How Small Devices are Having a Big Impact on U.S. Utility Bills

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Abstract

Energy consumption attributed to electronic devices in the typical U.S. home has more than doubled since 1980 and is expected to continue to grow at a rate nearly double the forecasted growth rate for residential electricity end use.[1] The breadth of these devices also grows continuously, driven by technological innovation designed to meet surging consumer demand and changing lifestyles.
While the traditional sources behind this increasing energy consumption trend are office equipment and consumer electronics, other miscellaneous devices, such as power tools, portable appliances, and personal care products contribute as well.
The growth in electricity consumption within the typical home from miscellaneous end uses is in addition to the rising costs of fuel, such as gasoline for automobiles and oil for home heating. These costs are intensifying, straining consumer budgets while adding to the climate change burden. To address these concerns, consumers, more than ever, need relevant information about the growing array of miscellaneous products and their energy consumption in order to make smart buying decisions.
As a result, new opportunities exist for ENERGY STAR to highlight existing electronics products that are efficient across multiple modes of operation, including "active" or "on" mode, and to address non-traditional miscellaneous products. As each opportunity to address multiple modes of operation and product types presents itself, it brings with it the need to overcome a variety of technical challenges while designing relevant policy options that will benefit consumers.

Introduction

The energy consumed by the typical U.S. home has more than doubled since 1980, according to the U.S. Department of Energy's (DOE) Energy Information Administration (EIA), and it is expected to continue to increase. The growing quantity of electrical products found in homes contributes significantly to this growth of energy consumption. While this trend is due in part to the proliferation of home computer equipment and consumer electronics, other devices, such as power tools, portable appliances, and personal care products, contribute as well. The individual and collective energy consumed by miscellaneous devices are worthy of scrutiny as consumer appetites for these devices drive their quantity, quality and usage patterns.
The growth in residential electricity consumption comes at a time when the United States is experiencing rising prices for electricity, natural gas, and heating oil, used primarily in the densely populated northeastern United States. Along with utility bills, car centric homeowners also feel the pain from spiking gasoline prices. In the short run, many home owners find these times confusing and frustrating, as they search for a way to lessen the bulging energy bills that have cut into discretionary spending. Neil Elliott of the American Council for an Energy Efficiency Economy likens the situation to being in an energy *straitjacket*. Few options for the nation as a whole exist in the short run, especially for people who have awakened to find they are vulnerable to rising energy prices. Adding to their anxiety is a growing awareness of the connection between the energy they use to support their lifestyle and global climate change, over which they feel they have little control.[2]
Sustainable pathways forward to break out of the *straitjacket* have been identified, but they will unfold over many years. In the short run however, consumers can begin to reduce their energy bills by understanding and managing the amount of energy consumed by miscellaneous devices.[3] This paper

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[1] Per the Annual Energy Outlook 2005, the growth rate for residential miscellaneous electricity consumption is 3.7% for 2005 – 2010 while the growth rate for residential electricity consumption is 2%.
[2] Despite rising gas prices, according to the U.S. Bureau of Economic Analysis, the total percentage of personal income spent on gasoline today is 3%, as opposed to 5% in 1981.
[3] In the California Independent System Operator area, for example, efficiency measures reduced energy consumption by 6.7% from 2000 to 2001.

will provide data and background information to define and substantiate the emergence of miscellaneous products as a new major category of residential end-use energy consumption. The miscellaneous category will be compared to other major end-uses in terms of their characteristics in the typical residential setting. Lastly, the paper will identify available policy options which are being pursued by governments looking to address the growing energy demand from miscellaneous products.

Background

What are the "Miscellaneous" Products?
EIA has traditionally tracked five main sources of energy consumption in the residential sector:

- Lighting;
- Major appliances (white goods);
- Water heating;
- Air conditioning; and,
- Space heating.

Miscellaneous electricity consumption constitutes all the energy consumed that is not directly a result of the use of the above sources. Examples of these miscellaneous products are extremely varied and include televisions, computers, mobile phones, small home appliances, such as toasters, coffee makers, baby monitors, and home security systems to name a few.

For the better part of the last 50 years, the utility bills for the typical U.S. home were dominated by the energy consumed by key products representing the five major categories listed above. Collective ownership of these products were hallmarks of growing economic prosperity, both at a national level and for individual households. Against the backdrop of abundant and inexpensive energy, homeowners traditionally gave little thought to the energy these products consumed. By the late 1970s, a growing environmental movement and higher energy prices drove several states to launch the first appliance efficiency standards. These were followed by the U.S. government's mandatory standards in 1987, as legislated by the National Appliance Energy Conservation Act. These initial standards took hold as a legitimate and cost effective means to ensure greater efficiency and paved the way for new standards to be developed and implemented for a variety of products such as furnaces and boilers, electric motors, lighting, pool heaters, and water heaters.

How Much Energy is Consumed by "Miscellaneous" Products?

Even as the energy attributed to miscellaneous products continued to grow, it was still outweighed in absolute terms by the five main categories listed above. However, the trend is clear – a plethora of new energy consuming devices now populate the typical home. The collective energy consumed by this new category constitutes a new major source of end-use consumption, and individually, is larger than several of the five major residential end-use categories.

Based on a 1995 EIA report, DOE estimates that in 1980, residential miscellaneous electricity consumption totaled 2.25 quads (Buildings and Energy in the 1980's, EIA). 18% of this consumption, or 0.4 quads, was due to "other" or miscellaneous consumption.[4] Electronics products, grouped into the miscellaneous category, accounted for only about 5% of home electric consumption. Electronics includes products such as consumer electronics and IT equipment, motor includes products such as pool pumps, well pumps, and fans and heating includes products used to heat water-beds, hot-tubs, pools, and other such products. (The breakdown of the miscellaneous category into electronics, motor, and fan consumption was based on an analysis by Marla Sanchez, Lawrence Berkeley National Lab, and John Cymbalsky, EIA.) The remaining 1.85 quads were attributed to the other five main categories. Figures 1 and 2, below, illustrate how the 2.25 quads were divided among the primary categories.

By 2005 total residential electricity consumption doubled to 4.5 quads, according to EIA. Of this, approximately 28%, or 1.3 quads, could be attributed to 'other' or miscellaneous energy consumption. The allocation of the remaining 3.4 quads was: appliances (20%); lighting (18%); air conditioning (15%); space heating (11%); and, water heating (8%). Electronics products accounted for about 13%

[4] Lawrence Berkeley National Lab's estimate for miscellaneous consumption in 1980 (as a percentage of EIA's 'appliance' category) is based on the 1980 consumption estimates for the heating, motor and electronics categories in Sanchez et al., 1998.

of total home electric consumption; almost three times the level in 1980 (Building Energy in the 1980's and Annual Energy Outlook 2005, EIA).[5] Figures 1 and 2, below, illustrate how the 4.5 quads were divided among the primary categories.

