Consumer Electronics Efficiency Programs: The Next Big Challenge

Alex Chase and Ted Pope, Energy Solutions
David Canny, Pacific Gas and Electric Company

ABSTRACT

Consumer electronics are at the forefront of today's energy efficiency challenge. They are now recognized as a prominent and growing energy consuming end-use but the market is fractionated among hundreds of manufacturers and products. How can efficiency advocates spur innovation and cooperation within this dynamic sector while simultaneously reducing its climate and energy resource consequences?

In this paper we assess the significance and relative merits of voluntary and mandatory consumer electronics efficiency initiatives. To that end, our findings are informed by the following: 1) implementing first-of-their-kind utility-sponsored computer monitor incentive programs in Pacific Gas and Electric Company and Southern California Edison territory; 2) interviewing key decision-makers at major consumer electronics retailers and manufacturers; and 3) engagement within the California Energy Commission's Title 20 appliance efficiency standards setting process. The opportunity in California and certain other states is even more pronounced because a combination of voluntary programs and regulations have led to broad savings in home energy use, with the *exception* of consumer electronics.

We identify and discuss four broad categories that contain strategies to reduce energy consumption and emissions from electronics: 1) government policies; 2) utility programs; 3) technical and market research; and 4) industry/stakeholder initiatives. In order to scale up current efforts in a way that achieves meaningful results, successful policymakers and implementers must be acutely aware of all the interrelated components in each category and a concerted effort will be required.

The Challenge of Rising Load Growth

Consumer electronics are at the forefront of today's energy efficiency challenge. While innovation is leading to lower energy use for a given level of service provided by consumer electronics, the level of service, the range of features and functionality, and the market saturation of consumer electronics are rapidly increasing. Consumer electronics are now recognized as a prominent and growing energy consuming end-use. Industry, government, utilities, and researchers are now beginning to respond to this load growth challenge. This product area presents challenges to efficiency advocates both because it is changing rapidly (the products themselves are rapidly evolving and often functionally overlapping with other similar products) and because, in many cases, the potential per-unit savings are small relative to past utility programs, but large in aggregate due to the very high and growing product penetration rates. The first step in addressing this challenge is identifying energy use associated with these products and forecasting to see where that energy use is trending.

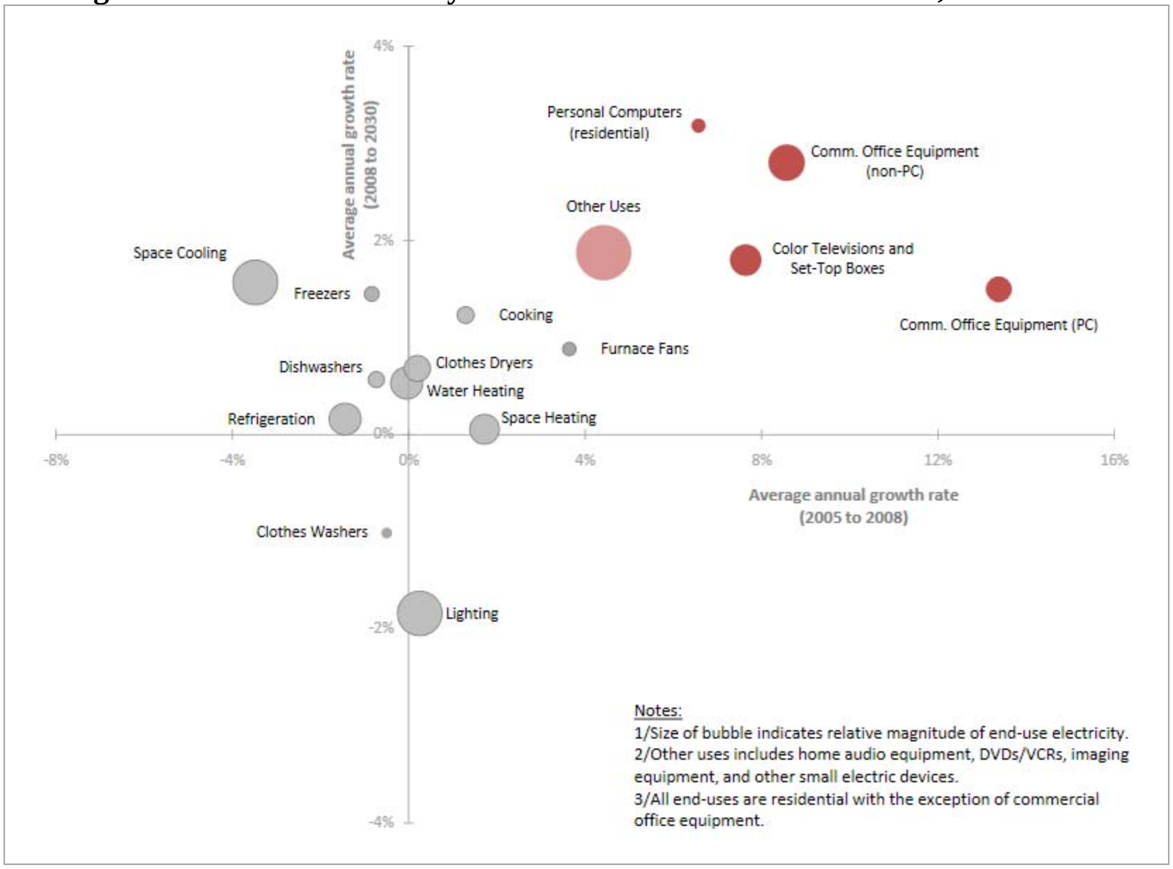
Relying on projections in the *2008 Annual Energy Outlook* (EIA 2008), we analyzed the load growth of electronics in the United States relative to other electrical end uses (Figure 1). The Energy Information Administration (EIA) models electricity consumption for the following categories of electronics: *Color Televisions and Set-Top Boxes, Personal Computers* (residential), *Commercial Office Equipment (PC), Commercial Office Equipment (non-PC)*, and *Other Uses*. The *Other Uses* category (also referred to as "Miscellaneous") includes consumer electronics such as home audio equipment, DVD players, and hand-held rechargeable devices, but also includes numerous other plug-loads such as coffee makers, ceiling fans, and microwave ovens. The projections include the estimated impacts of the "Energy Independence and Security Act of 2007" (EISA 2007) that was enacted in late December, 2007 and include a number efficiency provisions that affect energy projections—most notably for general service incandescent lighting.

