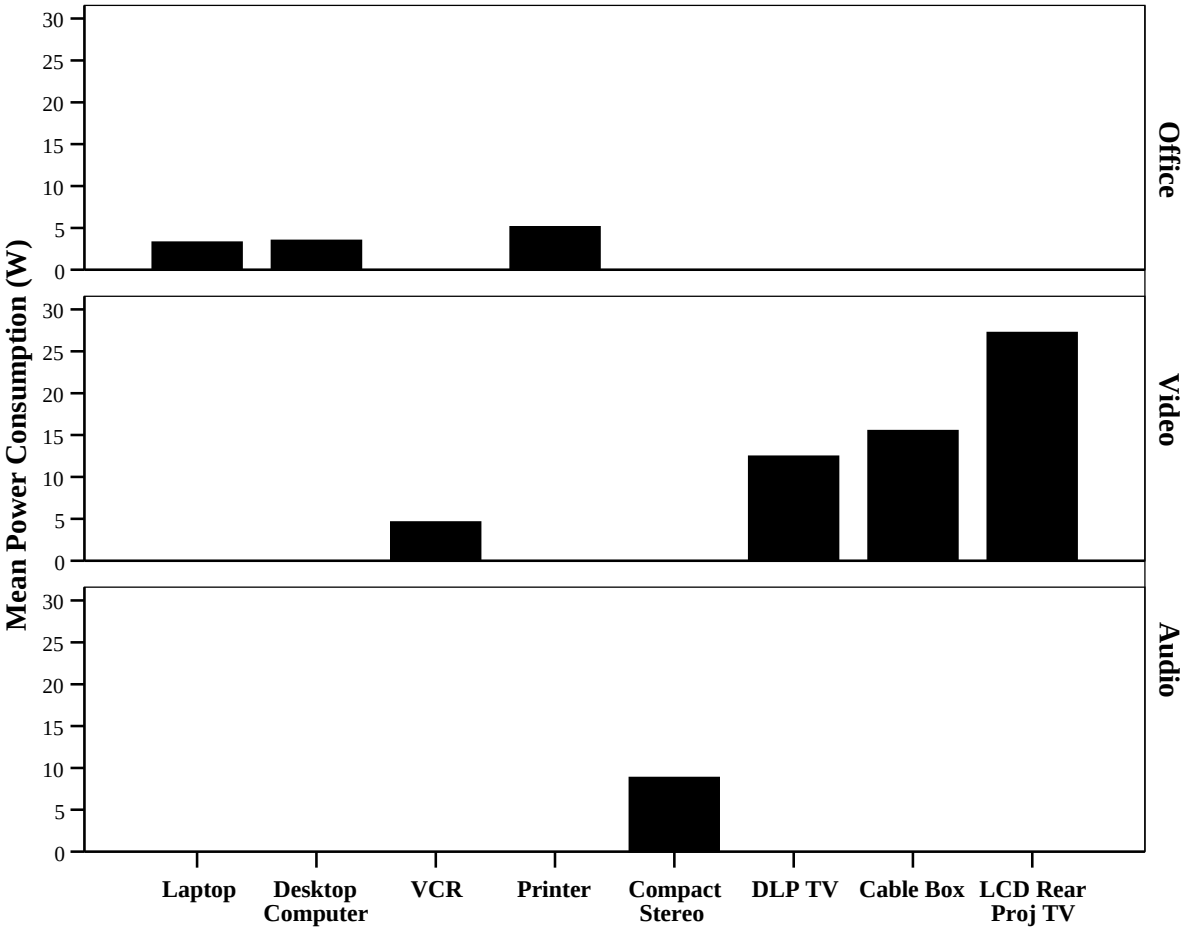
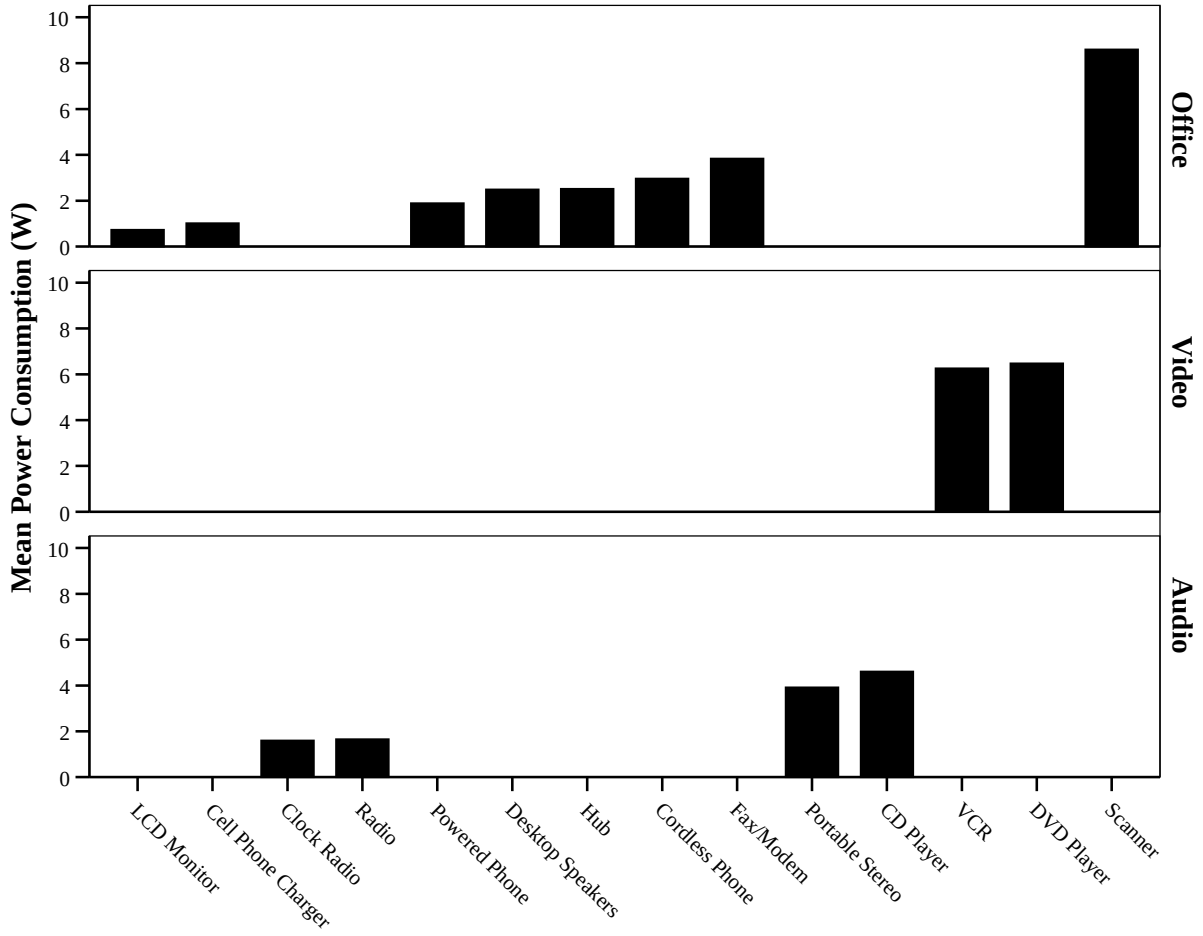