By 2015, EIA projects residential electricity consumption to increase 20% from 2005 levels, to 5.4 quads. Lighting will still account for about 18% of the total, but space heating, water heating, air conditioning and appliances will all consume smaller percentages of energy than they did in 2005. On the other hand, the total miscellaneous category is projected to grow to 34%, or 1.8 quads. Electronics products alone will account for 18% of total home electric consumption. Figures 1 and 2, below, illustrate how the 5.4 quads are divided among the primary categories. Other studies, such as a report prepared for DOE entitled *U.S. Residential Information Technology Energy Consumption in 2005 and 2010* (TIAX LLC), have concluded that the major drivers of residential energy consumption growth rates will be IT equipment, much of which has aggressive usage patterns.

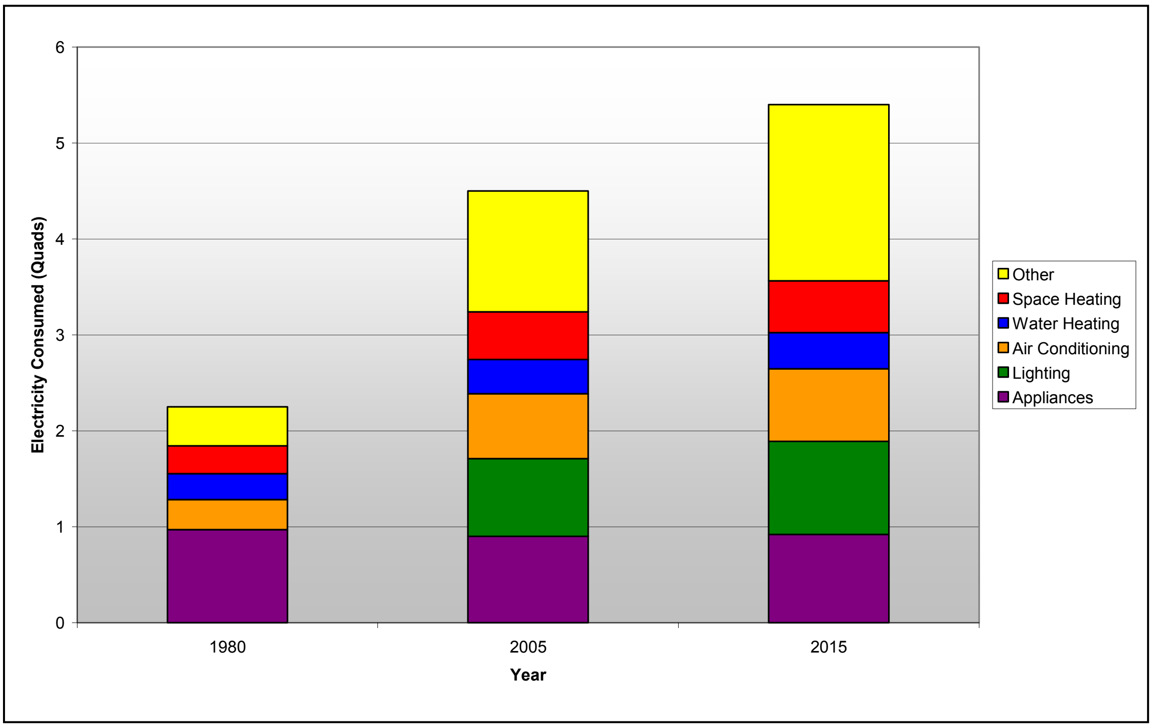

Figure 1. Total Residential Electricity Consumption for 1980, 2005 and 2015 (Projected)

Figure 1 Note: In 1980, EIA grouped lighting into the appliances category. Lighting has since been broken out separately as its own category, as reflected in the data for 2005 and 2015. (Source: EIA's *Building and Energy in the 1980's, June 1995; Sanchez et al,1998*)

[5] LBNL combined certain categories within EIA's 2005 data so comparisons could be drawn to 1980 data: for space heating, EIA's space heating and furnace fans categories were combined; for appliances, EIA's refrigerators, freezers, cooking, dryers, clothes washers and dishwashers categories were combined; for other, EIA's other, TV and PC categories were combined.

