Program and Policy Strategies for Tackling Miscellaneous Energy Loads

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ABSTRACT

About 20% of the total energy used in buildings can be attributed to a long and diverse list of appliances and equipment, including computers, servers, imaging equipment, televisions, and many others that we term Miscellaneous Energy Loads, or MELs. While federal and state energy conservation standards cover some of these, many others could benefit from the more expeditious influence of utility ratepayer-funded efficiency programs. These programs can also incentivize the turnover of the installed base of the older, less efficient models, which standards and voluntary ratings are usually unable to achieve.

In this paper, we present energy efficiency strategies for select top MELs, including regulatory options such as energy conservation standards, voluntary labeling such as ENERGY STAR®, and efficiency programs run by utilities and other program administrators. With efficiency improvements in traditional "prescriptive" categories, such as heating, ventilation, and air-conditioning (HVAC) and lighting, savings opportunities for programs are diminishing which makes it more attractive for program administrators to focus on MELs. Utilities have a role to play in the entire value chain, from manufacturing to retail and finally at the consumer level by raising awareness, convening stakeholders, and providing financial incentives. Similarly, standards and labeling programs make a significant impact by setting the minimum performance standards and differentiating the most efficient products.

Televisions, computers, ceiling fans, set-top boxes, and medical imaging equipment rank among the MELs that promise substantial energy savings. We analyze the available savings from these key MELs and recommend policy and program strategies for saving energy from MELs.

Introduction

Energy used by Miscellaneous Energy Loads (MELs) in commercial and residential buildings has been growing every year and is projected to grow faster than any other category in the next couple of decades (EIA 2013a). Studies suggest the total number of miscellaneous energy-consuming products in the nation is over two billion and growing. In both commercial and residential buildings, the energy use of MELs is now larger than any other major end-use category (EIA 2013b).

In an earlier research report (Kwatra, Amann, and Sachs 2013), we identified the largest MELs in terms of annual electricity consumption in residential and commercial buildings as well as MELs that use gas as a fuel and estimated the energy savings potential from these MELs based on the current stock energy consumption and the best technology available[1]. For this paper, we delve into a select set of five large MELs in greater depth to identify recommended program strategies and policy options to capture energy savings. We selected five MELs that represent significant savings potential on a per unit basis or in aggregate. Table 1 summarizes

[1] For detailed methodology for energy use calculations and references for individual product data, please see our earlier report (Kwatra, Amann and Sachs 2013)

per unit electricity consumption along with estimated savings potential. The selected MELs include the four largest residential MELs in terms of both per unit annual electricity use and national electricity use (TVs, ceiling fans, set-top boxes [STBs], and personal computers). From the commercial sector, personal computers represent the largest MEL in terms of installed base and second largest in terms of national electricity use; in comparison, medical imaging equipment has a low installed base, but with the highest per unit energy use at 93,000 kilowatt-hours (kWh) per year for an MRI it ranks tenth among commercial MELs.

Table 1. Estimated energy use and potential savings for MELs

MEL	Current Stock (kWh/yr)	Best Available (kWh/yr)	Max Tech (kWh/yr)	Total U.S. Energy Use (TWh/yr)	Savings %	National Savings (TWh/yr)
TVs	213	63	24	70.1	89%	62.2
Personal computers:						
Residential	158	34	NA	27.1	78%	45.0
Commercial	336	34		50.0	90%	
Ceiling fans	152	58	24	31.6	84%	23.6
STBs	142	86	65	32.0	54%	17.3
MRI equipment	93,000	55,800	NA	6.8	40%	2.5

Source: Kwatra, Amann, and Sachs 2013 for all products except STBs; for STBs Voluntary Agreement 2014 (current stock and total energy use), EPA 2014 (best available) and DOE 2013b (max tech estimates)