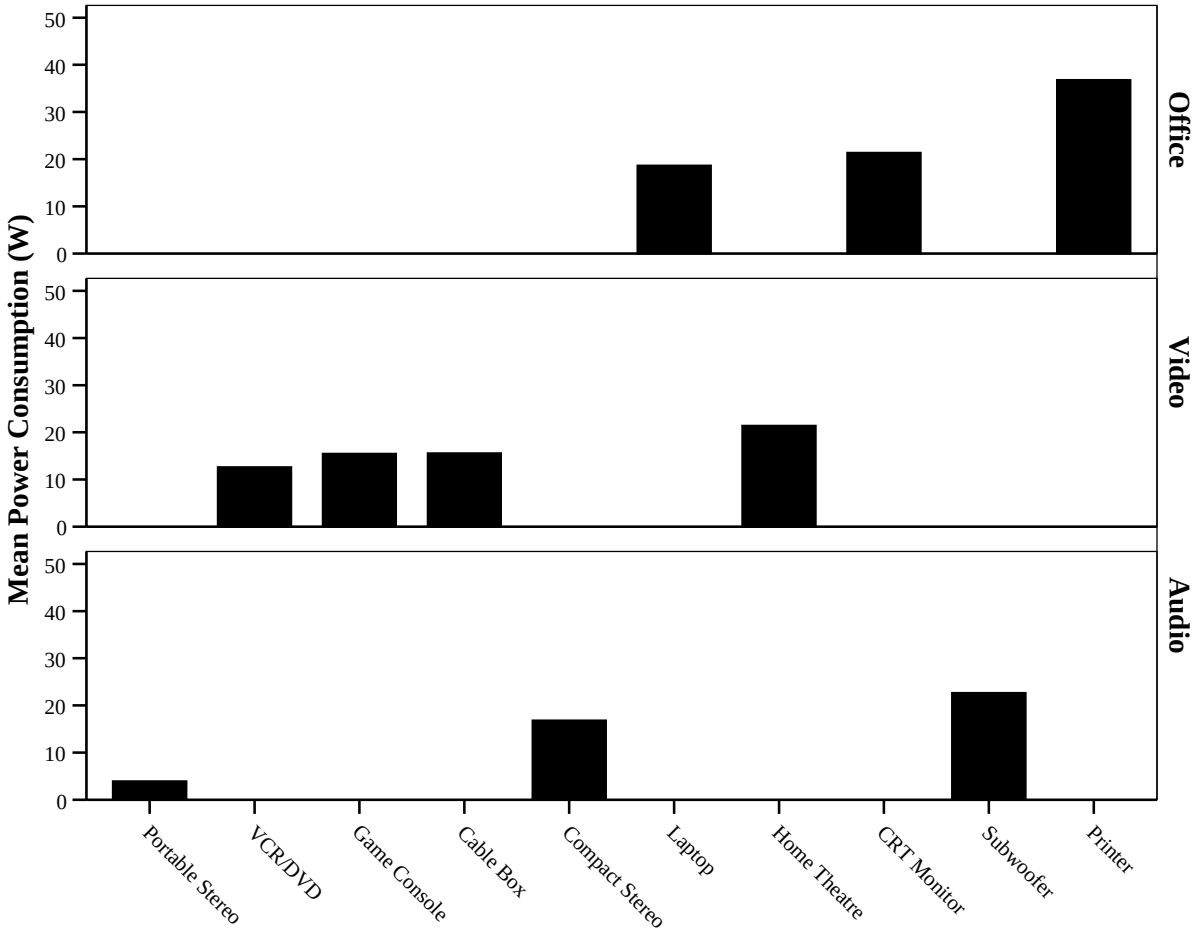