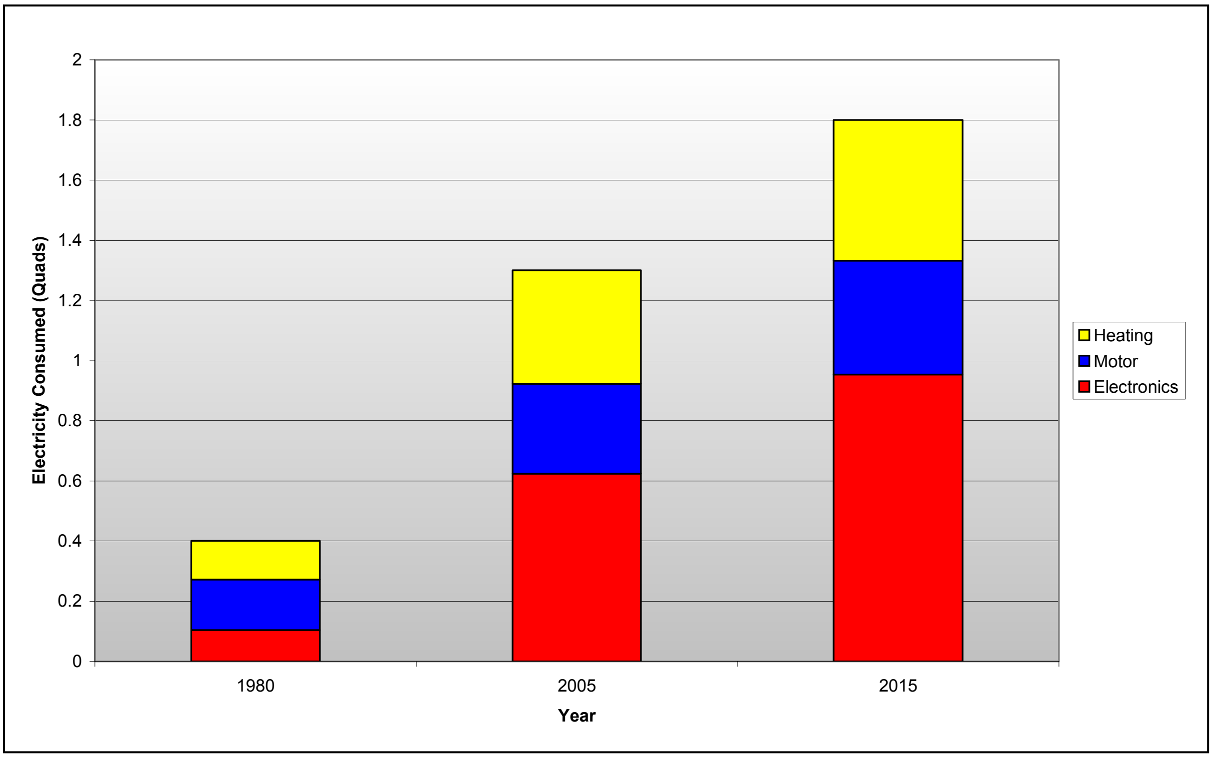

Figure 2. Breakdown of 'Other' Residential Electricity Consumption in 1980, 2005 and 2015 (Projected)

Figure 2 Note: Heating in Figure 2 does not refer to space heating; rather, it reflects heating for water-beds, hot-tubs, pools, and other such products. Motor in Figure 2 refers to fans and pumps. (Source: EIA's *Annual Energy Outlook 2005)*

Several studies, such as W*hole-House Measurements of Standby Power Consumption* (Ross, J.P. and Meier, A.) and *Developing and Testing Low Power Mode Measurement Methods (Nordman, B. and McMahon, J.E.)* have documented the breadth of miscellaneous products in the typical U.S. home. Hundreds of products found in homes (and in some commercial buildings) that use electricity have been identified. Many are commonly recognized such as televisions and coffee-makers, while others are less obvious, such as air cleaners and garage door openers. Often, certain rooms have their own unique devices, such as electric tooth brushes and shavers in bathrooms, coffee-makers and toasters in kitchens, and power tools in basements.
It is unknown how some of the newer miscellaneous products entering the market will affect future energy demands. For example, sales of mobile phones and game consoles are growing quite fast and are quickly becoming modern essentials, but have yet to reach market saturation. According to The NPD Group, mobile phone sales to U.S. consumers reached 34.8 million units in the first quarter of 2006; an increase of more than 11% compared to the same period in 2005. In spite of the growth in sales, U.S. market penetration for mobile phones in mid-2005 was still only at about 65%; nowhere near countries such as Germany and Switzerland, which were at 90% market penetration.[6] The U.S. still has a ways to go before reaching market saturation for these products. Alternatively, the market for products such as dehumidifiers is mature and more regional in nature with significantly fewer units being shipped. According to *Appliance Magazine,* an average of 972,685 units shipped annually from 2000 – 2003 in the U.S. TVs on the other hand, have more than 90% penetration in U.S. homes and shipments are once again growing briskly due to new technologies and features. In fact, according to iSuppli's TV Systems Market Tracker, shipments of TVs to the U.S. in 2005 increased 14% over 2004, going from 25.6 million units to 29.28 million units.
Not surprisingly, sales of consumer and IT electronics have the fastest rates of growth, due in part to their rapid obsolescence. According to the Consumer Electronics Association (CEA), sales of consumer electronics rose 11.5% from 2004 levels to $125.9 billion in 2005. For 2006, CEA expects 7.5% growth and sales of $135.4 billion. Many consumer electronics products such as televisions or

[6] Data is from research conducted by Merrill Lynch in June 2005.

cordless telephones have been prevalent for decades, whereas others, such as cable modems, have only recently emerged in volume. Digital cameras, which are usually plugged in to an electricity source to be recharged, have rapidly displaced their traditional single-lens-reflex (SLR) counterparts, only to now be overtaken in sales by camera phones. iSuppli estimates more than 57 million camera phones were sold in 2005, representing 46% of all handset sales. By 2007, InfoTrends predicts 109 million unit sales of camera phones, or 71% of all cell phone handset sales.

As compared to the other major common household products, miscellaneous products are more diverse and populous. They are also typically designed to perform a unique and sometimes infrequent task. Such a narrow usage pattern contrasts with general purpose lighting and cooling products, for example, which can be used for thousands of hours per year.

Why Care About Miscellaneous Energy Consumption?

As the name implies, the source of *miscellaneous* energy consumption can be nebulous, and its growth and impact on utility bills obscured, given the disproportionate attention paid to white goods, lighting, and the other primary energy usage categories. In some cases, the small physical size of certain miscellaneous devices obscures their importance as a group, making the tracking and inventory of their energy consumption challenging. While this is slowly changing, EIA has wrestled with the means to account for miscellaneous energy consumption in its Residential Energy Consumption (RECs) survey, with the exception of computers.

Slowing the energy consumption growth of miscellaneous products may require a different mix of actions from policy-makers and a persistent commitment to efficiency on the part of manufacturers. Increases in the prices of all forms of energy have begun to raise consumer awareness. In some cases, consumers do a fairly good job of not wasting energy because they understand the connection between a product and the energy it consumes. For example, consumers have become conditioned to flip the lights off when they leave a room. But it is probably unrealistic to expect that most home occupants would unplug a multitude of devices, which they may think are off in the first place since they are not "being used." Nor is central control of these devices an option. While programmable thermostats exist as a controlling device for products in the air conditioning and space heating categories, they have not always been found to save energy; a lack of consumer-friendly programmable thermostats has sometimes perversely caused more energy to be used than saved (Haiah et al, 2004).

Quantifying the size and growth of miscellaneous energy consumption is necessary to understand the impact on the home energy budget. This paper reveals that the energy used by miscellaneous devices is comparable in magnitude to the energy used individually by the five major end-use product categories. The growth of energy attributed to miscellaneous products has expanded the amount of funds families must contribute to their home energy budget. These actions have obvious implications for disposable income, which are well documented. On a positive note, the energy consumed by the major end-use categories has not experienced as much growth due the presence of mandatory standards, which are often coupled with consumer education, mandatory labeling and improved home building codes.[7]

Feature-rich products such as televisions and computers, which serve communication, entertainment and work purposes, have appreciably improved the quality of life to such an extent that many consumers view them as indispensable. Many U.S. consumers would no sooner sacrifice TV or high-speed Internet access, than they would sacrifice hot water and refrigerated food. In fact, as consumers cut back on non-essentials to conserve money, such as dining out and entertainment, they are spending more time at home, which translates into more hours watching television, playing video-games, or using the computer. Homebuilders recognize this trend. According to a 2004 builder survey conducted in the U.S. by Parks Associates, approximately 45% of homebuilders offer built-in home theatres as an option in new, single-family homes.