Findings

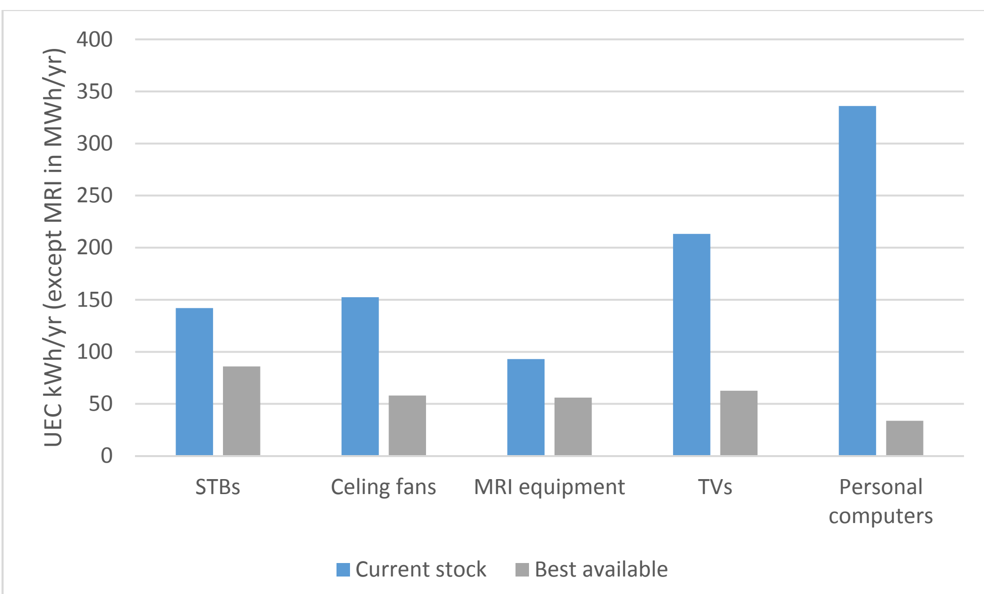

Figure 1. Per unit energy use of existing stock and best available. *Source:* Kwatra, Amann, and Sachs 2013 for all products except STBs; for STBs Voluntary Agreement 2014 (current stock) and EPA 2014 (best available).

Computers

Computers are one of the biggest MELs in both residential and commercial buildings. The existing stock of personal computers—including desktops, laptops, and all-in-one systems—in American homes is approximately 138 million. In the commercial sector, personal computers have an installed base of over 250 million (Urban et al. 2011). In recent years, sales of portable computers have outpaced those of desktop units for home computing, and this trend is expected to continue. On average, home computers use 158 kWh per year, for a total annual energy consumption of 27 27 terawatt-hours (TWh). Effective use of computer power management settings has a significant impact on energy use; recent studies of the existing computer stock estimate average energy use in active mode is 60 watts (W), while sleep and off-mode power are dramatically lower at 4W and 3W, respectively (Urban et al. 2011). As these numbers attest, early efforts to improve sleep and off-mode efficiency have paid off.

Typical household computers consume more than 90% of their annual energy use in active mode even though they spend less than 40% of the time in this mode (Urban et al. 2011). Efforts to reduce the energy consumed by personal computers must focus first on reducing active mode power, then on effective power management strategies that get computers to enter sleep mode faster and to stay in sleep mode longer when the unit is not in active use. A range of emerging technical opportunities will yield active-mode energy savings, including discrete graphics processing units (GPUs), solid-state drives, and high-efficiency internal power supplies. Further savings could come from more efficient microchip design and operation including consolidation of activity in high-use circuits and blocking of idle circuits. This strategy has been shown to reduce chip standby power in smartphones and handheld devices by 50% (Desroches and Garbesi 2011). As shown in Figure 1, the most efficient products on the market today use only a fraction of the energy of the existing stock, saving more than 250 kWh per unit annually.

The gap between energy performance in portable computers (notebooks, tablets, etc.) and in desktop computers is substantial; the premium on battery life for portable computers leads to more rapid adoption of cutting-edge technology. Power use is also of greater concern to end users of portable computers; while almost all PCs include power management features and many ship with these features factory-enabled, the use of these features is more widespread in laptops than in desktop computers. Similar technological potential exists for reducing energy consumption in desktop units; indeed, the leading products in the market are already much more efficient than the current stock (see Figure 1).

Product standards and labeling approaches. To date, there are no federal or state minimum efficiency standards for computers. The U.S. Department of Energy (DOE) recently issued a proposed determination that computers and battery backup systems meet the criteria for products subject to federal standards[2]. If DOE moves forward with a final determination, it will then begin the process to establish federal test procedures and minimum efficiency standards. Given the time needed to complete a rulemaking and the required compliance period, it is unlikely that federal standards for computers would take effect prior to 2020. As a result, federal standards are not a high priority strategy for capturing efficiency gains in personal computers. At the state level, California is considering standards for computers in its 2014 rulemaking; draft standards are expected to be released in November 2014 (CEC 2014). With their shorter rulemaking and compliance periods, state standards would be more effective than federal standards for this set of products.