Figure 14: Average Power Consumption in *On & Idle* Mode for Equipment Consuming Between 1W and 10W on Average in this Mode



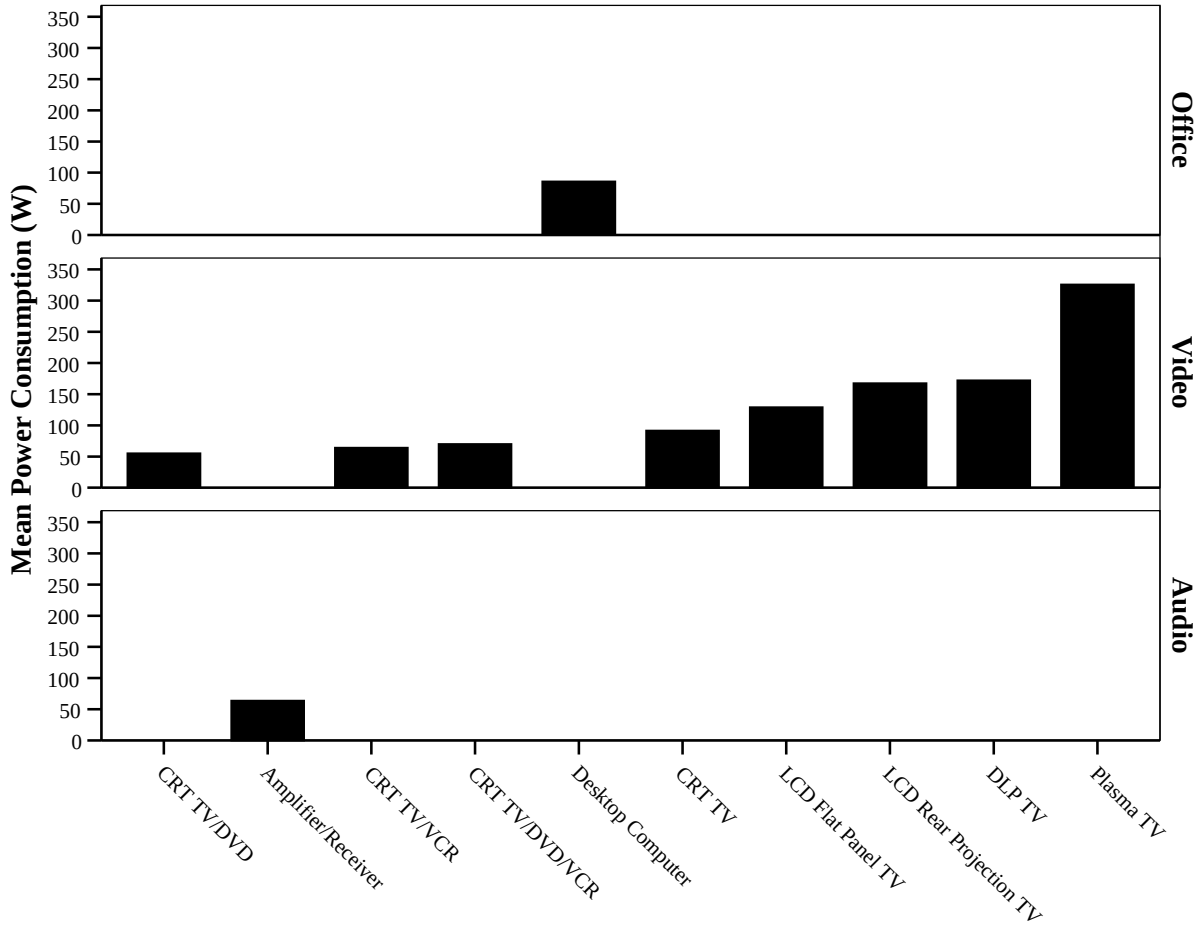
Turning to equipment that is in the *on& idle* mode, Figure 14 shows power usage in this mode for those appliances that use between 1W and 10W on average. This group includes a large number of office appliances, although the largest power users in this group are scanners, DVD players and VCRs. Figure 15 shows power usage for appliances that use between 10W and 50W on average in the *on & idle* mode. In this case there are as many office appliances as home entertainment appliances that have the largest power requirements, although printers draw more power than any other appliances that were measured in this mode.

Figure 15: Average Power Consumption in *On & Idle* Mode for Equipment Consuming Between 10W and 50W on Average in this Mode



Finally, Figure 16 shows the average power use of appliances that are among those that have the largest average power requirements in the *on & idle* mode, between 50W and 350W. With the exception of desktop computers and amplifier/receivers, nearly all this equipment is in the home entertainment – video category. The five largest average power requirements were observed for different types of televisions, ranging from plasma to DLP, LCD rear-projection, LCD flat panel, and CRT. This suggests that possibly the largest return in terms of efforts to reduce standby power consumption could be achieved with televisions, particularly those left in the *on & idle* mode, although in the *standby/off* mode, LCD rear-projection and DLP televisions – along with cable boxes – are again among the appliances with the largest average power usage.

Figure 16: Average Power Consumption in *On & Idle* Mode for Equipment Consuming Between 50W and 350W on Average in this Mode



5. Conclusion

This paper reports measurements of standby power energy use of common household appliances available on the market in Canada. Using a power quality logger, power measurements were made for a variety of appliances in different modes of operation. In many cases, power measurements were found to vary widely across modes of operation for any particular appliance, and different types of appliances were found to have quite different power requirements in the same mode of operation. For presentation purposes, appliances were grouped into one of five categories – home entertainment (comprising home audio and home video), office, kitchen, computing, and other.

Within the group of home audio appliances, compact stereos appear to draw the most power when in the *off/standby* mode, with most other equipment drawing less than 2W on average. In the *on & idle* mode, amplifier/receivers, subwoofers, and again compact stereos, draw the most power on average. In terms of home video equipment, in the *off* mode the appliances that draw the most power on average are LCD rear projection televisions, cable boxes and DLP televisions. In the *on & idle* mode, plasma televisions, DLP televisions, LCD rear projection televisions, and LCD flat panel televisions all draw in excess of 100W on average, while CRT televisions – whether or not in combination with VCRs and DVD players – draw on average between 50W and 100W.