In 1980, the average U.S. household spent $1,280 on utility bills (adjusted for inflation and not including water usage). Of this amount, approximately $230 was for the electricity to power miscellaneous products. Today, the average household utility bill is approximately $1,500 per year with $420 spent to power miscellaneous products. Add in the average annual household gasoline expenditures of $2,327, and this raises the estimated home energy budget to $3,800. Miscellaneous consumption would still represent 11% of this total.

[7] It should be noted that the intent here is to raise awareness of the unique nature and characteristics of the miscellaneous product category; not discount the importance of efficiency for the other major end-use products.

Miscellaneous plug loads have also emerged in the commercial sector. DOE estimates that for certain types of buildings, such as commercial office-buildings or schools, miscellaneous plug loads are equal to half of lighting levels. Figure 3 shows a breakdown of the electricity consumption attributed to the primary product categories in the U.S. commercial sector for 2005 and projected for 2015 (Annual Energy Outlook 2005, EIA) .

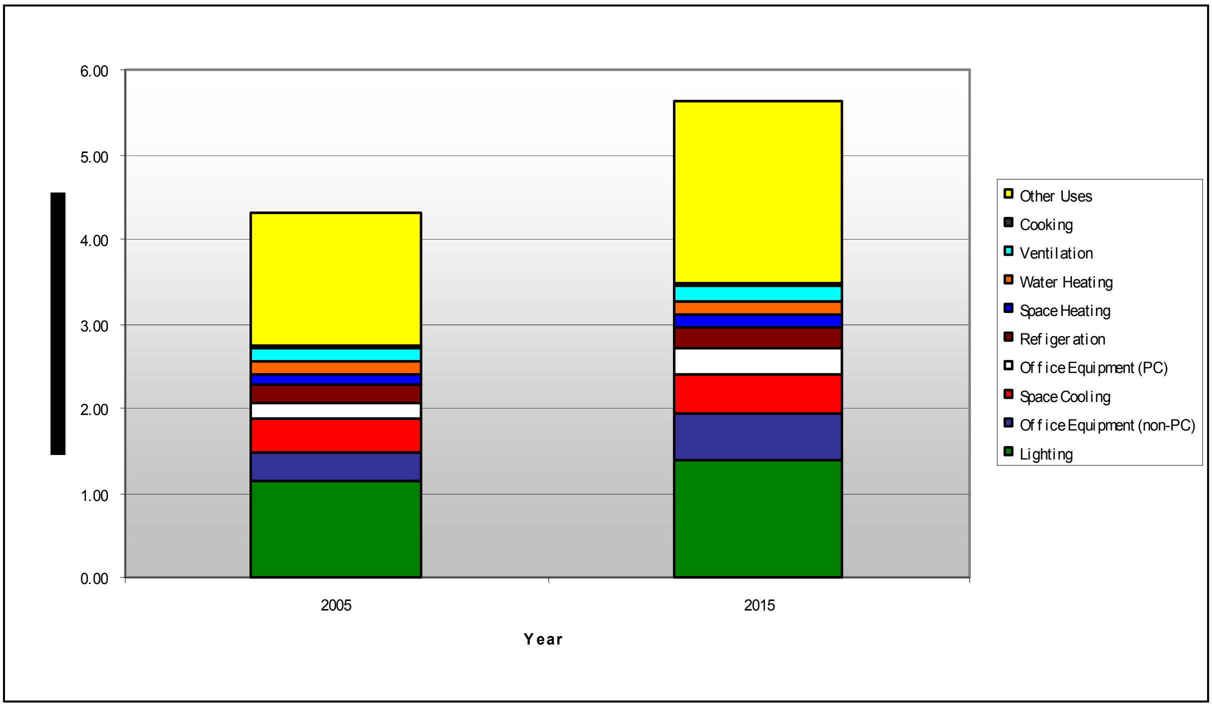

Figure 3. Percentage Breakdown of U.S. Building Sector Energy Consumption
Figure 3 is derived from EIA's *Annual Energy Outlook 2005.*

It should be noted that the building types in the commercial sector are more diverse than the residential sector. Universities, hospitals, industrial sites, etc have different types of functions that may require different levels of miscellaneous plug loads. There are some common miscellaneous devices, however, found in both the residential and commercial building types. But more study is required to determine whether common policies can be used to address the miscellaneous plug loads found in both sectors.
An analysis of projected overall growth of residential electricity consumption from 1980 to 2015 indicates that the miscellaneous category will contribute significantly to this growth. Conversely, the major end-use categories (e.g., heating, cooling, etc.) are mature and there is a greater probability that their energy consumption will be kept in check due in large part to mandatory minimum efficiency standards.[8] Products within the major end-use categories have also been through many design cycles, and so their efficiency has increased over time as technological advancements are made. For example, although the number of lighting fixtures per American home has increased along with the size of the typical home, several technical advancements and market efforts are minimizing the overall growth in energy use. The improved quality of compact fluorescent lamps in recent years has increased consumer adoption of screw-in lamps and fixtures that use fluorescent technology. In addition, residential fixture manufacturers are more accepting of the technology and most major manufacturers are offering decorative fluorescent lines (Vrabel, 2006). Use of high quality fluorescent lighting in a new home is an emerging trend due to efforts by EPA, electric utilities, and the adoption of state energy codes in California, such as Title 24. Additionally, the average new home in the U.S. is being built to the International Energy Conservation Code building code, which ensures greater efficiency compared to homes from a decade ago. An improved building envelope will use energy for heating and cooling more optimally.

[8] These standards are even more important given that the average total square footage of the typical U.S. home expanded to approximately 2,527 feet in 2001, from 2,278 feet in 1993, per DOE's 2001 Residential Energy Consumption Survey.

What is Being Done to Address the Energy Use of Miscellaneous Products?

Miscellaneous products, as with most products, have not ordinarily been designed to save energy as a primary function. Where a product incorporates energy management, action has been needed by the user to initiate this feature or it has been included as a safety precaution. In the case of programmable thermostats, they are marketed primarily to provide comfort and convenience, and secondarily to reduce energy cost. For most miscellaneous products, the options to control energy consumption range from the non-existent to intelligent engineering designs for 'smarter' operation. Some miscellaneous devices allow for passive or active means to manage energy use. Televisions, for example, are easily put into standby mode via a remote control. Computers, on the other hand, offer several means to implement power management. Other products, such as air cleaners or dehumidifiers provide occupancy or other sensors to manage energy. Products utilizing lithium ion battery chemistry have intelligence designed into the product circuitry to prevent over-charging, but this is primarily a safety feature that has a side benefit of energy management.