The average annual growth rate in energy consumption from 2005 to 2008 for consumer electronics and information technology equipment (hereafter referred simply to as "electronics") was significantly more than all other end-uses (shown by the horizontal x-axis in Figure 1). Commercial PCs had the highest growth rate (13.4%), followed by non-PC commercial office equipment (8.6%), color TVs and STBs (7.6%), residential computers (6.6%) and "other uses" (4.4%). With the exception of furnace fans (4.4%), all other end-uses had average annual growth rates under 2%.

The forecasted growth rate from 2008 to 2030 (shown by the vertical y-axis in Figure 1) follows a similar trend: electricity consumption from electronics is expected to increase at a much faster pace relative to other end-uses. The growth rates level off a bit compared to the previous three years but still increase at a rate of 1.5% per year or more for each electronic category. Residential PC energy consumption is projected to have the highest growth rate (3.2%), followed by non-PC commercial office equipment (2.8%), other uses (1.9%), TVs and STBs (1.8%) and commercial PCs (1.5%). It is notable that electricity consumption from lighting is expected to decrease by 1.8% per year, partially due to the efficiency standards passed in EISA 2007 and the general trend towards more efficient lighting (e.g., consumers replacing incandescent lamps with CFLs).

It is important to note that there is considerable uncertainty embedded in these projections. Multiple factors, such as technological innovations, consumer choices, and macroeconomic conditions, will ultimately shape actual outcomes. However, the significant load growth for electronics in recent years (and projections for the future) is generally consistent with findings in Ecos (2006), Energy Solutions (2006), and TIAX (2007).

Figure 1. End-Use Electricity Growth Rates in the United States, 2005 - 2030

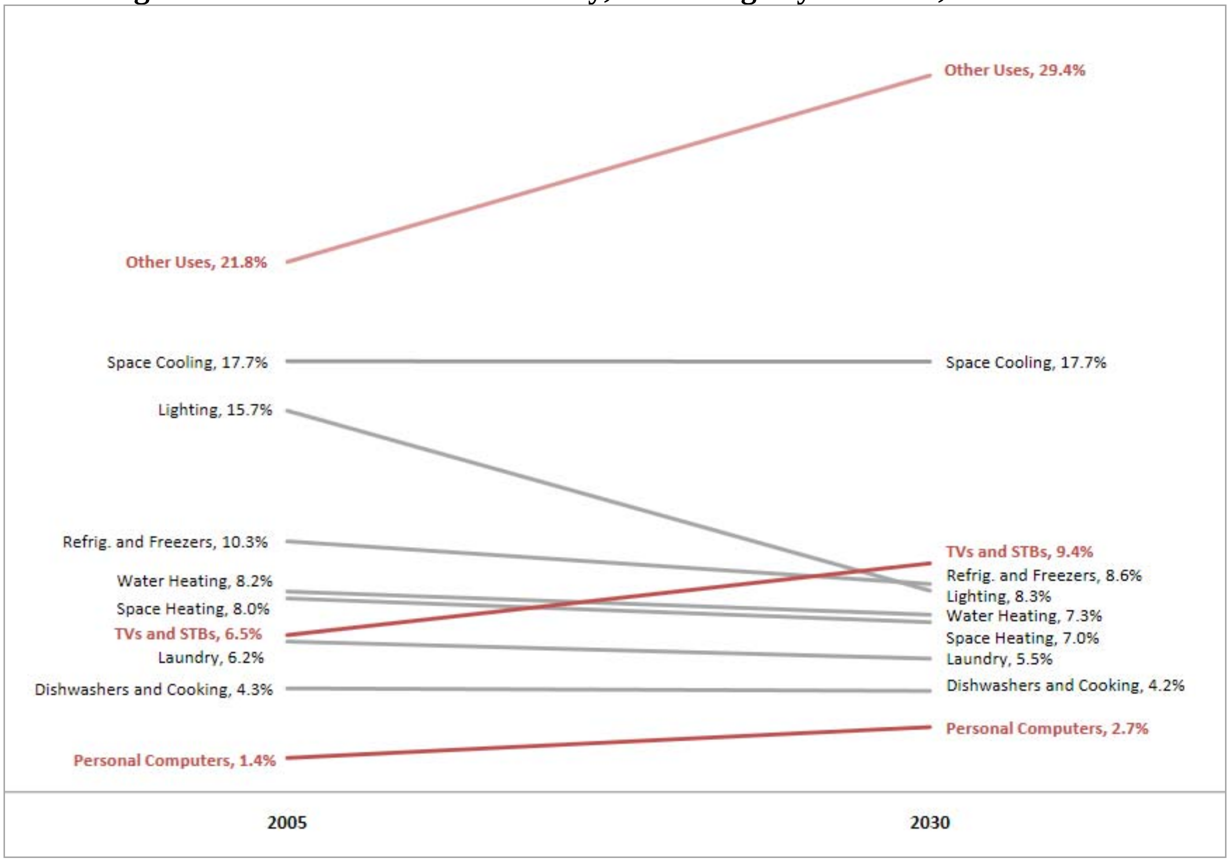


Source: Analysis of "Year-by-Year Reference Case Tables" in EIA 2008. Includes the estimated impact of H.R.6, "Energy Independence and Security Act of 2007" that was enacted in late December, 2007.