In terms of home office equipment, desktop and laptop computers draw the most power in the *off/standby* mode, but this is less than 4W on average. Older printers also have larger power requirements in this mode, but printers manufactured since 2001 do not appear to share this characteristic. In the *on & idle* mode, desktop computers have by far the largest average power requirements, with printers, CRT monitors, and laptop computers also using relatively large amounts of power (between 18W and 37W) on average.

Apart from refrigerators for which a number of measurement issues could not be resolved in a retail setting, kitchen appliances, in the *off* mode, used on average less than 2W of power.

Unfortunately, for many kitchen appliances there was no well-defined *on & idle* mode, so that standby power comparisons are difficult to make for this group.

Comparisons across the different appliance groups indicate that home video equipment generally draws the most power in the *off* mode, - particularly LCD rear-projection televisions, DLP televisions, and cable boxes, although compact stereos also draw in excess of 5W in this mode. In the *on & idle* mode, the highest average power usage is again observed for televisions, especially plasma, DLP, and LCD televisions. This suggests that possibly the largest return in terms of efforts to reduce standby power consumption could be achieved with televisions, particularly those left in the *on & idle* mode.

Overall, the standby power measurements reported here indicate that – depending of course on household behaviour in terms of the modes in which appliances are "operated" – households could save considerable amounts of energy by disconnecting appliances rather than having them operate in various standby or idle modes. Of course it would be necessary for household members to know that they should do this, and to this end there appears to be a very limited amount of information that is publicly available. Manufacturer specification sheets provided at the time of the appliance purchase (and often available from manufacturer web sites) typically indicate the rated power consumption in some modes, but usually not in all modes. For example, in terms of the audio equipment that was metered, only one manufacturer routinely supplied both a rated standby and "full power on" power consumption value in their equipment specifications. In any event, it might be expected that these specification sheets would only be given a cursory review by consumers, likely only at or shortly after the time or purchase, and that they would most likely not be available later as reminders of the amount of energy being consumed by the appliance in various modes of operation. Overall, this suggests that it might be useful to provide consumers with (a) better information about the power usage of appliances in various modes, (b) reminders over time about the consequences in terms of energy use concerning the modes in which their appliances are utilized, and (c) a source where they could readily assess the likely power usage of their appliances in various modes of operation.

As with any set of measurements such as those reported here, there are a number of caveats that are in order. First, while we are extremely grateful to the retailers and other groups that provided us with access to their appliances, it was not possible to evaluate all power modes in the circumstances in which these appliances were made available. Also, in many cases it was only possible to obtain power measurements for a relatively small number of different models of an appliance, and in some cases only for a single model. It would be expected that in view of these limitations, average power requirements may vary if the sample were to be increased. Nevertheless, the values that are reported here do provide a benchmark measure of the amount of power that is consumed by a variety of appliances in several different modes of operation.

Of course, knowing the average power requirements of appliances in particular modes only partially helps determine the standby energy requirements of a typical household. Another key piece of information concerns the usage patterns of these appliances – that is, the extent to which specific types of appliances are operated in particular modes. Combining information of this type – and typical household holdings of appliances – with the standby power requirements of each appliance will help determine the total amount of energy that is utilized for standby purposes, and the importance of addressing this issue in a wider Canadian context.

6. Bibliography

DXGaming (2006), “Game Console Energy Consumption”, http://www.dxgaming.com/?p=6&page=7

Kawamoto, Kaoru., et al (2000), “Electricity Used by Office Equipment and Network Equipment in the U.S.”, Lawrence Berkeley National Laboratory, Berkeley CA.

Kawamoto, Kaoru., et al. (2004), “Energy Saving Potential of Office Equipment Power Management”, *Energy and Buildings*, Vol. 36. pp. 915 - 923

Meier, Alan K., et al. (1999), “Energy Use of Televisions and Videocassette Recorders in the U.S.”, Lawrence Berkeley National Laboratory, Berkeley CA.

Picklum, Roger E., Bruce Nordman, and Barbara Kresch (1999), *Guide to Reducing Energy Use in Office Equipment*, Bureau of Energy Conservation, City & County of San Francisco, and Lawrence Berkeley National Laboratory, Berkeley CA.

Recording Industry Association of America, The (2004), “2004 Consumer Profile”, http://www.riaa.com/news/marketingdata/pdf/2004consumerprofile.pdf

Schmid, Patrick and Achim Roos (2005), “The AMD and Intel Energy Crisis,” Tom’s Hardware, http://www.tomshardware.com/2005/07/13/the_amd_and_intel_energy_crisis/index.html

Tesco.com (2006) “Micro Systems Product Guide”, http://www.tesco.com/electrical/p.aspx?id=MicroSystemsGuide

Appendix A: Device Measurement Protocols

A.1. LCD and CRT Monitors

Objective: To measure the standby and active power consumption of LCD and CRT monitors for a variety of sizes, models, and manufacturing year at minimum and maximum resolution, different refresh rates, with light or dark screen images, and various low-level power modes.

Equipment:

1. Tape measure
2. Data sheets
3. Pens, pencils, clipboards
4. Power line meter (PLM)
5. Flashlight

Procedure:

1. Record make, type (LCD or CRT), model, manufacturing date, and price (if available). Record the rated power from the nameplate or documentation (if available).
2. Record any important descriptive notes (e.g. external power supply, built-in speakers).
3. Measure diagonal size of actual screen area (inside frame).
4. Record brand of computer to which the monitor is attached.
5. With computer and monitor *off*, plug the monitor into the PLM and measure the power draw.
6. Turn the monitor *on*, and measure the power draw, taking note of power indicator.
7. Turn the computer *on,* and record the OS and version during boot-up. After boot-up is complete, measure the power draw of the monitor, and take note of power indicator.