Given the diversity of energy management features found in miscellaneous products, policymakers face a challenge to find a common thread upon which to base uniform requirements to reduce energy waste. In many cases, policies can be devised to encourage greater energy efficiency in these miscellaneous products, but the greater challenge is ensuring that they remain relevant given the changing mix of technology, consumer lifestyles, and the need to be cost effective.

Policy Pathways for Miscellaneous Products

As indicated earlier in the paper, standard making organizations have focused on more traditional and high profile energy consuming products over the last few decades (e.g., lighting, water heating, etc.). Products in these categories offer significant savings per unit and are relatively simple to characterize with little variance from one model to the next in terms of key components. As a result, standards for products in these areas have been embraced and implemented across the U.S. and globally. Meanwhile, the miscellaneous category has been growing, in both numbers and energy consumption, and slipping under the radar screen of energy modelers. These products have either been left out of the energy consumption equation completely or not addressed in their entirety (i.e., only low power mode requirements have been addressed). At the same time that consumers are being educated about the range of efficiencies and opportunities presented by more traditional products, and thus associating them with rising energy costs and high utility bills, we as consumers and policymakers are missing a growing contributor to the energy used in the home.

Over the last decade, the ENERGY STAR voluntary labeling program has sought out these miscellaneous products and taken a number of different approaches to developing specifications to address this category. Efforts began in the early- to mid-1990s with the more visible electronics products such as TVs and computers. These products represented large and widespread markets that were ripe for the type of market differentiation that the ENERGY STAR mark provides. More recently, however, EPA wanted to both expand the scope of products covered by these specifications and address additional operational modes. To conserve limited resources and maximize the energy savings potential, EPA identified three approaches, which are described in further detail below. The first approach was to address the energy being consumed by numerous miscellaneous products through a common thread: the power supply. A second approach, designed for those products where it was not feasible to isolate or appropriate to focus solely on the power supply, was to develop specific metrics to directly address Active mode for the entire product system. And finally, a third approach was to work with international stakeholders to harmonize test procedures and specifications as much as possible, given that a number of products in the miscellaneous category are globally manufactured and sold.

Power Supplies: The Common Thread

Focusing on the power supply provides enormous energy savings potential because:

- They have broad application in finished electronic products. EPA estimates there are more than 10 billion power supplies are in use worldwide.
- Many current power supply designs are only 30-60 percent efficient, but efficiencies of 90 percent or more are feasible.

The following is a brief discussion of EPA's three-pronged strategy to transform the power supply market.

Phase I: External Power Supplies (EPSs)
The first step in EPA's power supply strategy was to provide market-based incentives to improve the efficiency of EPSs. EPSs represented the best near term opportunity because 1) they are physically separate from their end-use devices and thus easier to measure, and 2) more research has been devoted to understanding their current and potential efficiencies. By pairing an end-use device with a highly efficient EPS, one can significantly reduce the energy consumption of the end-use device without investing in costly or time consuming product redesigns.
To prepare an EPS specification, EPA supported the development of one internationally recognized test procedure and then compiled a data set with over 600 EPS models tested in Australia, China, and the United States. Figure 4, below, illustrates the wide range of Active Mode efficiencies found in EPSs with a nameplate output power of 10 watts or less within EPA's data set. For example, within EPA's data set, EPSs with a nameplate output power of 3 watts had average Active efficiencies of 31.9 percent to 67.8 percent and No-Load consumption of 1.9 to 0.2 watts.

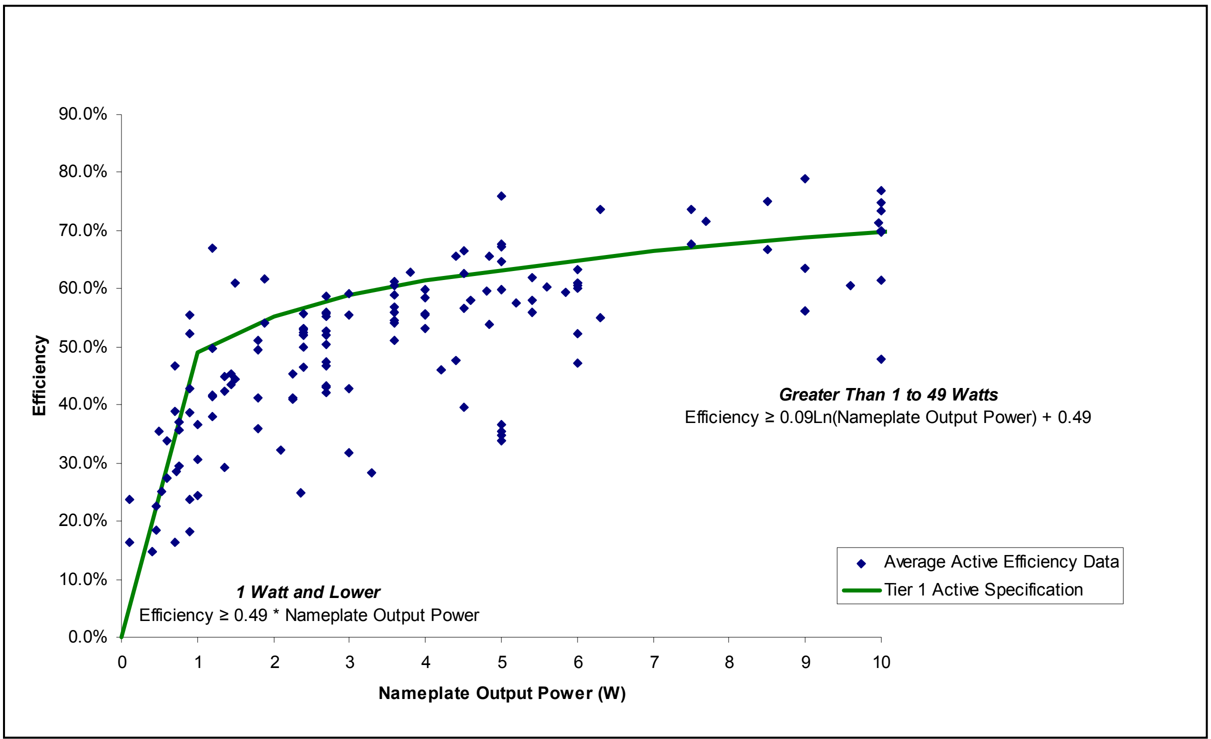

Figure 4. Range of Active Mode Efficiencies in EPA's Data Set
Figure 4 is derived from data collected during the development of EPA's Version 1.0 ENERGY STAR specification for external power supplies. A point above the line denotes an EPS model that exceeds minimum efficiency levels.