Electronics have become a significant portion of overall residential electricity consumption and are on a trajectory to become the dominant electrical end-use (see Figure 2). In the U.S. residential sector, the miscellaneous *Other Uses* category accounts for more electricity than any other major end-use: 21.8% of overall consumption in 2005 and projected to increase to 29.4% in 2030. The *Other Uses* category does include products not commonly referred to as part of the "electronics" category (e.g., coffee makers) but the increase in overall consumption is being driven primarily by the proliferation of consumer electronics and information technology equipment (EIA 2007).

The *Television and Set-top Box* category is expected to increase from 6.5% of overall residential electricity in 2005 to 9.4% in 2030, thus becoming the third-largest end-use behind *Other Uses* and *Space Cooling.* The percentage of electricity from personal computers is projected to increase from 1.4% to 2.7% during the same time period. If one assumes that electronics make up one-half of the *Other Uses* category in 2030 (thus 14.7% of total), the combined total percentage of electricity from all electronic equipment (including TVs, STBs, and PCs) is projected to be nearly 27%, significantly more than all the other major end-uses. It is clear by the slopes of the lines in Figure 2 that no other end-use is increasing as dramatically as electronics.

Figure 2. U.S. Residential Electricity, Percentage by End-Use, 2005 to 2030

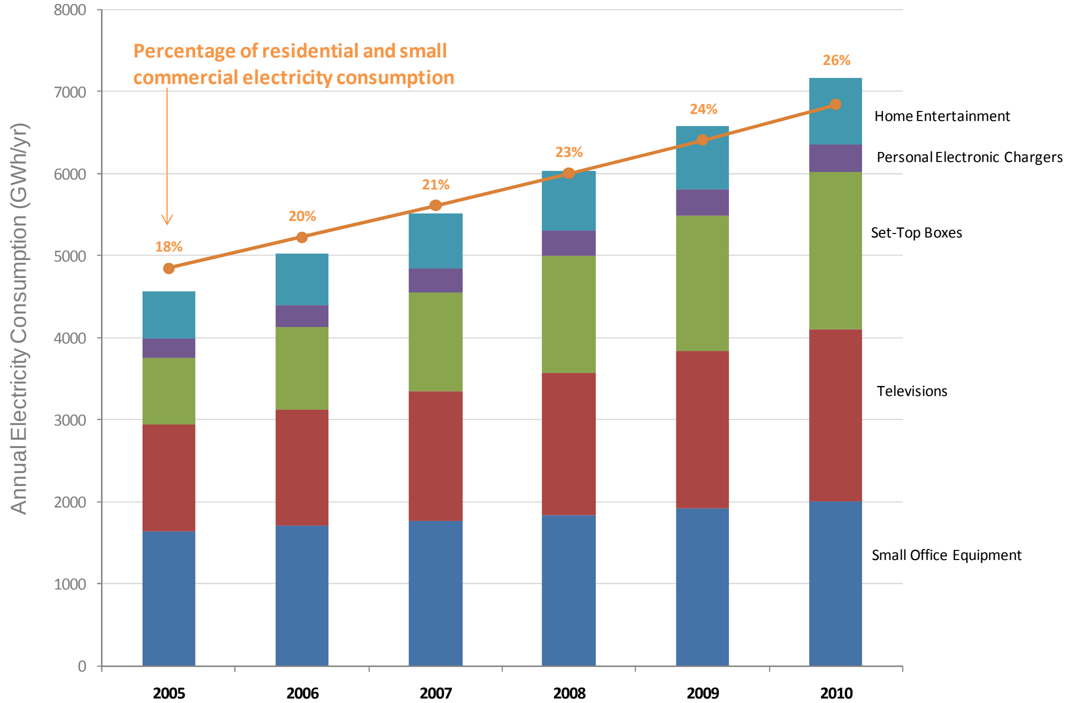


Source: Analysis of "Year-by-Year Reference Case Tables" in EIA 2008. The "Other Uses" category includes home audio equipment, DVDs/VCRs, imaging equipment, and other small electric devices. Total delivered electricity is 4.64 quad BTU in 2005 and 5.88 quad BTU projected in 2030.

Regional variations in weather and energy policy influence the average percentage of per household electricity consumption responsible from electronics. For example, a typical home in Phoenix, Arizona may consume more electricity from space cooling than the U.S. average and thus the consumption from electronics will be a lesser percentage of overall electricity. The opposite is true for many residences in Pacific Gas & Electric territory (located in northern California) where the generally milder climate requires less space cooling. Furthermore, the fact that per capita electricity usage in California has stayed relatively flat for the past thirty years (partially due to appliance standards, building codes, and voluntary efficiency programs) has made the percentage of electronics energy consumption greater than the national average (see Figure 3).