EPA has long maintained an ENERGY STAR program for computers. The most recent ENERGY STAR specification for desktop computers is Version 6.1 (effective June 2014); the previous spec (v.5.0) has been in place since July 2009. The new specification includes revised criteria for maximum annual energy use and requirements for power supply efficiency and power management features and settings. The revision also updates computer and graphics categories to better reflect the mix of products now on the market, duty cycles to address network connectivity, and incentives for high-efficiency power supplies and graphics switching. TopTen USA highlights the top-performing ENERGY STAR qualified laptops and non-expandable desktops (i.e., all-in-one units and mini-computers); the TopTen list is updated quarterly.[3] Other major environmental footprint reduction programs, such as EPEAT (Electronic Product Environmental Assessment Tool) and the Federal Energy Management Program Low Standby Power Program, are applicable to computers and base the energy portion of their rating criteria on ENERGY STAR standards.

Program strategies. To date, the number of efficiency programs specifically targeting computers has been limited. To the extent that computers have been covered, it is more often as part of broader campaigns to build awareness and encourage the purchase of ENERGY STAR electronics products and to educate users about the importance of power management. The most common computer-focused initiatives include retailer incentives and power management programs.

Compared with other products, incentives for computers have been more limited. Of the 20 or so programs offering incentives for consumer electronics in 2013, only 8 offered incentives for computers. Of these, all provided incentives to retailers ranging from $5 to $7 for ENERGY STAR qualified computers (all but one for desktops only); six offered a $10 incentive for desktops listed by TopTen USA. These incentives are designed to encourage retailers to stock, promote, and sell more efficient models. This can be a more effective strategy than offering incentives directly to consumers; small per unit incentives are unlikely to have much impact on consumer product decisions given computer price points.

Power management programs target commercial customers with educational resources, technical assistance, power management software and tools and, in some cases, financial

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[2] See http://www.gpo.gov/fdsys/granule/FR-2014-02-28/2014-04422

[3] See http://www.toptenusa.org/Top-Ten-Computers

incentives for the installation and use of power management software. Programs also provide power management information and tips to residential customers through bill stuffers and online.

Televisions

Televisions represent the largest residential MEL, accounting for 22% of the annual residential MEL load in this study and 4% of total household electricity use (DOE 2013a). Almost 99% of U.S. households own a TV (EIA 2012), and with an installed base of over 320 million units, TVs outnumber the U.S. population. More than half of households own three or more TVs. The biggest driver of annual TV energy consumption is hours of use. Estimates of active use of TVs center around 3.8 hours per day per TV (Urban et al. 2011), or 9.5 hours per day per household (Roth et al. 2008). In recent years, low-power liquid crystal display (LCD) and light-emitting diode (LED) TVs have dominated sales. Some of the efficiency gains realized from the shift to more efficient technologies are offset by a coincident increase in display size—as of 2011, the primary household TV had an average screen size of 38 inches (Urban et al. 2011). Overall TV energy-use trends in the near future may be impacted by increases in TV functionality (e.g., network capabilities), increasing duty cycles, and growing screen sizes. Increased per unit energy use from these factors may be offset by parallel trends favoring a shift toward watching content on other devices, including computers, tablets, and smart-phones.

The earliest ENERGY STAR specifications for TVs concentrated on standby and off-mode power and played an important role in driving down energy consumption in non-active modes; since 2008, each specification has limited standby power to 1W. As a result, unit energy consumption (UEC) is relatively insensitive to off-mode power and active mode accounts for over 85% of energy use.

Recent efficiency improvements have led to significant reductions in TV power requirements. As illustrated in Figure 1, the best models on the market today use one-quarter of the energy of the existing stock average. Recent and emerging advancements including reflective backlights, backlight dimming, automatic brightness control, occupancy sensors, and new display technologies offer the potential for further efficiency improvements. Other opportunities to reduce TV energy consumption stem from changes in viewing habits, including increases in collective viewing, turning TVs off when not actively watching, and reducing overall hours of use as well as use of advanced power strips or other tools to manage standby power, particularly for secondary TV and other units that are used less frequently.