Figure 5, below, illustrates the wide range of No Load efficiencies found in EPSs within EPA's data set. The final ENERGY STAR specification for EPSs, which took effect in January 2005, includes requirements for both Active (tested at 100 percent, 75 percent, 50 percent, and 25 percent of rated current output) and No-Load Modes and recognizes approximately the top 25 percent of models.

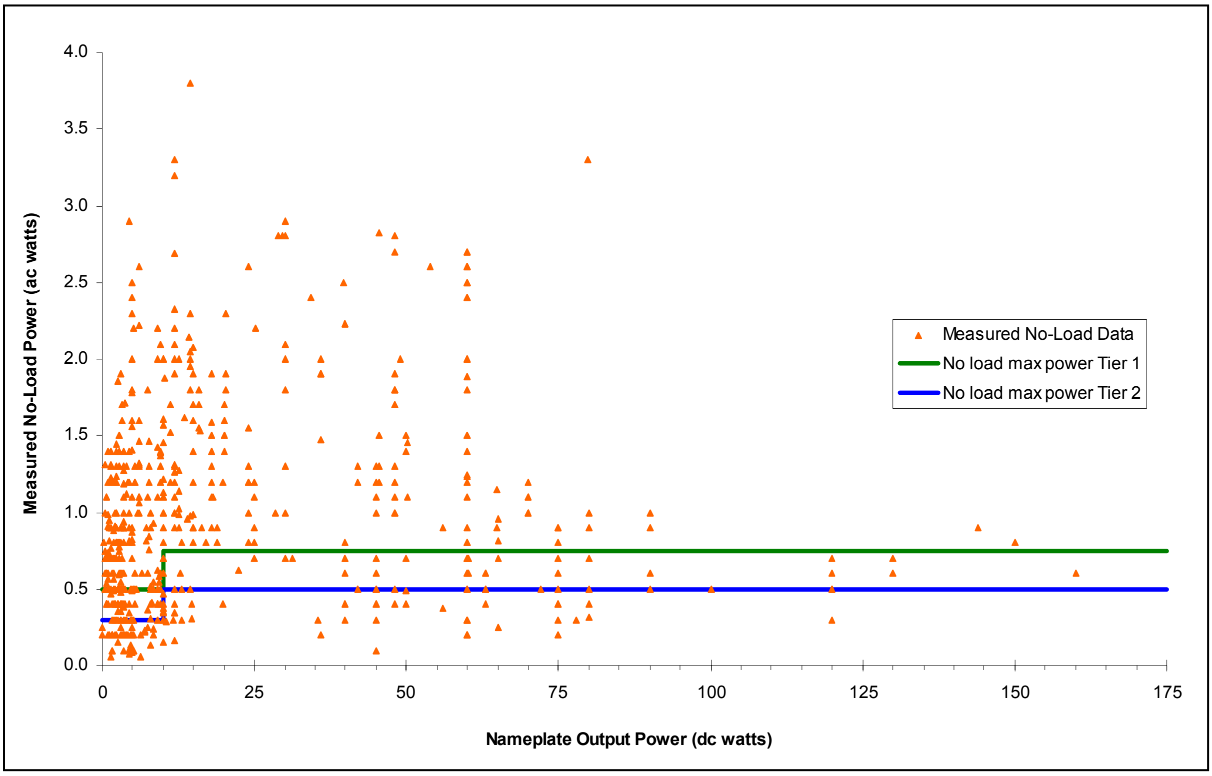

Figure 5. Range of No Load Efficiencies in EPA's Data Set
Figure 5 is derived from data collected during the development of EPA's Version 1.0 ENERGY STAR specification for external power supplies.

The ENERGY STAR specification for EPSs is designed to highlight those models with an efficient ac-dc or ac-ac conversion process. A broad array of single voltage external ac-dc and ac-ac power supplies, including those used to power computer and consumer electronics such as laptops, digital cameras, monitors, CD players, cell phones and cordless phones, are covered by this specification. As of May 2006, 26 manufacturers have joined ENERGY STAR and qualified more than 255 models. EPSs that earn the ENERGY STAR mark are on average 35 percent more efficient than conventional models. EPA projects a potential U.S. energy bill savings of $636 million, electricity savings of over 9 billion kWh, and prevention of 5.13 million metric tons of carbon dioxide pollution from 2005 to 2015 due to the specification.

In addition to recognizing efficient EPSs, EPA is 1) requiring ENERGY STAR EPSs in its latest electronic product specifications (e.g., ENERGY STAR for telephony, imaging equipment, etc.), and 2) allowing end-use product manufacturers, whose products otherwise might not be eligible for ENERGY STAR, to join the program and promote their end-use devices that use ENERGY STAR qualified EPSs (e.g., digital cameras, wireless routers, etc.). In this way, EPA is not only striving to increase the supply of efficient EPSs, but is also taking steps to stimulate demand for them.

Phase II: Battery Charging Systems (BCSs)

Soon after the launch of the EPS program, EPA began work on another specification to extend the brand to BCSs—the components used to recharge a wide variety of cordless products. BCSs found in small household appliances, personal care products, and power tools were specifically excluded under the EPS specification in order to allow time for the development of an appropriate test procedure and efficiency metric.

Based on a careful review of the energy used in more than 100 BCSs, EPA decided to focus on Nonactive modes (i.e., Battery Maintenance and Standby) because these modes offer significant potential for energy savings (70-75% of the energy is used after the battery is fully charged) and can be consistently measured through a robust and easy-to-use test method (see "Test Method for Determining the Energy Performance of Battery Charging Systems" on the ENERGY STAR Web site). The ENERGY STAR specification for BCSs allows models to qualify if they do not exceed a maximum

Nonactive Energy Ratio[9] based on the nominal battery voltage. By avoiding explicit requirements for Battery Maintenance and Standby Modes, EPA allows manufacturers to choose the most efficient design(s) for the overall operation of the product and takes into account products that do not have a Standby Mode.

The ENERGY STAR specification for BCSs took effect in January 2006. Consistent with the ENERGY STAR guiding principles, the final specification represented the top 24.8 percent of data points from EPA's data set. Care was taken to ensure that a wide array of models and manufacturers would be eligible to qualify as ENERGY STAR under the BCS specification, as illustrated in Figure 6 below.