8. Access the control panel, change the resolution to the lowest setting (typically 640x480), refresh rate to the lowest setting (typically 60Hz), and change the desktop image to as dark as possible. Access the monitor interface, set the brightness to a minimum, and set the contrast to a minimum, then measure and record the power draw.
9. Change the resolution to the highest setting, refresh rate to the highest setting, and change the desktop image to as light as possible. Access the monitor interface, set the brightness and contrast to the maximum values, then measure the power draw.
10. Restore monitor settings to as-found.
11. Access the power management settings, set the monitor low-power level automatic setting to minimum delay (e.g. "1 min"). Wait for the monitor to enter the low-power level, measure the power usage, and note the appearance of the monitor power indicator.
12. If there is more than one low-power setting available, repeat previous step for second power level.
13. Reset PM settings to as-found. Initiate any manual low-power level options available (e.g. "Suspend"), and measure the monitor power usage, taking note of power indicator.
14. Metering of the monitor is complete. Turn monitor *off*, unplug the PLM, and reconnect monitor to its original power source.

A.2. Computer Peripheral Devices

Objective: To measure the standby and active power consumption of various computer peripheral devices for a variety of models, and manufacturing years, in various power modes.

Equipment:

1. Data sheets
2. Pens, pencils, clipboards
3. Flashlight
4. Power line meter (PLM)

Procedure:

1. Record the type of peripheral device (e.g. computer speakers, etc)
2. Record make, model, manufacturing date, and price (if available).
3. Record the rated power from the nameplate or documentation (if available).
4. Record any important descriptive notes (e.g. external power supply).
5. With device *off*, plug the device into the PLM and measure the power usage.
6. Turn the device *on*, wait for any warm-up time to complete, and measure the power usage of the device.
7. If there are other power modes (e.g. active, idle), put device into these power modes, then measure the power usage.
8. Metering of the device is complete. Turn the device *off*, unplug the PLM, and reconnect the device to its original power source.

A.3. Personal Computers

Objective: To measure the standby and active power consumption of desktop and laptop computers for a variety of models, and manufacturing year at various power modes.

Equipment:

1. Tape measure
2. Data sheets
3. Pens, pencils, clipboards
4. Flashlight
5. Power line meter (PLM)

Procedure:

1. Record whether the computer is an Integrated Computer System (ICS), laptop, or desktop model.
2. Record make, model, manufacturing date, and price (if available).
3. Record the rated power from the nameplate or documentation (if available).
4. Record any important descriptive notes (e.g. external power supply, built-in speakers).
5. If metering an ICS or laptop, measure the diagonal size of the actual screen area (inside frame). Record type of monitor used (CRT or LCD).
6. If metering a laptop, remove or disconnect the battery.
7. Record the number of USB devices connected to the computer, and what the devices are.
8. With computer *off*, plug the computer into the PLM and measure the power usage
9. Turn the computer *on,* and record the OS and version during boot-up. Also record the RAM size, hard drive size, CPU make and speed. After boot-up is complete, measure the power usage of the computer. Note the appearance of the power indicator.

10. Access the power management settings, set the computer low-power level automatic setting to minimum delay (e.g. “1 min”). Wait for the computer to enter the low-power level, measure the power usage, and note the appearance of the computer power indicator.
11. If there is more than one low-power setting available, repeat previous step for second power level.
12. Reset PM settings to as-found. Initiate any manual low-power level options available (e.g. “Suspend”), and measure the computer power usage. Note the appearance of the computer power indicator.
13. Metering of the computer is complete. Turn computer *off*, unplug the PLM, and reconnect computer to its original power source.

A.4. Printers

Objective: To measure the standby and active power consumption of printers for a variety of models, and manufacturing year, in various power modes.

Equipment:

1. Data sheets
2. Pens, pencils, clipboards
3. Flashlight
4. Power line meter (PLM)

Procedure:

1. Record make, model, manufacturing date, and price (if available).
2. Record the rated power from the nameplate or documentation (if available).
3. With printer *off*, plug the printer into the PLM and measure the power usage.
4. Turn the printer *on*, wait for boot-up cycle to complete, and measure the power usage of the printer.
5. Either by accessing an option to print a test page, or by printing from a connected computer, measure the power usage while the printer is actively printing.
6. If there are any power management settings available, set them to the minimum delay. Wait for the printer to enter the low-power level, measure the power usage, and note the appearance of any power indicators.
7. Reset PM settings to as-found.
8. Metering of the printer is complete. Turn printer *off*, unplug the PLM, and reconnect printer to its original power source.