Product standards and labeling approaches. There are no federal efficiency standards for TVs. DOE has adopted a federal test procedure and manufacturers are required to test product energy use and label products under the federal EnergyGuide labeling program. In 2009, California adopted a two-tier standard for TVs that went into effect in 2011 and 2013. The Tier 2 standard is equivalent to ENERGY STAR v.4. Connecticut and Oregon have since adopted the California standard. An Appliance Standards Awareness Project/American Council for an Energy-Efficient Economy report, *The Efficiency Boom* (Lowenberger et al. 2012), estimated that a DOE standard modeled on ENERGY STAR v.5.3 would generate potential savings of 10 TWh in 2035, with a present value of $8.3 billion.

Rapid changes in the TV market stemming from the shift to digital broadcast and improvements in flat-screen technologies led to an accelerated revision schedule for the ENERGY STAR TV specification. Beginning with v.3 (effective in 2008), active power requirements were added to the ENERGY STAR specification. In 2010, v.4 further reduced power limits and addressed luminance and download acquisition mode, followed by v.5 in 2011 with a maximum active power limit reduction of 200-400W for large TVs relative to the 2008 specification. The current specification, v.6, took effect in 2013 with new active mode power requirements.

Even with the rapid advancement in ENERGY STAR requirements, efficiency gains beyond ENERGY STAR remain as higher efficiency products continue to be introduced. The highest efficiency products are designated by ENERGY STAR Most Efficient, TopTen USA and Super-efficient Equipment and Appliance Deployment (SEAD) Global Efficiency Medal. For a 42 inch TV, these programs recognize products that save as much as 45 kWh per year relative to ENERGY STAR, savings can be even higher with larger models.

Program strategies. As they have for other consumer electronics products, program administrators have typically targeted TVs through broad ENERGY STAR awareness campaigns. A number of programs complement their retail outreach with retailer, and to a lesser degree manufacturer, incentives for high efficiency products. In 2013, programs in nine states and British Columbia offered retailer incentives tied to product efficiency (e.g., ENERGY STAR level, ENERGY STAR Most Efficient, TopTen USA) ranging from $3.60 to $50 per unit sold. One utility offered a $25 consumer rebate for ENERGY STAR v.6 models, another offered manufacturer incentives for ENERGY STAR Most Efficient coupled with retail promotions directed to consumers. These numbers represent a drop in the number of programs offering incentives for TVs and in the amount of the typical incentive offered as the savings per product has dropped and uncertainty about savings has increased (NEEP 2013).

Set-Top Boxes

More than 220 million STBs are used to deliver pay-television services to TVs in more than 80% of U.S. homes (Voluntary Agreement 2014). STB energy use varies widely depending on the service provider and the type and vintage of the set-top box. In 2012, typical STB energy use ranged from 39 kWh per year for the most basic digital transport adaptors (DTAs) to more than 280 kWh per year for cable and satellite digital video recorders (DVRs) with an estimated weighted average of 142 kWh per year for the existing stock (Voluntary Agreement 2014). The majority of energy used by STBs is consumed when the box is not in use by the consumer (i.e., the viewer is not watching or recording content) because most boxes rarely go into a low-power standby mode and, even if they did, most use only a few watts less in standby than when fully active. As more and more pay-TV subscribers have migrated toward boxes incorporating digital video recorders (DVRs) and other features over the past few years, STB energy use has increased. Improvements in power supply and other component efficiencies have been offset by the higher power demands of these advanced features. Overall, the current stock of installed boxes uses an estimated 32 TWh of electricity each year (Voluntary Agreement 2014). Rapid evolution in the pay-TV industry and in the options available to consumers for streaming content directly to TVs, computers, tablets and other devices make it difficult to predict the future market for and use of STBs.

One of the best opportunities for reducing STB energy consumption hinges on lowering sleep mode power requirements and incorporating auto power down to ensure that boxes power down to a deep sleep mode when not in use. Many existing boxes as well as new models entering the market consume over 15W in sleep mode (although many boxes are rarely, if ever, turned off or put into sleep mode) (EPA 2014, NRDC 2011). Cable and satellite providers are beginning to introduce models that are more efficient and, based on pending regulations in Europe, there is room for further gains and the potential to bring sleep mode levels to 10W or less (EPA 2014, EU 2013). Newly deployed boxes are beginning to incorporate auto power down to sleep mode after several hours of inactivity; at present, 48 of the 113 boxes on the ENERGY STAR qualified products list include auto power down capability (but only six power down to a lower power deep sleep rather than a light sleep mode) (EPA 2014).