In late 2006, PG&E sponsored a research study that assessed the key market trends and energy characteristics for 33 unique electronic devices being used in their "Mass Market" segment, which primarily includes single and multifamily residential customers and small business that are not included in their major targeted market segments (Energy Solutions 2006). Figure 3 shows a baseline, "business-as-usual" energy consumption scenario from 2005 to 2010 for these electronic devices. The figure is illustrative of the significant load growth being seen in this segment and the possible implications in the absence of any coordinated mitigation strategies.

Figure 3. Consumer Electronics Load Growth in PG&E Territory, Baseline Scenario



Notes: figure shows a hypothetical baseline scenario (no efficiency program intervention) in PG&E territory. Home Entertainment includes DVDs, home theaters, and audio equipment; Personal Electronic Chargers only includes "maintenance" and "no load" modes; STBs includes cable and satellite boxes, DVRs, and IPTV; Small Office Equipment includes PCs, monitors, imaging equipment, and broadband equipment.

Source: Energy Solutions 2006

Greenhouse Gas Projections and Abatement Potential

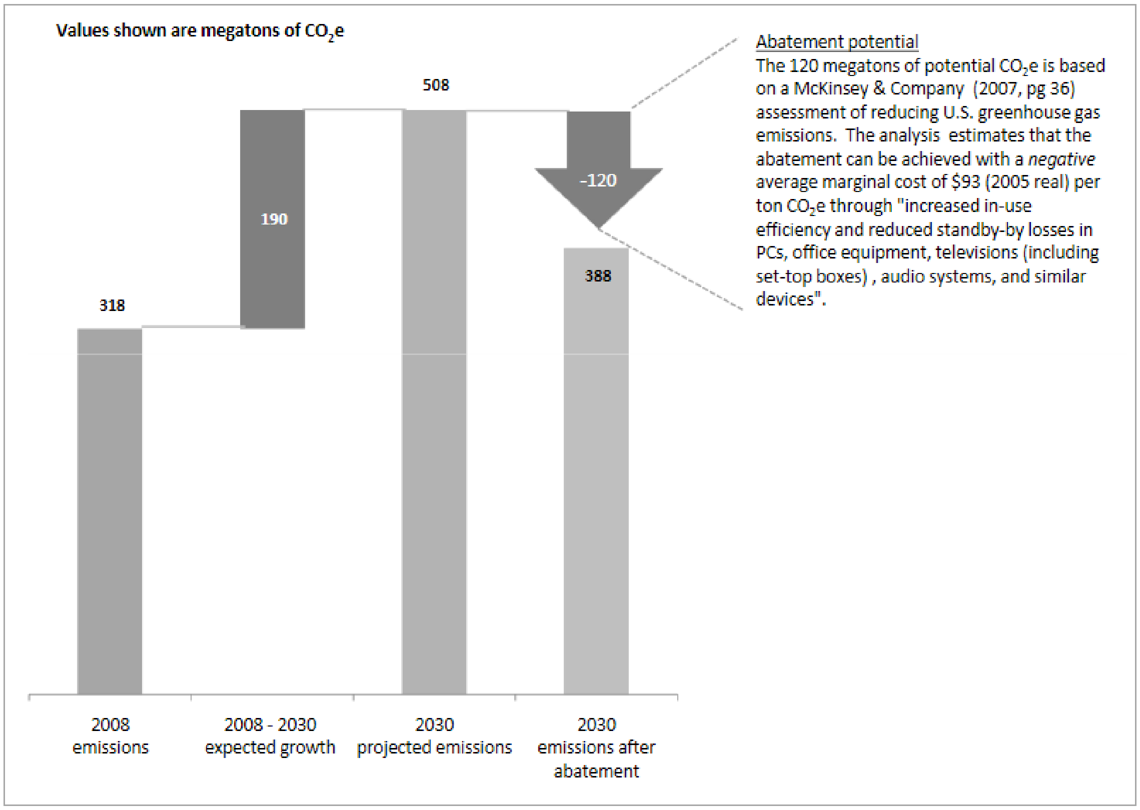
The rising electricity consumption from electronics translates directly to increased greenhouse gas (GHG) emissions and will make achieving regional, national, and international GHG reduction goals more challenging. We estimate that GHG emissions from electronics in the U.S. will be 318 megatons of CO_2e (see Figure 4).[1] By 2030, our reference case—using the *2008 Annual Energy Outlook* projections—increases by 60% (190 megatons CO_2e) to 508 megatons. This is clearly at odds with the GHG reduction goals established by current or pending legislation. In California, the Global Solutions Act of 2006 (AB 32) mandates that the state reduce its GHG emissions to 1990 levels by 2020, requiring approximately a 29% cut in emissions below current projections. In the U.S., a McKinsey & Company analysis (2007) estimates that emissions would need to be roughly 27% below 1990 levels by 2030 to meet the targets of bills that have been introduced in Congress that address climate change. More broadly, many experts, organizations and states (e.g., the Intergovernmental Panel on Climate Change, California, and a number of European countries) have asserted (through reports or policy directives) that global community needs to reduce current worldwide emissions 80% by 2050 to avoid the worst consequences of climate change.