Appendix B: Data Set Variable Descriptors

B.1. Variable List

Table B.1.1: Full Data Set Variable List

Variable	Label	Measurement Level	Additional Description
DeviceID	Device Unique ID	Scale	
SiteCode	Device Location	Nominal	Where the Device was metered.
OLDMeasurementID	Measurement ID	Nominal	Original Coding of Measurement (changed)
MeasurementCount	Number of Measurements	Nominal	
SerialNumber	Device Serial Number	Nominal	
OfficeNumber	Office Number	Nominal	Which office the device was metered if available.
EquipmentType	Equipment Type	Nominal	
Brand	Brand	Nominal	
Model	Model	Nominal	
ManufactureDate	Manufacturing Date	Scale	
ManufactureDateIsEstimated	<none>	Scale	Boolean indicator of estimated manufacturing date (0 = No, 1 = Yes)
CostPrice$	Price ($)	Nominal	Retail Cost of Device
CurrentValue$	Current Value ($)	Nominal	Resale Value of Device
MeasuredSize	Measured Size	Nominal	Size of display as measured. (TV/Monitor ONLY)
LabelledSize	Labelled Size	Nominal	Size of display as labeled (TV/Monitor ONLY)
RatedV	Rated Power (V)	Nominal	
VoltageType	Voltage Type	Scale	
RatedHz	Rated Power (Hz)	Nominal	
RatedA	Rated Power (A)	Nominal	
RatedW	Rated Power (W)	Nominal	
RatingFromManual	Source of Power Rating Information (For W, and Average Power Rating)	Scale	Where information for power rating was found
AveragePowerRatingW	Average/Operating Power Rating (W)	Nominal	
OnAndIdlePowerRatingW	On & Idle Power Rating (from Manual/Online info) (W)	Scale	

Variable	Label	Measurement Level	Additional Description
OffPowerRatingW	Off Power Rating (from Manual/Online info) (W)	Scale	
StandbyPowerRatingW	Standby/Power Save Rating (from Manual/Online Info) (W)	Scale	
External_PS_Description	External Power Supply Description	Nominal	
CPU_Make	CPU Make	Nominal	
CPU_Speed	CPU Speed (MHz)	Nominal	
OS__Version	OS & Version	Nominal	
RAM_Size	RAM Size (MB)	Nominal	
HD_Size	HD Size (GB)	Nominal	
No._of_USB_Devices	No. of USB Devices	Nominal	
BiosDate	Motherboard BIOS Date	Scale	
Description	Description	Nominal	
OffIndicator	Off Indicator	Nominal	
OnIndicator	On Indicator	Nominal	
DeviceType	<none>	Nominal	
StandbyIndicator	Standby Indicator	Nominal	
VoltsRMS_mean	Volts RMS Mean	Scale	
CurrentRMS_mean	Current RMS Mean	Scale	
Frequency_mean	Frequency Mean	Scale	
Power_mean	Power Mean (W)	Scale	
PowerMin_mean	PowerMin Mean (W)	Scale	
PowerMax_mean	PowerMax Mean (W)	Scale	
ApparentPower_mean	Apparent Power Mean	Scale	
ApparentPowerMin_mean	Apparent PowerMin Mean	Scale	
ApparentPowerMax_mean	Apparent PowerMax Mean	Scale	
TotalPowerFactor_mean	Total Power Factor Mean	Scale	
CurrentTHD_mean	Current THD Mean	Scale	
VoltsRMS_median	Volts RMS Median	Scale	
CurrentRMS_median	Current RMS Median	Scale	
Frequency_median	Frequency Median	Scale	
Power_median	Power Median	Scale	
PowerMin_median	PowerMin Median	Scale	
PowerMax_median	PowerMax Median	Scale	
ApparentPower_median	Apparent Power Median	Scale	
ApparentPowerMin_median	Apparent PowerMin Median	Scale	
ApparentPowerMax_median	Apparent PowerMax Median	Scale	
TotalPowerFactor_median	Total Power Factor Median	Scale	
CurrentTHD_median	Current THD Median	Scale	

Variable	Label	Measurement Level	Additional Description
VoltsRMS_sd	Volts RMS Standard Deviation	Scale	
CurrentRMS_sd	Current RMS Standard Deviation	Scale	
Frequency_sd	Frequency Standard Deviation	Scale	
Power_sd	Power Standard Deviation	Scale	
PowerMin_sd	PowerMin Standard Deviation	Scale	
PowerMax_sd	PowerMax Standard Deviation	Scale	
ApparentPower_sd	Apparent Power Standard Deviation	Scale	
ApparentPowerMin_sd	Apparent PowerMin Standard Deviation	Scale	
ApparentPowerMax_sd	Apparent PowerMax Standard Deviation	Scale	
TotalPowerFactor_sd	Total Power Factor Standard Deviation	Scale	
CurrentTHD_sd	Current THD Standard Deviation	Scale	
VoltsRMS_min	Volts RMS Minimum	Scale	
CurrentRMS_min	Current RMS Minimum	Scale	
Frequency_min	Frequency Minimum	Nominal	
Power_min	Power Minimum	Scale	
PowerMin_min	PowerMin MInimum	Scale	
PowerMax_min	PowerMax Minimum	Scale	
ApparentPower_min	Apparent Power Minimum	Scale	
ApparentPowerMin_min	Apparent PowerMin Minimum	Scale	
ApparentPowerMax_min	Apparent PowerMax Minimum	Scale	
TotalPowerFactor_min	Total Power Facto Minimum	Scale	
CurrentTHD_min	Current THD Minimum	Scale	
VoltsRMS_max	Volts RMS Maximum	Scale	
CurrentRMS_max	Current RMS Maximum	Scale	
Frequency_max	Frequency Maximum	Nominal	
Power_max	Power Maximum	Scale	
PowerMin_max	PowerMin Maximum	Scale	
PowerMax_max	PowerMax Maximum	Scale	
ApparentPower_max	Apparent Power Maximum	Scale	
ApparentPowerMin_max	Apparent PowerMin Maximum	Scale	
ApparentPowerMax_max	Apparent PowerMax Maximum	Scale	