At the household level, the introduction of improved "whole-home" systems can eliminate the need for more than one DVR. One primary DVR server relays programming to thin-client boxes with much lower power requirements cutting household level STB energy use by as much as 70% (NRDC 2011). On average, the best available technologies can cut annual STB energy use by close to 40% relative to the existing stock (see Figure 1). As noted, trends in STB deployment and features make it difficult to predict future STB energy use.

Product standards and labeling approaches. At the present time, there are no federal or state efficiency standards or labeling requirements for pay-TV STBs. In December 2013, DOE, pay-TV service providers (cable, satellite and telco), manufacturers, and efficiency advocates announced a voluntary agreement for STBs. The non-regulatory consensus agreement establishes efficiency levels and procurement requirements for pay-TV companies serving 85% of residential pay-TV customers as well as public disclosure of model-specific STB energy use and annual independent auditing to ensure compliance.[4] Under Tier 1 of the agreement, 90% of new boxes purchased by service providers as of January 1, 2014 will meet ENERGY STAR v.3. Tier 2 takes effect in January 2017 and requires efficiency improvements of 10-45% relative to Tier 1 (depending on box type). New features may offset some of these efficiency gains.

The current ENERGY STAR specification for STBs (Version 3.0) has been in effect since September 2011. The v.3.0 specification set more stringent efficiency levels and added incentives for deep sleep mode and the use of thin clients. EPA recently completed the v.4.1 specification to take effect in December 2014.[5] This version will harmonize the ENERGY STAR test method with the voluntary agreement. Under the STB program, ENERGY STAR sets requirements for manufacturers and service providers and requires that a minimum of 50% of STBs purchased and deployed by participating service providers are ENERGY STAR-qualified.

[4] The text of the voluntary agreement is available at www.ncta.com/energyagreement. Model specific energy use information can be found on the participating service providers' websites (satellite and telco) or on the CableLabs site: www.energy.cablelabs.com.

[5] https://www.energystar.gov/products/specs/sites/products/files/FinalVersion4.1Set-topBoxCoverLetter.pdf

Program strategies. Given the unique distribution model for set-top boxes—service providers work closely with manufacturers to tailor boxes to their needs and offerings and then purchase and deploy the boxes in customer homes—this product has presented a challenge for program administrators and, as a result, program implementation has been very limited. Recent program offerings have included incentives targeted to local service providers for the purchase of more efficient STBs and incentives to customers and service providers for the replacement of non-ENERGY STAR boxes and for upgrades to a whole-home system using thin clients (NEEP 2013). Many of the programs tried to date have been short-term or small-scale pilots.

Ceiling Fans

Energy use by ceiling fans is highly variable by season and region. Approximately 82.6 million U.S. households have ceiling fans—with a third of these homes using four or more fans (EIA 2013). TIAX (Roth et al 2008) estimates average annual operating hours to be 2,300. Electricity use for ceiling fans (not including attached lights) is projected to increase through 2030, as newly constructed homes tend to have more ceiling fans installed, and more new homes are built in warmer areas where ceiling fans are used more intensively (EIA 2007). Performance of a ceiling fan is measured in terms of airflow per unit of energy and is dependent on the electric motor and the blade design among other things. Most residential ceiling fans (and all ENERGY STAR-qualified fans) feature the ability to reverse the motor and airflow direction, allowing year-round operation of the fan.

The existing stock of ceiling fans uses an estimated 152 kWh per year (Desroches and Garbesi 2011). To meet current ENERGY STAR specifications, manufacturers are using improved motors that are approximately 15% more efficient than conventional shaded pole motors. The best available units on the market have moved to DC motors, which, when combined with improved fan blade design and balance and sealed bearings, can reduce motor power requirements by an additional 65-70%. As a result, these fans can perform at 680 cubic feet per minute (cfm) per watt, compared to 122 cfm/W for ENERGY STAR and 70 cfm/W for the existing stock[6] (Desroches and Garbesi 2011; Lowenberger et al 2012). These efficiency improvements translate into annual per unit energy savings of 94 kWh for the best available models (as shown in Figure 1).