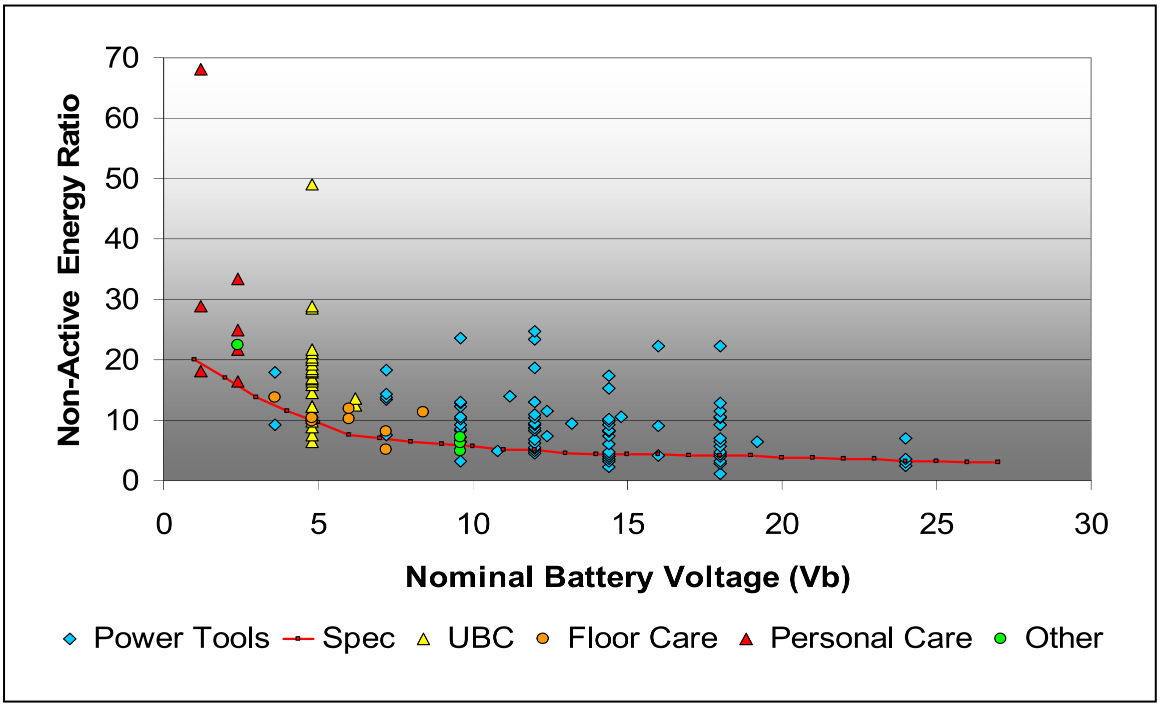

Figure 6. BCS Specification by Product Type

Figure 6 is derived from data collected during the development of EPA's Version 1.0 ENERGY STAR specification for battery charging systems.

In the United States alone, more efficient battery chargers have the potential to cut energy consumption by more than 1 billion kWh per year, saving Americans more than $100 million annually while preventing the release of more than 1 million tons of greenhouse gas emissions.

The BCS specification is intended to complement the EPS specification to comprehensively cover a variety of different miscellaneous products and ultimately impact their power conversion efficiency and standby power consumption. The last phase of the power supply strategy will allow EPA to reap even greater environmental savings.

Phase III: Internal Power Supplies (IPSs)

Following successful development and launch of the EPS and BCS specifications, the U.S. EPA has now shifted focus to the development of a test procedure for IPSs. Given the complex nature of these devices, however, the U.S. EPA recognizes that the same efficiency levels will not work for all IPSs and their end-use products. The U.S. EPA has therefore decided to follow a product-specific approach with IPSs, based on the end-use products for which they are designed. The first end-use product specification that will incorporate an IPS requirement is the new ENERGY STAR specification for computers.

[9] Nonactive Energy Ratio (ER) is the ratio of the accumulated nonactive energy (Ea) divided by the battery energy (Eb). Accumulated Nonactive Energy (Ea) is the energy, in watt-hours (Wh), consumed by the battery charger in battery maintenance and standby modes of operation over a defined period. Battery Energy (Eb) is the energy, in watt-hours (Wh), deliverable by the battery under known discharge conditions.

Since its inception in 1994, the ENERGY STAR computer specification has sought to bring energy savings to consumers through low power mode requirements. However, with enabling rates reaching only 11% and computers spending most of their time outside of these low power states, EPA realized that to guarantee significant savings, energy consumed during active mode would need to be addressed. One way to reduce active power is through the internal power supply.

While beginning revisions to the ENERGY STAR computer specification in 2004, EPA was also supporting another initiative created to help develop a market for more efficient internal power supplies. The utility-funded 80 PLUS program offers incentives to computer manufacturers that incorporate 80%+ efficient internal power supplies into their computer and server designs. The program also provides power supply manufacturers a vehicle to certify and market their more efficient power supplies to interested buyers. To date, 11 power supply manufacturers, three of which hold a significant share of the market, have certified internal power supply models through the 80 PLUS program.

With a variety of models and brands now available in the marketplace, EPA felt confident that including an internal power supply requirement under the new ENERGY STAR computer specification was both technically feasible and cost effective for manufacturers to incorporate. Therefore, in addition to including more challenging low power mode and power management requirements, EPA is requiring a minimum 80% internal power supply efficiency for ENERGY STAR qualification. Replacing a standard efficiency internal power supply (70% efficient) with an 80% efficient model could save 50 kWh/year for each computer and more than 200 kWh over the expected four-year lifetime of the computer.

In addition to minimum power supply efficiency, EPA is also including a Power Factor (PF) of 0.9. While PF may not contribute to the efficiency of the power supply, studies show that it does help to reduce the overall plug load of the building by minimizing harmonic distortion. Use of high efficiency power supplies will result in direct reduction of energy use, due to lower power consumption. Power factor correction adds another 12 to 21% to the resulting energy savings, based on the cable lengths typically found in residential and commercial buildings (40 feet and 100 feet, respectively). Many power supply manufacturers are designing PF into their high efficiency models already. The new ENERGY STAR computer specification goes into effect on July 1, 2007, which includes the 80% efficiency and 0.9 PF internal power supply requirement.

Other Approaches to Addressing Active Mode

Another approach that EPA is increasingly adopting to address the power consumption of products in the miscellaneous category, particularly when revising existing product specifications, is to set new criteria that focus on reducing the Active Mode power consumption of these products. This approach is more complex than EPA's power supply strategy (and may take more time to design and implement), but allows manufacturers more design flexibility when meeting the energy efficiency criteria.