Variable	Label	Measurement Level	Additional Description
TotalPowerFactor_max	Total Power Factor Maximum	Scale	
CurrentTHD_max	Current THD Maximum	Scale	
VoltsRMS_range	Volts RMS Range	Scale	
CurrentRMS_range	Current RMS Range	Scale	
Frequency_range	Frequency Range	Scale	
Power_range	Power Range	Scale	
PowerMin_range	PowerMin Range	Scale	
PowerMax_range	PowerMax Range	Scale	
ApparentPower_range	Apparent Power Range	Scale	
ApparentPowerMin_range	Apparent PowerMin Range	Scale	
ApparentPowerMax_range	Apparent PowerMax Range	Scale	
TotalPowerFactor_range	Total Power Factor Range	Scale	
CurrentTHD_range	Current THD Range	Scale	
MeasurementCode	Measurement Code	Scale	
BrandID	Brand	Nominal	
ModelID	Model	Nominal	
EquipmentCode	Equipment Type	Nominal	
EquipmentCategory	Equipment Category	Nominal	
EquipmentCategoryID	Equipment Category	Nominal	
GeneralEquipmentType	GeneralEquipmentType	Nominal	
GeneralTypeID	GeneralEquipmentType	Nominal	
kWh_per_year	kWh / year	Scale	
AnnualCostLow	COMPUTE AnnualCostLow = kWh_per_year * 0.025	Scale	
AnnualCostMedium	COMPUTE AnnualCostMedium = kWh_per_year * 0.055	Scale	
AnnualCostHigh	<none>	Scale	
Temp	Device Unique ID	Ordinal	
ManufactureDateBand	Manufacturing Date (Banded)	Ordinal	
ModelIDMask	Model Number	Scale	
NonNegPowerMean	Power Mean (W)	Scale	
NonNegPowerMin	PowerMin Mean (W)	Scale	
NonNegPowerMax	PowerMax Mean (W)	Scale	
ModelIDMaskStr	Model Number	Nominal	
DeletedObservation	Deleted Observation	Scale	
PrimaryLast	Indicator of each last matching case as Primary	Ordinal	
CPUMakeCode	CPU Make	Nominal	

B.2. Variable Values

Table B.2.1: Full Variable Values List

Value		Label
VoltageType	.00	AC
	1.00	DC
RatingFromManual	0	Device
	1	Product Manual
	2	Unavailable
MeasurementCode	1.00	Off
	2.00	On & Idle 1
	3.00	On & Idle 2
	4.00	On & Active
	5.00	Minimum Settings
	6.00	Medium Settings
	7.00	Maximum Settings
	8.00	Automatic/Manual Standby 1
	9.00	Automatic/Manual Standby 2
	10.00	Automatic Standby 3
	11.00	Manual Standby 1
	12.00	Manual Standby 2
	14.00	Hard Off
BrandID*	1-98	
ModelID*	1-348	
EquipmentCode	1	Adding Machine
	2	Amplifier
	3	Blender
	4	Breadmaker
	5	Can Opener
	6	CD Clock Radio
	7	CD Player
	8	Cell Phone Charger
	9	Clock Radio
	10	Coffee Grinder
	11	Coffee Grinder/Brewer
	12	Coffee Machine
	13	Coffee Maker
	14	Coffee Mill
	15	Component Stereo
	16	Compressor
	17	Conference Phone
	18	Cordless Phone
	19	CRT Monitor
	20	CRT Television
	21	CRT Television/DVD
	22	CRT Television/DVD/VCR
	23	CRT Television/VCR
	24	Deep Fryer
	25	Desktop Computer
	26	Desktop Fan
	27	Desktop Speakers

*Brand and Model Values are omitted from this table.

Value		Label
EquipmentCode (continued)	28	DLP Projection Television
	29	DLP TV
	30	DVD Player
	31	Electric Knife
	32	Envelope Stamper Feeder
	33	Espresso Machine
	34	Fan
	35	Fax/Modem
	36	Food Processor
	37	Hub
	38	Indoor Grill
	39	Integrated Home Theater
	40	Interac Machine
	41	Iron
	42	Juice Extractor
	43	Juicer
	44	Juicer/Blender/Grinder
	45	Kettle
	46	Label Writer
	47	Laptop
	48	LCD Monitor
	49	LCD PROJO
	50	LCD Rear Projection
	51	LCD Television
	52	Letter Opener
	53	Letter Scale
	54	Microwave
	55	Mini Stereo System
	56	Other
	57	Pencil Sharpener
	58	Photocopier
	59	Plasma Television
	60	Portable Stereo
	61	Powered Phone
	62	Printer
	63	Radio
	64	Range
	65	Receipt Printer
	66	Reciever
	67	Refridgerator
	68	Rice Cooker
	69	Scanner
	70	Shaver
	71	Slow Cooker
	72	Smoothie Maker
	73	Space Heater
	74	Stand-up Fan
	75	Stand Mixer
	76	Stapler
	77	Sub-woofer
	78	Toaster
	79	Toaster Oven
	80	Toothbrush

Value		Label
EquipmentCode (continued)	81	Tuner
	82	Turntable
	83	VCR
	84	VCR/DVD
	85	Wall Audio System
	86	Cable Box
EquipmentCategoryID	1	Computer Equipment
	2	Home Theater
	3	Kitchen Equipment
	4	Office Equipment
	5	Other
GeneralTypeID	1	Adding Machine
	2	Amplifier/Reciever
	3	Blender/Juicer/Etc
	4	Breadmaker
	5	Can Opener
	6	CD/Clock/Radio
	7	Coffee Grinder/Machine
	8	Compressor
	9	Computer Monitor
	10	Desktop Computer
	11	Desktop Speakers
	12	Electric Knife
	13	Envelope Stamper Fee
	14	Fan
	15	Fax/Modem
	16	Hub
	17	Indoor Grill
	18	Integrated Home Thea
	19	Interac Machine
	20	Iron
	21	Kettle
	22	Label Writer
	23	Laptop
	24	Letter Opener
	25	Letter Scale
	26	Microwave
	27	Other
	28	Pencil Sharpener
	29	Phone
	30	Photocopier
	31	Printer
	32	Range
	33	Receipt Printer
	34	Refridgerator
	35	Rice/Slow Cooker/Deep Fryer
	36	Scanner
	37	Shaver
	38	Space Heater
	39	Stapler
	40	Stereo
	41	Television
	42	Toaster