[6] This is an average of efficiency requirements at three different fan speeds low, medium, and high.

Product standards and labeling approaches. A federal standard for ceiling fans has been in effect since January 2007, following adoption of state standards in New York and Maryland. The standard requires ceiling fan light kits to ship with the number of compact florescent lightbulbs (CFLs) needed to fill all medium-based sockets in the fixture and require the fan to be controlled separately from the lights; as of 2009, light kits with other lamp base types cannot operate at more than 190W. The standard also requires fans to have more than one speed and a switch to reverse action of the fan blades for appropriate operation in heating and cooling seasons. In March 2013, DOE launched a rulemaking to update the standard by the 2015 deadline; any amended standard should take effect in 2018[7]. The Federal Trade Commission requires energy labeling of ceiling fans including airflow, power consumption, and efficiency at high speed as well as a comparison of airflow efficiencies based on the size of the fan. The label also carries a reminder for consumers to turn off the fan when leaving the room.

The ENERGY STAR specification for ceiling fans establishes minimum airflow efficiency requirements for low, medium, and high speed operation (155, 100, and 75 cfm/W, respectively); the current airflow requirements went into effect in 2009. The specification also requires the use of one or more wall-mounted switches, a remote control, or pull chains that allow users to easily adjust fan speed. As of April 2012, integral and attachable light kits must meet the requirements of the ENERGY STAR luminaire specification. As of 2013, ceiling fans are also eligible for the ENERGY STAR Most Efficient designation; products meeting these criteria operate at more than twice the airflow efficiency required for ENERGY STAR-qualification with low, medium and high speed minimums of 400, 270, and 170 cfm/W.

Program strategies. The most common program strategy for ceiling fans is a customer rebate for the purchase of ENERGY STAR-qualified ceiling fans. Mail-in or instant rebates of $12 to $40 have been offered in as many as 19 states over the past decade. Many of these programs target fans and add-on ceiling fan light kits. Earlier programs were developed primarily to capture lighting savings. The addition of ceiling fans to the ENERGY STAR Most Efficient program may increase program interest, particularly in regions with high fan operating hours.

Medical Imaging Equipment

Large hospitals in the United States account for less than 1% of all commercial buildings but consume 4.3 percent of total delivered energy in the commercial sector. As a group, healthcare facilities are among the most energy-intensive buildings in the nation (EPA 2013; Singer and Tschudi 2009). While the installed base of miscellaneous medical devices tops 30 million (McKenney et al. 2010), energy load profiles for most medical equipment have not been well studied or characterized. Medical imaging equipment including magnetic resonance imaging (MRI), computed tomography (CT) and X-ray equipment represent a key set of MELs in the healthcare market with annual revenues of around $8.5 billion and growing (EPA 2013). There are 170,000 X-ray systems installed in the United States. with estimated annual energy consumption of 0.7 to 4.7 TWh (Zogg et al. 2009; McKenney et al. 2010). The installed base of MRI machines is estimated to have grown more than 40% in just three years, from 7000 units in 2005 to 9400 units in 2008 (Zogg et al. 2009).

All three of the medical imaging equipment types identified have a very high power draw and are often left in standby mode when not in use. TIAX (McKenney et al. 2010) estimates the

[7] The rulemaking docket is available here http://www.regulations.gov/#!docketDetail;D=EERE-2012-BT-STD-0045

standby power draw of an MRI machine at 14kW, with off-mode power draw as high as 7 kW. The energy consumption of MRI and CT equipment has grown considerably as more powerful technology provides better resolution and advanced diagnostics. Opportunities for energy savings in medical imaging equipment could reduce annual energy consumption by 40% (Figure 1). These opportunities include shifting to digital X-ray technology, developing effective power management strategies and educating technicians on the use of power management, particularly in settings where the use of medical imaging services is intermittent. Future research and product development with a focus on energy efficiency are likely to reveal additional opportunities to reduce energy use. Clinics could save over $2000 per year per unit and hospitals could save over $6000 per unit with the purchase of more efficient equipment (EPA 2013).