A McKinsey & Company report, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost*, analyzed over 250 opportunities to reduce or prevent GHG emissions and for each

[1] We use CO_2e, or carbon dioxide equivalent, throughout this paper to represent a standardized measure of GHG emissions that accounts for the different global warming potentials of GHGs.

measure estimated (1) the amount of CO_2e that can be reduced annually and (2) the average cost of reducing one ton CO_2e. Of all the options analyzed, commercial and residential electronics had the most favorable economics associated with abatement measures: a *negative* marginal cost of \$93 per ton CO_2e (McKinsey & Company 2007, Exhibit 11). The "negative cost" indicates that there is a net benefit to the economy over the lifecycle of the option, primarily due to avoided electricity costs. The estimated abatement potential in 2030 associated with electronics is 120 megatons CO_2e, as shown and described in Figure 4. Achieving this abatement potential would result in a roughly 24% decrease in emissions relative to the 2030 reference case. This reduction on its own would not completely meet the reduction targets discussed above; but it is also not necessarily a direct comparison since those goals include GHGs from all sectors (e.g., transportation, industry, etc.). Even so, additional abatement—at a presumably less favorable average marginal cost—would be required to return projected 2030 emissions down to current levels and beyond.

Figure 4. Greenhouse Gas Emissions Growth and Abatement Potential for Residential and Commercial Electronics in the U.S.



Notes for Figure 4: Emissions values derived by using "Year-by-Year Reference Case Tables" in EIA 2008 and applying a 0.61 kilogram CO_2e per kWh emissions factor (recommended by the U.S. Energy Information Administration, as reported in McKinsey & Company 2007, pg 74). Analysis assumes that electronics constitute one-half of the "Other Uses" end-use category reported in EIA 2008.

Strategies to Reduce Energy Consumption and Emissions

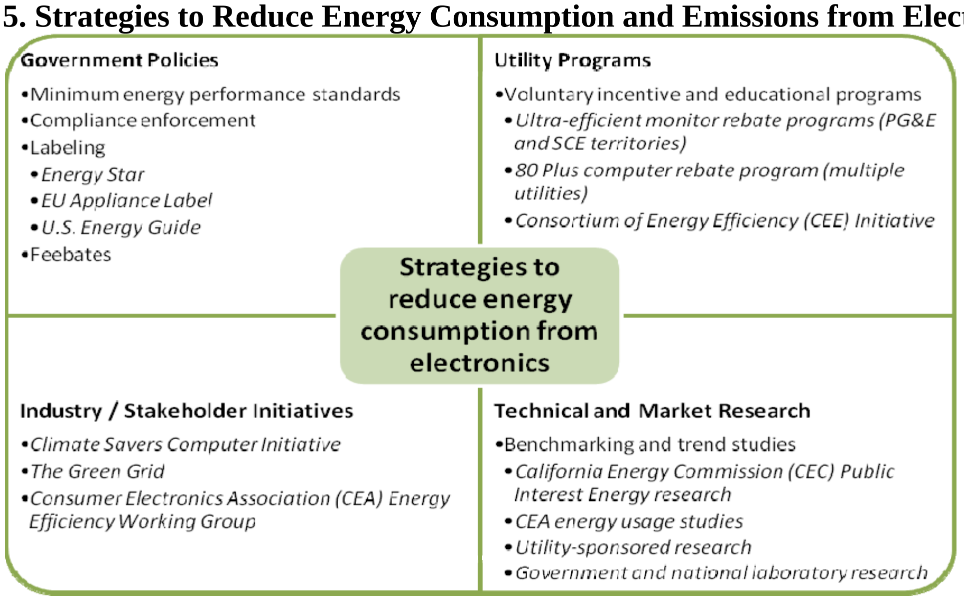
Three key conclusions can be made based on the discussion and figures presented in the previous sections:

1. The electronics category is growing faster than any other major end-use and is on pace to become the dominant electricity consuming end-use per household;
2. The estimated CO_2e abatement potential presented Figure 4 is significant but additional measures will be required to level emissions and then ultimately achieve reductions that are in line with regional, national, and global reduction targets; and
3. Greenhouse gas abatement opportunities can on average be achieved with an negative life-cycle incremental cost resulting in a net benefit for the economy.

The favorable economics are encouraging and should provide motivation for policymakers and stakeholders to increase their level of commitment and action in this segment. However, in order to scale up current efforts in a way that achieves meaningful energy savings, a concerted effort will be required.

We identify four broad categories that contain strategies to reduce energy consumption and emissions from electronics: 1) government policies, 2) utility programs, 3) technical and market research, and 4) industry/stakeholder initiatives (shown as four quadrants in Figure 5). The increased attention on load growth due to electronics over the last few years has spurred activity within each category and we anticipate this trend will continue. The preponderance of these activities influence (and are influenced by) other activities in the same or different quadrants. Thus, successful policymakers and implementers must be acutely aware of all the interrelated components. We provide a survey of each category in the following sections.