Value		Label
GeneralTypeID	43	Toothbrush
(continued)	44	Tuner
	45	Turntable
	46	VCR/CD/DVD
	47	Cable Box
ManufactureDateBand	1	< 1999
	2	1999
	3	2000
	4	2001
	5	2002
	6	2003
	7	2004
	8	2005 +
DeletedObservation	0	Valid
	1	Invalid/Delete

Appendix C: Glossary of Acronyms

BIOS - Basic Input/Output System

CPU - Central Processing Unit

CRT - Cathode Ray Tube

CSV - Comma-separated Values

DLP - Digital Light Processing

DVD - Digital Video Disc

FLOPS - Floating point operations per second

ICS - Integrated Computer System

LCD - Liquid Crystal Display

LSD - Least Significant Digit

OS - Operating System

PLM - Power Line Meter

PM - Power Management

POD - Point-of-deployment module (CableCARD)

RAM - Random Access Memory

RMS - Root Mean Squared

THD - Total Harmonic Distortion

USB - Universal Serial Bus

VA - Volt-Amp

VCR - Video Cassette Recorder

W - Watts

Appendix D: PQL 120 Logger Specifications

Power Quality Logger
Models PQL 120 (1Meg) - AEMC Instruments (www.aemc.com).
User Manual

GENERAL

The PQ logger is a single-phase data logger that is designed to record a whole suite of electrical power quantity and quality parameters for North American commercial, industrial and residential applications. It can be plugged into a standard AC receptacle. Any single-phase appliance can be plugged directly into the AC receptacle provided on the logger. The PQ logger records and stores measured and calculated parameters in its memory. Along with the standard power quantity parameters, it calculates and stores the harmonic information of the input waveforms. The recorded information can be retrieved into a computer the input waveforms. The recorded information can be plugged directly into the AC receptacle provided on the logger. The PQ logger records and stores measured and calculated parameters in its memory. Along with the standard power quantity parameters, it calculates and stores the harmonic information of the input waveforms. The recorded information can be retrieved into a computer via a serial link using the DataView® software package. With the DataView® Professional package information can be viewed on the computer monitor in real time and stored directly into the computer memory.

ELECTRICAL MEASUREMENTS

True RMS measurement. No missing cycles. 128 samples are simultaneously taken for voltage and current channels. Frequency is tracked every cycle and dynamically adjusted for synchronization using phase-locked loop (PLL) technology. System temperature drift is automatically minimized using proprietary technology (Patent Pending). Measurement and operation are enhanced by the use of a 32-bit RISC microprocessor.

Voltage: Range: 0V to 140V
Resolution: 0.1V
Accuracy: ± (0.3% Reading + 0.3V)

Current: Range: 0A to 15A (70A peak maximum)
Resolution: 0.01A
Accuracy: ± (0.5% Reading + 0.3A) @ 0.75A to 15A
± 0.30A @<0.75A

Frequency: Range: 45 to 65Hz
Resolution: 0.01Hz
Accuracy: 0.1Hz

Harmonics: Range: Up to 50th for both Voltage and Current
Resolution: 0.1V for Voltage and 0.1A for Current
Accuracy: ± 1.0% of Range up to 25th harmonic. ± 2.0% of Range from 26th through 50th harmonic @ 0% to 100% Voltage Range and 5.0% to 100% Current Range

Power: Watt / VA / Var

Range: 2,100 Watt, VA or Var
Resolution: 0.1 Watt, 0.1VA, 0.1Var
Accuracy: ± (2.0% of Reading + 4x) Where x is Watt or VA or Var @
Current >0.75A, V>75V, THD ≤ 10%

Power Factor (PF) / Displacement Power Factor (DPF)

Resolution: 0.01
Accuracy: ± 0.03 @ PF/DPF = 1

Programmable Parameters

- MIN, MAX, and RMS of the following parameters:
- Voltage, Current, Frequency, Even Voltage Harmonics, Odd Voltage Harmonics, Even Current Harmonics, Odd Current harmonics
- Real Power, Reactive Power and Apparent Power
- Total Harmonic distortion for voltage and Current (IEEE or IEC Definition) (See Automatic Storage)
- Power Factor (Total and Displacement)
- K-Factor

Demand (10/15/30 minutes or user-definable) and Peak Demand (Real Power (W) or Apparent Power (VA))
Voltage Sag: User-definable magnitude. (See Automatic Storage)
Voltage Surge: User definable magnitude (See Automatic Storage)

Reference Conditions:

(1) Accuracy specifications apply in the 23º C ± 5 º C (30% to 50% RH) range and arithmetic mean of the RMS values of Voltage and Current obtained over 250MS sampling period.
(2) (2) Add 200 ppml ºC from -10ºC to 18ºC and 28ºC to 50ºC to all accuracy specifications.
(3) Calibration cycle is 1 year.

INPUT

Channels: 1 voltage/ 1 Current
Sample Rate: 128 per cycle per channel

RECORDING

Storage rates: 125ms to 7 days
Recording Session Length: 15 minutes to 8 weeks selectable from table or user programmable
Total memory: PQL 120 448,000 records
Date and Time: MM/DD/YY hh/mm/ss.sss