Product standards and labeling approaches. Currently there are no standards or even voluntary ratings for efficiency in medical imaging equipment. The EPA has indicated an interest in developing an ENERGY STAR specification for medical imaging equipment. COCIR, an industry association in Europe, has led in defining a Self-Regulatory Initiative for medical equipment that presents specifications and methodology for reduced environmental impact from products including ultrasound, MRI, CT, X-ray and nuclear medicine. In the United States, Lawrence Berkeley National Laboratory has developed a tool for benchmarking and quantifying medical equipment energy use with support from the California Energy Commission (Black et al. 2011).

Program strategies. Through the Hospital Energy Alliance, part of the Commercial Building Initiative, DOE is working with the healthcare industry to identify opportunities to save energy in facilities and equipment, including medical imaging equipment. A growing number of utilities are working with hospitals and other healthcare facilities to reduce energy consumption; to date these efforts have focused on facility benchmarking and upgrades to lighting, HVAC, and other building systems. The emergence of energy efficiency ratings for medical equipment can help create a market for more efficient products and provide a mechanism for program administrators to add medical equipment to their program offerings. Upstream programs targeting manufacturers also offer the potential to accelerate introduction of more efficient technologies.

Discussion

Policy and program activity targeting the MELs reviewed reflect both opportunities and challenges for expanded efforts to address growing miscellaneous energy loads. Table 2 summarizes the impact that standards, labeling and programs can have on the MEL categories reviewed. Among the products discussed, it is helpful to group insights for the electronics products together and to address ceiling fans and medical imaging equipment on their own.

Table 2. Impact of various strategies on energy savings from MELs

MEL	Mandatory Standards	Voluntary Labeling	Ratepayer-Funded Programs	Remarks
Computers	Medium	High	High	State-level standards have a better chance at keeping up with the technology than

				national standards.
Televisions	High	High	Medium	
Set-top boxes	Medium	High	Low	The voluntary agreement is an innovative strategy for STBs.
Ceiling fans	High	High	Medium	
Medical imaging	High	Medium	Medium/High	Federal standards can ensure basic minimum energy performance levels.

Key insights include:

- Standards and product labeling programs can play an important role in capturing efficiency improvements and removing the least efficient products from the market, if they can keep up with rapid technical and market evolution. New efforts to identify the very highest efficiency products (e.g., TopTen USA, ENERGY STAR Most Efficient) can increase savings for customers and program administrators and are nimble enough to respond to this evolution in a more timely manner than traditional programs.
- The small per unit savings for TVs and computers, particularly relative to product prices, have led programs to favor midstream incentives over consumer rebates for these products. Small per unit incentives (on the order of $10) can entice retailers to stock more efficient products and maintain overall program cost-effectiveness. However, as the market share for ENERGY STAR qualified TVs and computers grows to represent a large portion of all available products, programs must look to “super-efficient” designations to maintain savings goals or consider shifting incentives to other products where savings may be higher or where more effort is needed to increase retailer stocking of high-efficiency products.
- Rapid product development makes it difficult to keep standards, labels, and specifications relevant; program administrators may find themselves offering incentives for products that have become the norm. For example, EPA reported 2012 market penetration of ENERGY STAR v.5 computers at 50%, including 21% for desktops and 69% for notebooks/laptops (EPA 2013); more recent research by NRDC suggests that more than 90% of currently available desktops and notebooks qualify for v5 and that as many as 50-70% of products will qualify for v6.1 by the time the specification takes effect (P. Delforge, NRDC, pers. comm., March 19, 2014). Similarly, ENERGY STAR v.5 TVs achieved 65% market penetration in 2012, within one year after the effective date.
- Emerging technology, golden carrot, and other types of incentives targeted toward accelerating the development and introduction of high-efficiency products and components hold more promise than further reliance on consumer and retailer incentives for incremental efficiency improvements for some products. As an example, program administrators could pool funds together to provide a large, lump sum incentive to any manufacturer that commits to meeting a leading edge efficiency level in a large majority (80-90%) of its products (P. Delforge, NRDC, pers. comm., March 19, 2014). This concept builds on elements of the original golden carrot program and the set-top box

voluntary agreement to deliver an incentive for super efficiency with assurances that the products will be introduced into the market at large scale.