Figure 5. Strategies to Reduce Energy Consumption and Emissions from Electronics

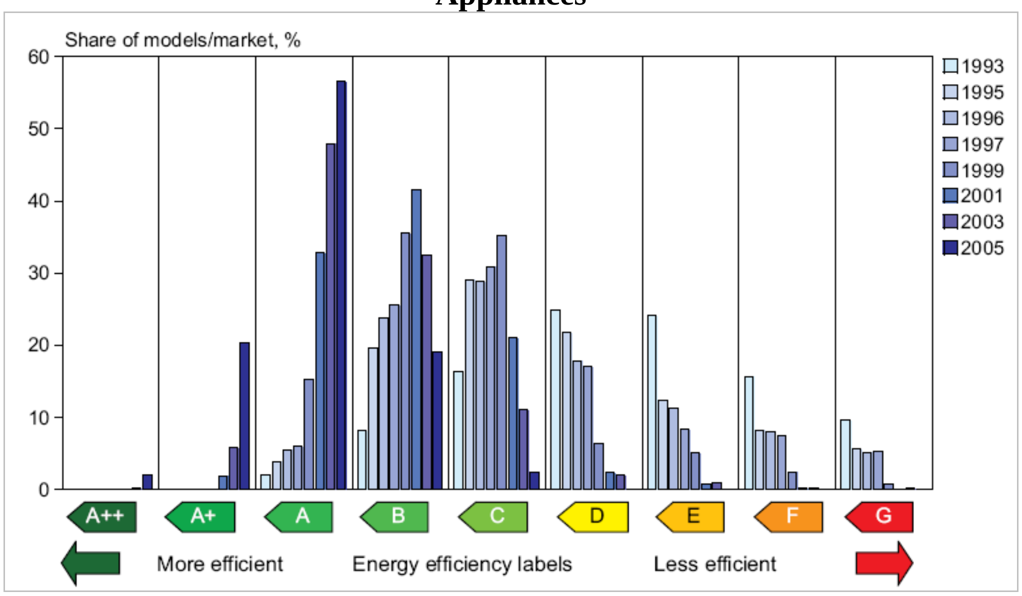


Note: selected examples are shown in *italics* above but are not meant to be exhaustive of current efforts.

Government Policies

Government policies related to electronics energy use have primarily focused on product labeling and minimum energy performance standards. Energy labeling in the U.S. is further distinguished by mandatory product labeling (e.g., Energy Guide) and voluntary certification (e.g., Energy Star). The "Energy Independence and Security Act of 2007" recently mandated that the Federal Trade Commission establish labels for televisions, computers, monitors, set-top boxes, and digital television adaptors within 18 months of enactment (by May 2009) . Energy Guide labels have been used for years on white goods (e.g., refrigerators, washers and dryers), but this will be the first time that electronics will carry a mandatory label that gives customers an estimate of energy performance. At the time of writing this paper, the FTC has not provided a clear indication of the label's format nor has it provided details on the stakeholder process to inform the final label design. Efficiency advocates should follow and stay engaged in this process to ensure that effective labels are adopted and that they hold the potential to shift the market towards more efficient products. The market impacts of a European Union appliance labeling program for cold appliances serves as a motivating example (Figure 6). The EU established nine classes of energy efficiency—"A++" being the most efficient and "G" being the least efficient—and the figure shows the percentage of more efficient models trending upward from 1993 to 2005.[2]

Figure 6. Impacts of the European Union Appliance Labeling Program for Cold Appliances



Source: IPCC 2007, Figure 6.5, 425.

The general framework utilized in the European Union labels (having multiple efficiency levels) could be applied for a mandatory or voluntary labeling program and could also be used as a basis to for utilities to establish incentive levels for their programs. In the U.S., Energy Star

[2] There are certainly other factors that could have influenced this market shift (e.g., technological innovation that would have occurred absent the labels) but that type of detailed discussion is outside the scope of this paper. See Section 6.8.2.1 (p. 424) of IPCC 2007 for additional background on the EU labeling program for cold appliances.

has been the leading organization to establish voluntary labels. In the electronics area, Energy Star has largely addressed the low-power operating modes (e.g., off, sleep, standby) and they are now increasingly addressing active mode power consumption. The Energy Star specification for computer monitors has covered active mode since 2005; the latest computer specification (version 4.0, effective July 2007) addresses "Idle" mode[3]; and the upcoming television specification (version 3.0, effective November 2008) will include an active mode requirement. This is an encouraging and important step towards addressing total unit electricity for electronics since, for many electronics, active mode energy consumption eclipses energy consumed in lower power operating modes.

In addition to product labeling, establishing minimum energy performance standards (MEPS) is the other major, broadly targeted government policy that is addressing electronics energy consumption. Similar to Energy Star specifications, most countries or states with MEPS have only addressed standby mode levels, but it is likely that active mode MEPS will become increasingly prevalent over the next several years. In California, the California Energy Commission (CEC) adopted maximum standby power levels for televisions, DVDs, and consumer audio products that became effective in 2006. It also established standards effective in 2007 for external power supplies used with laptop computers, mobile phones, printers, scanners, personal digital assistants (PDAs), digital cameras, and other consumer electronics applications. The CEC has opened a new appliance efficiency standards rulemaking in 2008 and is considering establishing active mode standards for televisions and battery chargers. Additional electronics, such as computer monitors, set-top boxes, and game consoles, may be considered in 2009 or beyond. Standards-setting organizations in at least Europe, Australia, and China are making similar deliberations. Careful consideration must be taken when establishing MEPS for electronics to ensure the most effective outcome. Policy makers must take into account all other concurrent international activities (mandatory and voluntary) that could influence the desired outcomes of setting an efficiency standard for their geographical area.[4]

Utility Programs

Due to the load growth challenges described in the beginning of the paper, electric utilities are increasingly considering adding electronics to their energy efficiency program portfolios. The authors of this paper have been involved in designing, marketing and implementing efficiency programs that promote ultra-efficient computer monitors in Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) territories. In both programs, the utilities provide incentives ($10 per monitor in PG&E territory and $5 in SCE territory) to retailers that sell ultra-efficient computer monitors—defined as monitors that surpass the Energy Star active mode specifications by 25% or more. A key reason for offering the rebates to retailers (i.e., a "midstream" rebate) is because the retailers have direct connections to "downstream" end-use customers and "upstream" manufactures. Retailers can influence customer purchases by stocking more ultra-efficient monitors and by identifying those monitors to customers through in-store signage and other marketing collateral. The retailers can also send signals "upstream" to supply chain vendors and manufactures by purchasing a larger percentage

[3] Energy Star defines Idle as the state in which the operating system and basic other software have completed loading, the machine is not asleep, and activity is limited to those basic applications that the system starts by default.
[4] See Pope et al (2008) for a further discussion of the changing landscape for conceptualizing, developing and ultimately adopting appliance standards.

of qualified monitors. The goal is that these signals influence the manufactures to offer more qualified monitors at lower price points, thus spurring a market transformation.