Computer Monitors

The new ENERGY STAR computer monitor specification, which took effect on January 1, 2005, was EPA's first foray into the development and implementation of an Active Mode specification for a product within the miscellaneous category. In the early part of this decade, market penetration of ENERGY STAR qualified computer monitors exceeded 90% and there were limited additional energy savings to be gained by merely lowering the Sleep Mode levels specified for ENERGY STAR qualification. EPA had to pursue an Active Mode specification for these products in order to both gain additional carbon savings and ensure that the ENERGY STAR continued to be a differentiator in the marketplace for the computer monitor product category.

A primary reason why Active Mode had not been addressed for this category under previous ENERGY STAR specifications was because no test procedure existed to measure the active mode power consumption of computer monitors, irrespective of display technology. As such, EPA worked closely with interested stakeholders to develop a sound test procedure to measure the power consumption of computer monitors in Active, Sleep and Off Modes. Once finalized, manufacturers were requested to test their latest models using this test procedure. EPA received data on approximately 270 monitor models, all of which were available or being introduced to market as the specification was being developed, and only these data points were used when setting the Active, Sleep, and Off Mode levels for the new ENERGY STAR specification. Due to the new specification alone, EPA projects a potential U.S. energy bill savings of almost $590 million, electricity savings of 8 billion kWh, and 1.2 million metric tons of carbon (MMTC) avoided over the time period of 2005 to 2015.

Imaging Equipment
A similar approach was used when developing the new ENERGY STAR specification for imaging equipment, scheduled to take effect on April 1, 2007. When EPA initiated the specification revision cycle for imaging equipment in 2003, the specifications had been in effect for up to seven years and ENERGY STAR qualified printers, copiers, and fax machines accounted for 92 to 99 percent of units sold in 2000 (Gartner 2001). The high market penetration levels alone suggested that a review of ENERGY STAR performance specifications was warranted. Further, as imaging equipment products increased in speed and functionality, Active Mode contributed to a greater portion of total product energy use.

When EPA began to revise the imaging equipment specifications, the need to address Active mode for some products quickly became apparent. This was accomplished with the "typical electricity consumption" (TEC) approach that considers the electricity consumed by imaging equipment during its entire duty cycle. This method for assessing product energy efficiency was received favorably by many stakeholders and at the time, demonstrated a forward-thinking approach to the development of an energy-efficiency specification. The revised imaging equipment specification will save U.S. consumers more than $3 billion over the next five years and avoid greenhouse gas emissions equivalent to taking more than four million cars off the road.

Televisions
EPA is following a similar approach in revising the current ENERGY STAR specification for televisions. When first developed, the ENERGY STAR specification for televisions focused on Standby Mode due to the vast amount of time these products spent in standby mode and the millions of televisions in use in U.S. homes. In 1998 when the specification was introduced, EPA estimated that ENERGY STAR qualified televisions would use about 20 percent less energy in a year than comparable televisions. However, Active power consumption is now becoming increasingly important due to changes in product technology and usage patterns that result in increased energy consumption. Such changes include:

- The advent of new display technologies, some of which *may* use significantly more energy than their traditional counterparts;
- The trend towards larger screen sizes;
- The marketing of televisions as part of "home theater packages," which may be used in conjunction with a variety of audio and video devices, increasing overall system energy consumption;
- The burgeoning availability of new cable and satellite programming content, leading to increased television viewing; and,
- The growth in sales of game consoles, meaning there is an increase in the number of hours a typical television operates each day.

Today, TVs account for about four percent of annual residential electricity use in the U.S. – enough to power all of the homes in New York State for an entire year (Natural Resources Defense Council, February 2006).

EPA is working with stakeholders and a number of key governments, including Australia and the European Union, to develop a single, harmonized global test procedure for televisions. This test procedure, when completed, will be used by each of the government entities to implement policies to encourage the sale of more energy efficient televisions, thereby giving consumers a means to factor power consumption into the purchasing decision.

International Harmonization of Test Procedures and Specifications
As various governments and other entities develop standards for these miscellaneous products, harmonization will be a key element to successful implementation. Manufacturers are designing these products for global distribution and are looking for ways to streamline their certification processes. Through harmonization, countries can combine their resources and technical knowledge to create test procedures and specifications that will be applicable worldwide. For countries that have yet to begin addressing these product types, global test procedures and specifications will provide for ease of adoption and implementation. As an added benefit, countries will have access to a large data set already developed and maintained by those governments that have already made the decision to align their test procedures and specifications. Policymakers representing the European Union,

Canada, Australia, Japan, Taiwan, New Zealand and China are considering the inclusion of miscellaneous products such as computers, TVs, EPSs, and BCSs in their voluntary and/or regulatory standards and working very closely with EPA to harmonize their respective approaches. Through initiatives such as the Asia Pacific Partnership, the U.S. is also working with fast-growing markets India and South Korea. This brings the total population that could benefit from harmonization of test procedures and specifications to well over 3 billion.

An important step taken by the U.S. EPA and its country partners towards global harmonization of test procedures is that products are now required to be tested to the appropriate conditions of intended markets where the products are to be sold as ENERGY STAR qualified. EPA has implemented this policy in specifications moving forward, particularly for products in the home electronics and office equipment categories, because energy consumption values may vary according to the input voltage/frequency combination. In some instances, particularly for those product-categories that have a 1-watt Off Mode specification, the variance caused by testing at market-specific input voltage/frequency combinations is enough to qualify products in certain markets and not in others. As the ENERGY STAR program develops an increasingly international scope, EPA has determined that it is important to confirm that products meet specifications at the representative market conditions where the products are sold. This ensures that consumer expectations are satisfied when they purchase products that carry the ENERGY STAR mark.

Conclusions

As illustrated throughout the paper, the energy consumed by miscellaneous products continues to grow. Through their ongoing work to understand and control this energy consumption, U.S. EPA has learned some key lessons. Most importantly, it is possible to develop and implement measures to mitigate the amount of energy consumed by the miscellaneous products category, as many of the products have common elements such as power supplies. However, often a combination of measures works most effectively, such as both voluntary and mandatory standards, as well as Market Transformation tools such as consumer education campaigns, government procurement, rebates, and/or tax incentives. These measures aid in raising awareness of the energy consumed by miscellaneous products, allowing increased information to be shared with consumers and empowering them to make more informed purchasing decisions. There is still a lot of additional work that needs to be done to continue addressing the power consumption of miscellaneous products, especially in terms of increased data collection to better understand this product category. However, due to the global nature of many of the products in this category, international cooperation is vital as it brings together the critical mass needed to effect change.

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