- As the per unit energy consumption of new products continues to decline, savings come from getting the biggest energy users out of homes and offices – take-back programs and efforts designed to change user behavior (better power management practices, reduced usage, device switching) may have a bigger impact than pushing for small incremental savings by buying the highest-efficiency units.
- Addressing growing MELs will require broad market approaches as well as a much larger number of sector-specific efforts to reduce energy use by specialty or niche equipment. Attention should be given to improvements in components, power management, and strategies that can work in other applications/products. Behavioral opportunities should also be identified and implemented.

References

Black, D.R., J. Lai, S.M. Lanzisera, K.D. Parrish, B.C. Singer. 2011. *Healthcare Energy Efficiency Research and Development.* Berkeley, CA: California Energy Commission.

CEC (California Energy Commission). 2014. "Notice of Pre-Rulemaking Schedule." http://www.energy.ca.gov/appliances/2013rulemaking/documents/pre-reulemaking_schedule.pdf

Desroches, L.B. and K. Garbesi (2011). *Max Tech and Beyond Maximizing Appliance and Equipment Efficiency by Design.* Berkeley, CA: Lawrence Berkeley National Laboratory.

DOE (2013a). "Appliance & Equipment Standards Televisions." Retrieved Jan 21, 2013, from http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/34. Washington, DC: U.S. Department of Energy.

———. 2013b. "Engineering Analysis for Set-top Boxes." Docket EERE-2010-BT-NOA-0067. http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/33

EIA (Energy Information Administration). 2007. *Miscellaneous Electricity Services in the Buildings Sector.* Washington, DC: U.S. Energy Information Administration.

———. 2013a. *Analysis and Representation of Miscellaneous Electric Loads in NEMS.* Washington, DC: U.S. EIA.

———. 2013b. *Annual Energy Outlook 2013.* Washington, DC: U.S. EIA.

EPA (Environmental Protection Agency). 2014. "ENERGY STAR Set-top Box Qualified Products List." Retrieved June 12.

———. 2013. "ENERGY STAR Unit Shipment and Market Penetration Report Calendar Year 2012 Summary."

EU (European Union). 2013. "Commission Regulation (EU) No 801/2013." http://www.eceee.org/ecodesign/products/Lot26_networked_standby_losses/REG_801-2013_Standby_losses.pdf

Kwatra, S., J. Amann and H. Sachs. 2013. *Miscellaneous Energy Loads in Buildings.* Washington, DC: ACEEE.

Lowenberger, A., J. Mauer, A. deLaski, M. DiMascio, J. Amann, S. Nadel. 2012. *The Efficiency Boom: Cashing In on the Savings from Appliance Standards.* Washington, DC: ACEEE and Appliance Standards Awareness Project.

McKenney, K., M. Guernsey, R. Ponoum, J. Rosenfeld. 2010. *Commercial Miscellaneous Electric Loads: Energy Consumption Characterization and Savings Potential in 2008 by Building Type.* Washington, DC: TIAX LLC for US Department of Energy.

NEEP (Northeast Energy Efficiency Partnerships). 2013. *Business & Consumer Electronics: A Strategy for the Northeast.*Lexington, MA: NEEP

NRDC (Natural Resources Defense Council). 2011. *Better Viewing, Lower Energy Bills, and Less Pollution:Improving the Efficiency of Television Set-Top Boxes.* New York: NRDC.

Roth, K., K. McKenney, C. Paetsch, R. Ponoum. 2008. *Residential Miscellaneous Electric Loads: Energy Consumption Characterization and Savings Potential in 2006 and Scenario-based Projections for 2020: Final Report.* Washington, DC: TIAX LLC for U.S. Department of Energy.

Singer B.C., W.F. Tschudi. 2009. *High Performance Healthcare Buildings: A Roadmap to Improved Energy Efficiency.* Berkeley, CA: Lawrence Berkeley National Laboratory.

Urban, B., V. Tiefenbeck, et al. (2011). *Energy Consuption of Consumer Electronics in U.S. Homes in 2010.* Cambridge, MA: Fraunhofer Center for Sustainable Energy Systems.

Voluntary Agreement. 2014. "Voluntary Agreement for Ongoing Improvement to the Energy Efficiency of Set-Top Boxes." January 1. www.ncta.com/energyagreement

Zogg, R., W. Goetzler, et al. (2009). *Energy Savings Potential and RD&D Opportunities for Commercial Building Appliances Final Report*. Navigant. Washington, DC: U.S. DOE, Energy Efficiency and Renewable Energy, Building Technologies Program.