In practice, the programs have achieved success with one major consumer electronics retailer but have also encountered barriers to recruiting other retailers. The most evident success is that the major participating retailer has increased the number of qualifying monitors models that it offers in response to program participation. Prior to the programs, it was estimated that each of their stores in PG&E and SCE territories had between 4 and 6 ultra-efficient monitors available to purchase. The most recent analysis indicates that these stores now offer anywhere between 10 and 17 qualifying monitors—thus achieving a key program goal of influencing stocking practices.

There is still much more potential for success with other major consumer electronics retailers. Each retailer has different operating structures and business interests and therefore has unique barriers to participation. Based on numerous retailer interactions, we found the that the most common barriers included: 1) the programs were not sufficiently large enough (both in terms of rebate amounts and geographic territory) to make it worthwhile to dedicate internal resources towards program implementation; 2) the tracking and reporting program requirements are perceived as burdensome for the retailers; and 3) retailers are adverse to having inconsistent product promotions in different stores.

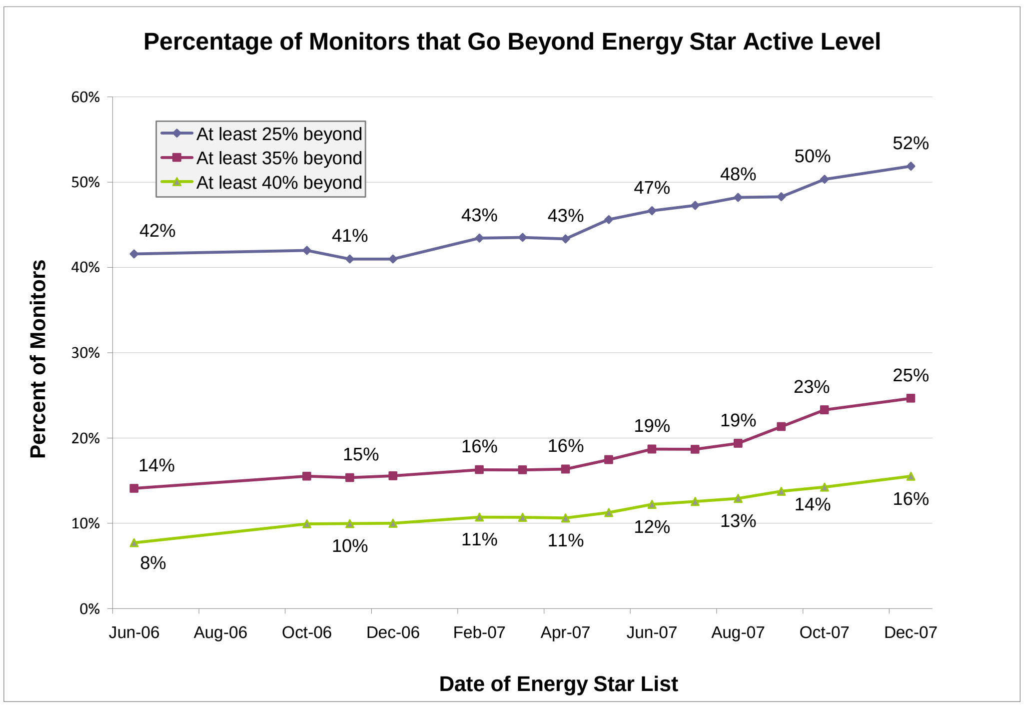
Fortunately, most of these challenges appear soluble. California IOUs are well underway in laying the groundwork for an integrated statewide program in 2009 and beyond. Preliminary conversations with retailers suggest that the consumer electronics program can be made sufficiently attractive to key retailers if multiple products, such as TVs, computers, monitors, imaging equipment, are included within a single program to improve economies of scale and larger total incentive payments. The collaborative statewide approach being contemplated responds to several retailers' requirement that programs involve large regions to make it worth their trouble. Even a statewide program may not be sufficiently large for some retailers, especially if burdens of participation cannot be minimized.

The tension between the utility's usual requirements for tracking program participation and the challenge such tracking requirements create for retailers may be addressed from two directions. First, utilities will need to work with their utility commissions to develop new more flexible EM&V protocols for these more complex market situations where the cost or even feasibility of obtaining complete end-consumer participant data is a barrier. Second, program design teams must work closely with the retailers to understand their unique internal tracking systems in order to structure program designs and tracking requirements (within the context of the accepted EM&V protocols) that minimize barriers for the major retailers.

Another challenge associated with consumer electronics programs, compared to a typical white goods rebate program, is the pace of change of the efficiency performance of both the top performing quartile and the base case. Consumer electronics efficiency characteristics can change substantially in a two- to three-year utility program cycle. Figure 7 below illustrates this point. The curves show the rapid increase in proportion of all Energy Star monitors that exceed the minimum Energy Star specification, even in the absence of utility programs for monitors. Utilities will need to frequently or continuously track the market to make sure qualifying levels are at an optimum level and to document the relative savings relative to shifting baseline performance. Identifying and documenting representative "baseline" performance on a periodic or ongoing basis is critical for utilities so that incentive amounts and performance levels can be modulated during the program period to ensure such programs don't become victims of their own success during ex post evaluations. In this market, backward looking assessments will struggle to accurately distinguish between free riders, free drivers, and participants. For example, experience working with the retailers in California suggests that changes made in procurement decisions for California stores may influence the retailer's national procurement decisions, which is great news for efficiency advocates but complicates determining attribution to the utility program.

Utility program designers and managers must understand all activities in the other "quadrants" of figure 5 to maximize their chances of success. Ideally, they should strive for alignment with government policies (Energy Star levels and potential standards levels). Increasingly, there is a need to be aware of industry/stakeholder initiatives outside of utility program and government efforts. For example, what will Wal-Mart's initiative to increase the efficiency of the TVs they sell by 30% by 2010 do to claimed savings levels for utility programs?

Figure 7. Percentage of Monitors on the Energy Star List that Go Beyond Specification Level, June 2006 to December 2007



Source: PG&E 2008

Industry and Stakeholder Initiatives

As public awareness of climate change and the need to exploit energy efficiency opportunities increases rapidly, industry is repositioning to address both consumer demand for "green" product attributes and, increasingly, corporate environmental stewardship and risk management obligations. In recent years and months, a spate of efficiency and green initiatives relating to consumer electronics has been announced by industry leaders both on the manufacturing and retail sides. Wal-Mart has very recently announced very aggressive goals for increasing the efficiency of consumer electronics products, including the aforementioned 30%

improvement for TVs sold by 2010.[5] Dell, HP, and Intel all have announced initiatives to "out-green" their competitors. Climate Savers Computer Initiative[6] is another industry driven effort to establish its own specification levels. These initiatives are a positive development because they focus both customer demand and manufacturer interest on greater efficiency. It is important, however, for actors in the three other quadrants to closely follow (and be involved in) and understand the implications of these initiatives on their labeling, standards, and utility programs efforts.

Technical and Market Research

The final quadrant, technical and market research should not be overlooked as a key factor in promoting more efficient consumer electronics. Effective utility program design and government policy require accurate and timely market data. As noted in previous sections, the efficiency of consumer electronics changes rapidly compared to most other appliances and equipment. Additionally, the shifts in market saturation, feature loading, and functionality change even more dramatically. Such rapid market developments challenge the customary pace of market characterization and product saturation studies relied on by utility program planners. Even the ongoing maintenance of adequate test methods poses a challenge to the industry. Greater emphasis must be paid to identifying and tracking changes over shorter intervals of time, so that reasonably accurate assessments of products performance and impacts are available to inform decision making and planning in the other three quadrants. As never before, attempts must be made not only to understand where the market is and has been over the last several years, but to forecast ahead a year to two where the market is likely to be in order for program design and policy initiatives to be relevant by the time they are fully deployed.

Conclusions

It is abundantly clear that consumer electronics are a significant load growth and carbon challenge to utilities and society. The good news is that there is much that can be done to mitigate the consumer electronics load growth without curtailing the important consumer utilities these products deliver. A number of factors associated with consumer electronics require that they be handled with new, more nuanced strategies compared to other appliance and equipment segments. Greater attention to the interconnections between government policy, utility programs, industry efforts and technical and market research will be required to ensure rapid success with efforts in any one of the four quadrants of activity. There is a clear need to improve networks and conduits for information sharing among stakeholders—both among quadrants and among states and countries. These considerations suggest the need for an international organization or collaboration to act as a clearinghouse for all issues related to electronics and energy.

[5] At the time of this writing, Wal-Mart has not given specifics on how they will measure or implement this goal.
[6] www.climatesaverscomputing.org

References

[Ecos] Ecos Consulting. 2006. *Final Field Research Report*. Prepared for the California Energy Commission under PIER contract #500-04-030. Prepared by Suzanne Foster Porter, Laura Moorfield, and Peter May-Osterndorp. October 31.

[EIA] Energy Information Administration. 2008. *Annual Energy Outlook 2008* (Revised Early Release). Report #:DOE/EIA-0383 (2008). Released Date: March 2008 (Revised).

____ Energy Information Administration. 2007. *Annual Energy Outlook 2007*

Energy Solutions. 2006. *Consumer Electronics: Market Trends, Energy Consumption, and Program Recommendations 2005-2010*. Prepared for Pacific Gas and Electric, Application Assessment Report #0513. Prepared by Energy Solutions (Alex Chase, Ryan Ramos, and Ted Pope). December.

[IPCC] Intergovernmental Panel on Climate Change. 2007. *2007: Residential and commercial buildings. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Levine, M., D. Ürge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, G. Levermore, A. Mongameli Mehlwana, S. Mirasgedis, A. Novikova, J. Rilling, H. Yoshino, [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

McKinsey & Company. 2007. *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* December.

[PG&E] Pacific Gas and Electric Company. 2008. *Proposal Information Template for: Computer Monitors and Video Displays*. Submitted to the California Energy Commission in consideration for the 2008 Rulemaking Proceeding on Appliance Efficiency Regulations, Docket number 07-AAER-3. Prepared by Energy Solutions (Alex Chase). January.

Pope, T., A. Chase, P. Eilert, and G. Fernstrom. 2008. “The New Landscape for Appliance Efficiency Standards.” Paper to be published in *Proceedings of the ACEEE 2008 Summer Study on Energy Efficiency in Buildings*. Washington, D.C.: American Council for an Energy-Efficient Economy.

[TIAX] TIAX LLC. 2007. *Energy Consumption by Consumer Electronics in U.S. Residences*. Prepared for the Consumer Electronics Association. Prepared by Kurt W. Roth and Kurtis McKenney. January.